Poverty & Environment Indicators

Prepared for UNDP-UNEP Poverty and Environment Initiative

March 2008 • St Edmund's College, Cambridge

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Prepared by **Flavio Comim**

Research Team **Pushpam Kumar, Nicolas Sirven, Ely Mattos, Monica Concha, Esmeralda Correa, Carla da Silva, Philipe Berman**


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Acknowledgments

This report has been prepared under the leadership of the UNDP-UNEP Poverty & Environment Initiative (PEI). We are grateful to the team leader David Smith and to his team for their valuable assistance and guidance. In particular, we would like to express our gratitude to Jonathan Duwyn, who saw this project to the end, and to Thierry Oliveira, Esther Reilink, Kamilla Henningsen, Mamadou Kane and Louise Sorensen who were all essential to its realisation.

This report focuses mostly on conceptual and methodological issues based on empirical work done in partnership with Country Officers who assisted and guided us in the collection of country data from the PEI participating countries. We would like to thank Teresa Pinto (MICOA) and Sonia Santos (MPD), the focal points for Mozambique, together with Xavier Chavana (MPD); Alex Mulisa (REMA), Maximillien Usenguremyi (MINECOFIN) and Cyril Turatsinze (REMA), focal points for Rwanda, together with Rose Mukakomeje (REMA); Blandina Cheche (VPO), and Arnold Mapinduzi (NEMC), the focal points for Tanzania; Ronal Kaggwa (NEMA) and George Sserunjogi (Ministry of Finance), the focal points for Uganda; Joseph Mukui (MENR), Samson Wasao (PEI Project Manager) from the Kenyan PEI team; Moussa Barry (Ministry of Environment) focal point for Mali; and Abdelkader Ould Saleck (Prime Minister's Office - Environment) focal point for Mauritania.

We are most grateful to Angels Varea and Kate Crofts, from the Von Hugel Institute, St Edmund's College, for their work on project management and financial administration respectively. Our thanks also go to Mauro Lima from Comdesenho for his design and layout work.

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Executive Summary

This report has been prepared for UNDP-UNEP under the Poverty & Environment Initiative. It is targeted to policy-makers working with poverty and environment issues in Africa. The report aims to explain technical aspects in using and developing Poverty & Environment indicators, providing a tool-box that will enable readers to use indicators to mainstream environment into poverty reduction strategies.

An effort has been made to use language not overly academic and to include examples based on the reality of countries. However, some unavoidable technical language remains and for this reason it is important to see the report as part of a capacity-building strategy in which complementary training might be needed for those not conversant with some methodological and statistical aspects.

The major messages of this report are:

- Poverty reduction strategies cannot be successfully achieved without taking into account the environment
- Human Development can be promoted with moderate increases in countries' ecological footprint
- General Human Well-Being and general Environment indicators are not particularly focused on the links between poverty and environment
- The existing P&E indicators can only partially solve the problems of 'integration' between their different dimensions and 'reference' about the choice of variables that involve evaluative considerations
- The measurement of P&E links involves the steps of i) conceptualisation of phenomena, ii) identification of data, iii) development of indicators and iv) elaboration of an index or composite indicators
- Indicators should be arranged hierarchically to tell a coherent story

This report recommends the use of 'adjustment factors' and 'regression analysis' to develop P&E indicators. The application of the new methodology proposed herein enables the development of indicators that are:

- Relational: they have at least two dimensions, one for poverty and one for the environment
- Objective: they represent factual and concrete processes, avoiding subjective views
- Multidimensional

The rationale for using 'adjustment factors' is straightforward: we integrate poverty & environment dimensions by adjusting (up or down) poverty levels according to the nature and extent of environmental problems. Three data elements are needed to use this method: the indicator on environmental degradation, the degree of qualified association between environment and poverty (from the regression analysis) and the multidimensional indicators on poverty.


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Introduction


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Poverty reduction cannot be achieved without taking into account the environment. Degraded ecosystems increase hunger, exacerbating risks, diseases and taking children out of school. Efforts to reduce human poverty cannot ignore the role that changes in ecosystems play in shaping human lives. Indeed, the importance of addressing the links between poverty and environment has been widely acknowledged by governments, preparing their Poverty Reduction Strategy Papers (PRSPs), and by international organisations, but full implementation of poverty and environmental strategies remains elusive.

The challenge lying ahead consists in effectively developing concrete mechanisms for monitoring poverty from an environmental perspective. One possible solution for this challenge is the elaboration of Poverty & Environment Indicators that could be used in the formulation of Poverty Reduction Strategies (PRS).

Poverty

Before elaborating indicators one needs to know what the object of investigation is about. In fact, the identification of poverty & environment links is not a trivial matter. The concept of poverty has many definitions. Poverty can be absolute when it refers to lack of food and water or can be relative when it addresses the problems of social exclusion. Poverty can be transitory when people are deprived due to temporary conditions, such as a drought causing crop losses, but can be chronic when hunger is a permanent state (even across generations).

Poverty can be related to an extreme deprivation of well-being and can be assessed as deprivation of resources, self-esteem, basic rights or capabilities. Without entering into controversies about what is the best way of assessing poverty, it is possible to acknowledge that all poverty concepts (and their respective measures) have something in common: poverty is about a minimum condition below which no human being should live. It is about a threshold that defines a basic condition for humanity.

Environment

Similar controversies exist about the concept of environment, given that it covers a wide range of ecological aspects. To simplify matters, this work builds upon the Millennium Ecosystem Assessment (MA) perspective according to which the environment is best seen as made of different ecosystems and their services.

Ecosystems are interacting complex of sets of plants, animals and microorganism communities together with the nonliving environment. The main feature of ecosystems is that both populations and environments interact as a functional unit. It is possible to define an ecosystem at various scales (from small to large). It should then be stressed that ecosystems without their activity, organisation, autonomy and resilience over time, cannot develop their functions. As a consequence, they cannot offer services that benefit people.

It is important to note that both issues, namely, poverty and environment, are about benchmarks and thresholds. In the first case, what is considered acceptable or not for a human being to be or to do is a question that depends on the values and ethical norms of particular societies. In the second case, the ecosystems and their services are defined by what is a functional unit at any scale, defined according to different thresholds of sustainability and interactions among the parts of a system. Different ecosystems, such as forests, marine, coastal, drylands or mountain systems, provide and regulate different services. Their impacts on human well-being can differ and can be manifested distinctly in a variety of contexts. It is reasonable to expect that the task of mapping poverty & environment links proves daunting and that often policy-makers and researchers refer to these links as ‘complex’. However, understanding these links and decomposing this complexity is a necessary condition for using and building poverty & environment indicators, as discussed below.

Box 1

Acknowledging the importance of the environment for poverty reduction

The degradation of ecosystem services is an important hurdle preventing developing countries from reducing poverty. As mentioned in the Millennium Ecosystem Assessment[1], “The degradation of ecosystem services is harming many of the world’s poorest people and is sometimes the principal factor causing poverty”. Giving that most of the world’s poorest people still live in rural areas, they are naturally dependent on the ecosystems for producing their food, rearing their livestock or simply hunting. Their survival is affected by mismanaged ecosystems, trapping them in cycles of poverty.

The problems, as noted by DFID, the European Commission, UNDP and the World Bank[2], “are well-known –degrading agricultural lands, shrinking forests, diminishing supplies of clean water, dwindling fisheries, and the threat of growing social and ecological vulnerability from climate change and loss of biological diversity.” If ecosystems and their services continue to be degraded no sustainable path of poverty reduction can be achieved.

How Essential is the Environment for Poverty Reduction?

It is important to confront the widespread feeling, still common in some countries, of scepticism towards the essential function of the environment in promoting human well-being and reducing poverty, against some general empirical evidence about the association between environmental aspects and poverty features. We can start with some obvious facts displayed in simple correlations about environment and poverty dimensions. In this exercise, we highlight the position of the countries that are part of the P&E Initiative, namely, Mozambique, Rwanda, Mali, Mauritania, Tanzania, Kenya and Uganda.

A brief look at diagram 1 below reveals the existence of an inverse relation between the population with access to improved water and the incidence of undernourishment for most countries in the world. For instance, we can see how the very low levels of 'population with access to improved water' in Mozambique, Mali and Tanzania are correlated with very high levels of undernourishment. Without entering into the question of what causes what, the message suggested by the evidence is straightforward: water access goes together with a good nutrition. This is particularly relevant for countries developing their PRSPs that should consider water management as part of their poverty reduction strategies.


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Box 2

Working definitions of poverty and environment

Poverty – poverty is an unacceptable deprivation of multidimensional well-being. Individuals are poor in many different dimensions. They can be poor because, for instance, they don't have what to eat, or poor because they only have dirty water to drink, or poor because they are illiterate, etc.

Environment – environment is defined by different ecosystems and their services. Ecosystems can vary in temporal, spatial and administrative scales and can vary across scales.

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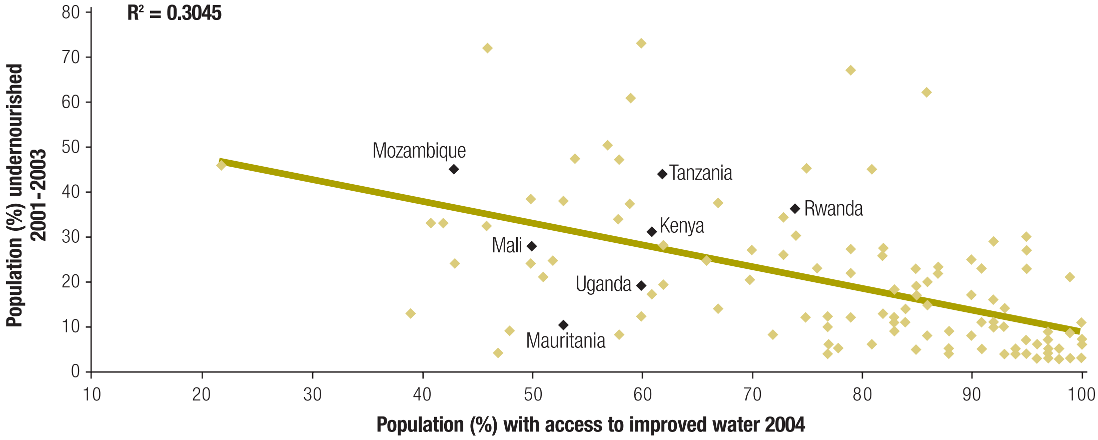
Diagram 1

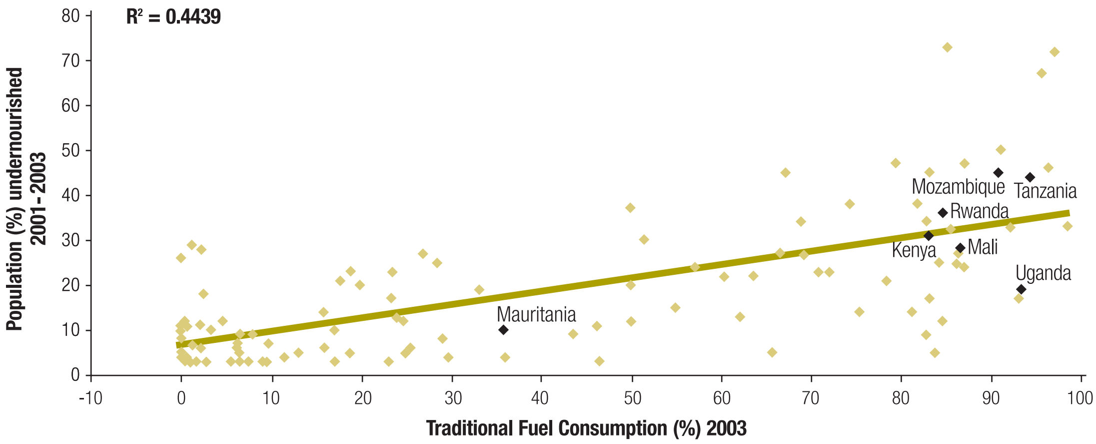
Water and Nourishment[3]

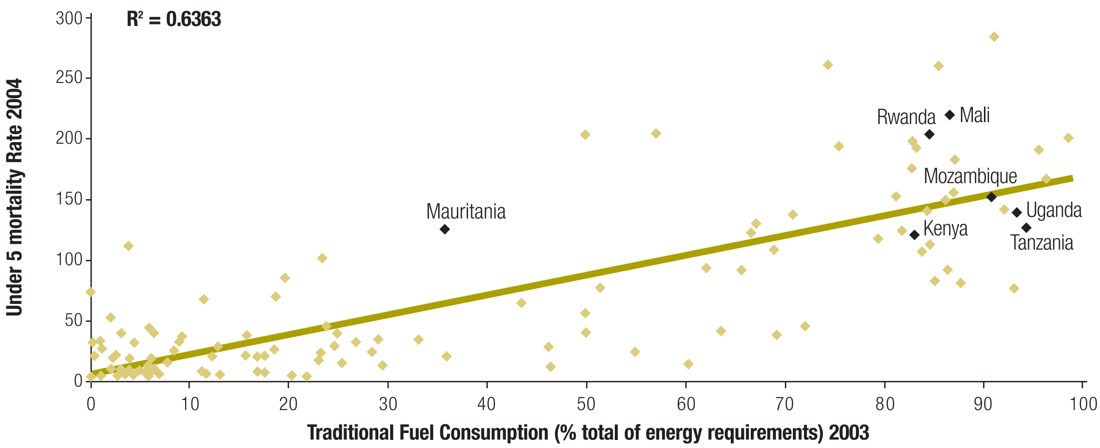


Another good illustration is provided by the links between traditional fuel consumption, undernourishment and under-five mortality rate (see diagram 2 below). The environmental conditions that limit access to energy and food also influence the elements for increasing preventable mortality among children. The diagrams below exemplify this link. We can see that countries with a very high percentage of use of traditional fuel consumption, for instance, Uganda, Tanzania, Mozambique and Mali, are also those with very high levels of undernourishment and under-5 mortality rate. Acknowledging these preliminary associations is important for thinking about poverty and environment links and the elaboration of indicators. Thus, the provision of more environmentally-friendly sources of energy is also a step towards poverty reduction.

Diagram 2

Traditional fuel consumption, nourishment and under-five mortality rate[4]





Human Development and Ecological Footprint

On more general lines, we can compare the Human Development Index with the Ecological Footprint measure[5] (a measure of demand for ecosystem services) to show how there are wide areas of coverage in which human development can be achieved without increasing the ecological footprint. From bottom scores of low-human development to high scores of high-human development, it is possible to develop without actively degrading the environment, as illustrated by the golden arrow in diagram 3.

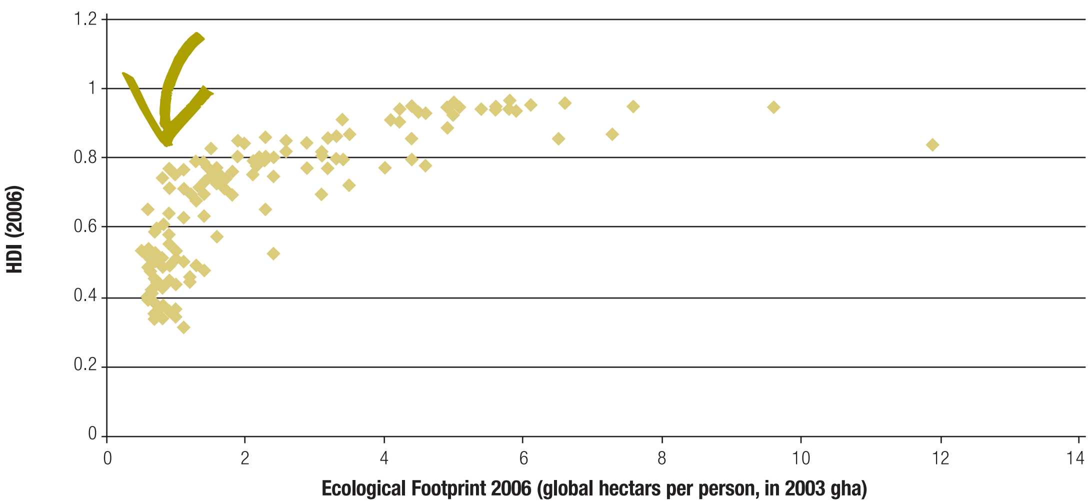
In addition, calculations based on econometric specifications[7] reveal that the impact of biocapacity[8] levels (a measure of bioproductive area or supply) on human poverty, as measured by UNDP's Human Poverty Index-1 is highly statistically significant. What does it mean? We use this measure of biocapacity as a well-known measure that summarises the description of the environment in terms of its productive capacity. Then, we have calculated the elasticity between biocapacity and human poverty to assess this impact. (an elasticity is precisely a measure of sensitiveness of the impact of one variable on another[9]).

Formally, we can ask how much poverty changes when biocapacity changes. The results show that biocapacity and poverty are negatively related, that is, that when biocapacity decreases, poverty increases. In other words, when the environment is degraded, poverty increases. More specifically, when biocapacity decreases in 1%, the human poverty index increases by 0.26%.Other variables can be used to calculate poverty & environment elasticities for particular countries.

The Structure of the Report

With this objective in mind, this report is divided into four parts. The first part introduces some well-known general indicators that relate human well-being dimensions to environmental conditions. Although not central to this report, an investigation of a sample of general indicators raises important practical issues in defining poverty & environment indicators. The second part explores what recent studies have said about poverty & environment links, with the purpose of learning about the existence of concrete associations that might inform policy-makers about similar situations that might be going on in their own countries. The third part presents basic definitions used to handle poverty & environment indicators, including criteria for choosing indicators and the use of scale scores to help making a decision. Finally, the report describes a new methodology for elaborating poverty & environment indicators that solves some technical limitations of previous methodologies. These limitations will be addressed at the end of the first and second parts.

Diagram 3
Human development and ecological footprint[6]



$$\frac{\Delta\%HPI_1}{\Delta\%BC} = 0.26 \Rightarrow$$ when environment degrades in 1% poverty increases in 0.26%

Reviewing Studies on Human Well-Being & Environment Indicators

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A sensible first step for those interested in using poverty & environment indicators is to assess what is currently available. Studies addressing the interactions between human well-being dimensions and environmental aspects can be classified (for a better understanding) into two groups: i) general human well-being and environment indicators (HWB&E) and ii) specific poverty & environment indicators (P&E).

Many other[10] classificatory schemes could be used to categorise existing indicators, but here we will adopt a simple approach aiming to clarify interactions between poverty & environment links. Analysing these two sets of contributions –even briefly- is an important step towards identifying what further needs to be done. By appreciating the valuable elements that are put forward by these studies we can understand their limitations and build on a more solid basis.

Although too general to account for the particular aspects involved in monitoring poverty & environment, the category of HWB&E indicators can be used to contextualise the situation of particular countries in comparison to others. More importantly, they provide transparent results that can help with communication of the progress that a country is achieving. They also provide important sources of information and can be used to convey a broad idea of the status of poverty in those countries where most people are poor and HWB measures are definitely influenced by widespread poverty. If, on the one hand, standardisation of results tends to ignore the specificities of local contexts, on the other, it offers legitimisation of outcomes by giving comparability among contexts.

The category of HWB&E indicators comprises a wide variety of elements ranging from economic (inspired by national accounting practices) to participatory indicators (based on focal groups exercises). Most indicators are regularly compiled and published by public agencies, but there are also other indicators that have been elaborated as part of academic studies, as shown below.

The category of HWB&E indicators reports over time the pressures that human activities generate on the environment and the impact on human well-being. It is possible to classify the indicators into five basic groups, as illustrated by table 1, that present different perspectives in categorising the links between HWB&E and the role attached to the meaning of 'sustainability' in defining environmental and human thresholds. A comprehensive list is out of the scope of this work[11] and these are just some among the most prominent aggregate type indicators. Below we review one case from each of the five groups as an illustration.

Table 1
HWB&E Indicators

Indicators	Main features
Ecological Footprint, Biocapacity and Ecological Debt (WWF, Zoological Society of London and Global Footprint Network)	Categories of demand, supply and gap (overshoot) based on areas of productive land (global hectares per person)
Environmental Sustainability Index and the Environmental Performance Index (Yale and Columbia University with the World Economic Forum and European Commission)	Wide list of variables and indicators for more data-driven environmental analysis and decision-making. Focus on the state of environmental systems
Barometer of Sustainability, Human Well-Being Index and Ecosystem Well-Being Index (Prescott-Allen)	Human well-being and ecosystem indicators are combined hierarchically within a two-axes scale
Human Development Index 'family of indicators', including e.g. the Environmental Behaviour Indicator by De la Vega and Urrutia	The human development index can be modified by adding an environmental dimension or by relating it to a well-know measure, such as the ecological footprint
Index of Sustainable Economic Welfare (ISEW) and Genuine Progress Indicator, Daly and Cobb	The Gross Domestic Product is corrected for not taking into account the welfare loss due to environmental degradation and other losses

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The Ecological Footprint

The Ecological Footprint index is meaningful as a demand measure that assesses the pressure from human activity on the state of biodiversity and biosphere. It uses as a benchmark the measure of 1 planet, calculating the number of global hectares per person that are used. Global hectares are calculated taking into account the area of biologically productive land and water necessary for the provision of ecosystem services, such as food, fibre and land, plus the calculation of land needed to absorb carbon dioxide (CO_2) from fossil fuels emissions. The message it conveys is simple: humanity needs to reduce its global footprint to avoid living with a permanent loss of biodiversity and erosion of its natural resource basis. It is important to observe the divide that exists between the rich and the poor in the formulation of this measure.

Indeed, between 1992 and 2003, measured in constant global hectares, the average per person footprint in low and middle-income countries has practically not changed, while the average per person footprint in high-income countries increased by 18 per cent. So, one problem with the Ecological Footprint measure is that it seems best adapted to address sustainability issues that might emerge from developed countries.

Most poor countries' footprints are below the world average and don't say much about the needs of the poor. This happens because the resource intensity used in poor countries tends to be much lower in comparison to that of developed countries. The biocapacity index seems to be best suited to the task of describing the function and status of ecosystems in poor countries, but there is nothing specific about how poverty relates to environmental degradation. The balance between ecological footprint and biocapacity provides a measure of ecological debt that could be used to indicate the use of ecological resources that will not be available for future generations. Although focused on a single dynamics, it is useful as a communication tool.

Box 3

Same indicators, different problems

The 2005 Environmental Sustainability Report acknowledges that[12]:

"Given the diversity of national priorities and circumstances, there will never be full agreement on a universally applicable set of weights for the aggregation of the 21 ESI indicators. Indeed, in some countries, water issues will be most pressing: in others, air pollution may be the priority. Developed countries are likely to put more emphasis on longer-term challenges such as climate change, waste treatment and disposal, clean and sustainable energy supply, and the protection of biodiversity. Developing nations will stress more urgent and short-term issues such as access to drinking water and sanitation, environmental health problems, and indoor air pollution."

The Environment Sustainability Index

The Environment Sustainability Index (ESI) and the 2006 Pilot Environment Performance Index (EPI) follow a different methodology. They involve the compilation of large datasets (respectively, 76 and 16 datasets) and their classification into broad categories. Informed by the model 'Pressure-State-Response', as will be discussed below, the ESI categorise many different aspects of social, economic and environmental sustainability, such as i) environmental systems, ii) reduction of environmental stresses, iii) reduction of human vulnerability to environmental stresses, iv) societal and institutional capacity to respond to environmental challenges and v) global stewardship.

Alternatively, the EPI is built around rankings based on rate of progress toward established goals around policy categories of i) environmental health, ii) air quality, iii) water resources, iv) biodiversity and habitat, v) productive natural resources and vi) sustainable energy. Both indicators purport to be tools for guiding national policy-making in environmental and developmental terms. However, EPI is a more focused and less-ambitious index centred on environmental performance. It might be less useful though for policy-makers interested in institutional issues (for that, ESI is more suitable). The ESI uses magnitude of environmental stresses as a pressure indicator of underlying systems. This index could be a valuable guide if disaggregated and if questions more to the heart of particular countries could be seen beyond the aggregation processes (see box 3).

One indisputable added-value of both ESI and EPI is their comprehensiveness and comparability, with large indicator sets that could be used to contextualise the relative position of a country vis-à-vis others. Although not focused on poverty[13], these indicators can help with the identification of environmental stresses and could provide a complementary guide for policy-makers from poor countries (see table 2). The higher the scores, the higher are the levels of sustainability in the different dimensions. We can see that the countries that are part of the Poverty and Environment initiative are at the lower spectrum of the environmental sustainability index, with problems related not only to the quality of their water, air and biodiversity but also to increasing pressures on their ecosystem services. It is worth noting here the cases of Kenya, Rwanda, Mozambique and Mauritania, all open to very high levels of human vulnerability.

Individual performances are best understood by looking at the different dimensions. For instance, it is possible to see in table 2 the environmental stresses in Tanzania and Mozambique, the problems with human vulnerability in Mozambique, the relatively low levels of social and institutional capacity in Rwanda and Mauritania. The overall ESI can be used to assess the overall state of magnitudes of environmental pressures and responses at national level.

The Barometer of Sustainability

The Barometer of Sustainability[14] is another tool available for communicating and measuring the general level of a society's well-being and progress towards sustainability. The main function of the Barometer is integrating its dimensions, namely, the Human Well-Being Index (HWI) and the Ecosystem Well-Being Index (EWI). The intersection between these two scales provides a picture about the general level of well-being and the hurdles in ensuring sustainability in such a way that a lower score on one axis overrides a higher score on the other. This means that the dimension that is in worse condition defines the parameter of sustainability. The HWI consists of the following indicators: i) health and population, ii) wealth, iii) knowledge and culture, iv) community and v) equity. The EWI is made of averages of i) land, ii) water, iii) air, iv) species and genes and v) resource use.

Indicators should be arranged hierarchically to tell a coherent story

Overall, 36 indicators are used for HWI and 51 indicators are used for EWI. The idea of comparing different dimensions, also used between the ecological footprint and the biocapacity indicators, provides a criterion of sustainability that considers indicators within a structure, rather than simply using a disjointed compilation of statistics. This is an important lesson emphasised by the Barometer of Sustainability more than by any other HWB&E indicator: indicators should be arranged hierarchically to tell a coherent story. One shortcoming of the Barometer of Sustainability is that it is not updated. It has also been criticised for its lack of transparency in defining its weighting scheme[15].

Human Development Indexes

Based on the public attention received by the Human Development Index (HDI), a 'family' of adjusted HDIs was constituted by diverse attempts at incorporating environmental dimensions into the HDI. In fact, the possibility of including an environmental dimension has been explored since 1994 but not officially realised due to problems of finding comparable, valid, reliable environmental data that could be judged equally desirable internationally[16]. Calls for 'greening' the HDI[17] have been raised but rejected based on the arguments that[18]

- Resource exploitation and environmental degradation are not directly related (a country with a high HDI can have a high or a low resource exploitation)
- There is no clear direction of improvement to environmental variables (that is, 'zero' pollution does not seem to be desirable for its negative consequences)
- Entering a new environmental variable could be open to the criticism of not being commensurable
- Changing the HDI could make comparability with HDIs from previous years almost impossible

Among recent academic attempts to include environmental concerns into the HDI fabric, we could mention De La Vega and Urrutia's HDPI[19] (a pollution-sensitive human development indicator) that has adjusted the income dimension to the behaviour of an environmental indicator, measured in terms of carbon dioxide (CO_2). Despite arguing for the inclusion of other dimensions, such as those of air, water pollution, deforestation, population growth, energy consumption and the depletion of physical resources, the authors defended the exclusive use of CO_2 on the grounds that selected indicators should be available to many countries, with regular publication of data.

Neumayer in 2001 put forward a proposal for

Table 2

Environmental Sustainability Index: illustrations

	ESI	Environmental System	Reducing Environmental Stresses	Reducing Human Vulnerability	Social and Institutional Capacity	Global Stewardship
Mali	53.7	59.4	49.6	28.7	39.6	87.1
Uganda	51.3	49.3	47.1	31.5	47.1	81.9
Tanzania	50.3	38.9	60.7	32.8	51.6	63.4
Kenya	45.3	46.1	52.9	25.9	41.4	54.8
Rwanda	44.8	44.6	45.8	21.7	35.0	78.4
Mozambique	44.8	55.6	60.6	1.9	48.9	65.7
Mauritania	42.6	57.7	47.7	22.6	31.8	42.6

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'checking' whether a given level of human development is sustainable or not. Instead of including another variable into the HDI, the suggested alternative is to assess the level of 'genuine savings', discounting the effects of depreciation from the natural resource stock. So, an adjustment factor (or in other words, a mechanism for adjusting, correcting, the value of a parameter or variable) is used.

A similar argument against adding new dimensions was developed by Morse[20] in 2003 who noted that a well-known measure, such as the ecological footprint, could be directly related to the three components of the HDI, providing an indicator of HDI per unit of the ecological footprint. The lesson emerging from this discussion for understanding the links between poverty & environment is that adding new dimensions to already existing indicators doesn't seem to be a promising alternative when compared to the adjustment of variables. It is important to analyse the impact of the inclusion of new dimensions before actually doing it. The association between poverty & environment is not automatic and should not be taken for granted a priori.

Index of Sustainable Economic Welfare

Finally, the Index of Sustainable Economic Welfare (ISEW) and Genuine Progress Indicator, by Daly and Cobb, correct GDP (Gross Domestic Product) by distributive considerations and environmental aspects. First, the value of personal consumption expenditures is adjusted by an index of distributional inequality of income (in other words, the total value of consumption is adjusted downward the more unequal is the distribution of income). After that, estimates of the values of the services from household labour, consumer durables and streets and highways are added.

Then, other expenditures are subtracted, among which we find the costs of environmental degradation, such as water, air, pollution, losses in ecosystems and the long-term damage caused by CO_2. The adjustment technique used in the formulation of ISEW is not unique. As we saw above, similar versions of adjustment of GDP have been used in correcting the HDI for environmental impacts. Despite being criticised for being highly dependent on certain 'key and rather arbitrary assumptions'[21], and for assuming perfect substitutability within natural and other forms of capital (that is, that we can have more machines and less environment and that is all right), the ISEW should be valued for being based on two widely acknowledged shortcomings of traditional HWB indicators, namely, that distributional and environmental issues are ignored.

To a certain extent, even the HDI ignores both dimensions. One limitation of the environmental variables included in the ISEW is that only those that have impact on costs are considered: so, water matters in terms of the cost of water pollution, air is important to the extent that we can have measures of the cost of air pollution, the loss of agricultural land should also be measured in terms of costs, and so on. However, environmental variables might reveal other obvious costs (in particular, in terms of human development) that might not be fully accounted in monetary terms.

Adjustment Factors can be used as a way of integrating the human and the environmental dimensions

Lessons Learned

To conclude this section, it is important to remark that although the above general indicators are not particularly focused on the association between poverty & environment, they provide relevant lessons to be learned and useful suggestions about how they can be used in the assessment of national poverty reduction policies. First, we have seen that the Biocapacity Index seems to be more suited to poor countries than Ecological Footprint measures.

The Biocapacity Index gives an idea of the state of the environment and as such could be used to track progress in managing ecosystems. Yet, the Biocapacity Index does not aim to provide a comprehensive picture as the ESI and EPI do. These two indicators can be quite useful as monitoring schemes for policy and governance issues. It is advisable that policy-makers look at their components and work with them separately according to their needs and political priorities. Large datasets, like those offered by the ESI and EPI, might bewilder more than help for one simple reason: the integration criteria is not clear.

For this reason, the Barometer of Sustainability should be appreciated: it provides a clear way of thinking about the aspects to be integrated. For this matter, the Ecological Debt indicator does just that. There are many ways of pursuing integration of indicators and the lessons from our brief report on the ISEW and the 'family' of 'green' HDI indicators suggest that many different elements can be used to produce adjustment factors as a way of integrating the human and the environmental dimensions. Box 4 looks at the integration issue in depth. The third part of this report explores the concept of adjustment factors.

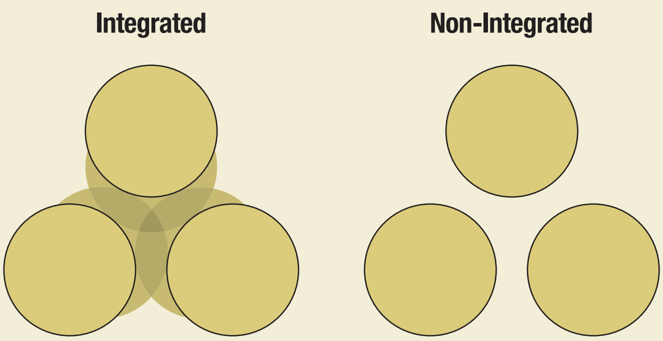
Box 4

The Integration Condition

The association between human well-being and the environment is difficult to measure with a single indicator (the same applies to measures that try to link poverty & environment dimensions). This means that more indicators are needed to capture the meaning of this association. In other words, the association is multidimensional. By combining several indicators into a composite measure, one would get a better overall estimate of the phenomenon. But how should we combine or aggregate separate measures? There are no particular rules that specify how different variables or indicators should be combined. The most common procedure to follow is simply to add or take an average between different indicators from different dimensions. This is what is usually done with many HWB&E indicators. A divide between the human and the environmental dimensions is kept throughout, being bridged at the end by a process of aggregation. This problem is known as 'the integration issue'[22], and several integrative approaches have been used to bring together HWB&E dimensions, such as:

- Monetisation of dimensions: money is used as a common denominator as in 'green accounting'
- Use of diagrams, such as AMOEBA[23] (where several indicators are plotted into a circular presentation)
- Use of weights for aggregating different dimensions into a single index
- Use of mathematical models to relate indicators to each other and find out policy impacts
- Use of adjustment factors, using the state of one dimension to modify or correct another

However, often by following some approaches the dimensions are not fully integrated, in the sense that their association doesn't produce new variables that represent their integration (indicated by the shadowed areas below). In general, when composite indicators are elaborated, the integrity of original indicators remains untouched. This is what usually happens with visual and numerical forms of integration. The result is that the level of intersection between the different dimensions is very low. The difference between integrated and non-integrated variables is visually illustrated by the picture below:



Non-integrated series are those in which the different indicators 'do not talk to each other', that is, when for instance environmental dimensions are not part of the story that human indicators are telling (or vice-versa). Integration is better described as a question of degree. In fact, integration should be defined depending on the quality of the links between the different dimensions. For the sake of analytical clarity a criterion could be used to classify the degree of integration for HWB/P&E indicators. They could be considered of

- degree zero of integration (I0), if there is no integration between the different components of indicators. Poverty and environment are treated as two separate issues. Example: a composite indicator which simply aggregates its different dimensions;
- degree one of integration (I1), if integration is achieved with dimensions being defined separately but composed at the final moment of the elaboration of the index based on some criterion. Example: the Ecological Gap or the Barometer of Sustainability;
- degree two of integration (I2), if dimensions are built from an integrated perspective from the start, with original variables being integrated themselves, representing factors that overlap between HWB and the environment, leading to the creation of different variables. Poverty and environment are treated as the same issue.

Integrated variables of degree two (I2) are per definition relational, that is, they constitute a causal relation (or strong association) between the dimensions that they amalgamate. The relational variable must make sense per se. For instance, 'erosion' and 'hunger' can be integrated either:

- in degree zero, if separate indicators are aggregated at the end to form a composite indicator;
- in degree one, if a comparison between erosion and hunger can reveal the seriousness of a particular situation or if sustainability criteria are imposed to select and order a range of values for these variables;
- in degree two, if it can give rise to a relational variable named e.g. 'hunger from erosion', describing the processes through which soil erosion and loss of fertility gives rise to lower productivity and crop losses as a justification for hunger experienced by individuals.

The integration condition should not be ignored by any form of sustainability indicator[24]. It is an essential and distinctive aspect of the processes that it tries to describe. Integration remains an important shortcoming of many HWB&E indicators and other sustainability and human indicators. It is better satisfied by P&E Indicators as seen below. It is important to remark that integration depends on the values and priorities of particular societies and for this reason there is no 'analytical fix' to it. Contextualisation of P&E indicators as relational helps, but their choice should be part of decision-making processes.

Reviewing Studies on Poverty & Environment Indicators

JONATHAN DUWYN

The characterisation of poverty & environment links is not a trivial issue. Quite often this association is described as complex[25] without further specification of the nature of the complexities it entails. In order to elaborate P&E indicators, it is important that we clarify the sources of complexity even if we cannot handle all of them at once. At least we can define a strategy for sequentially addressing them. The most relevant sources of complexity involved in the poverty & environment association are:

- assessment of the quantity and quality of natural resources
- characterisation of individuals' well-being and specification of their behaviour
- identification of multiple institutional and social causes shaping policy-frameworks
- assessment of the evolution of cumulative and path-dependent associations between poverty & environment dimensions

Many of these sources or conditions involve value judgments on minimal levels (of environmental conditions and poverty) that cannot be defined independently from the views of the stakeholders directly involved in the poverty & environment processes. Most recent attempts at developing P&E indicators acknowledge the role of communities in making these value judgments[26]. This issue is also known as 'the reference condition', as discussed in box 5.

In what follows, we review recent studies on poverty & environment indicators with the purpose of identifying indicators that could be potentially useful for policy-makers in defining strategies relevant to their context. By doing so, we also present some building blocks that will be used in elaborating a new methodology for P&E indicators.

Traditional environmental hazards are much more prevalent in poor countries. They exceed modern hazards by a factor of ten in Africa

Environmental Conditions and Health

Shyamsundar (2002) delves into the links between the environmental conditions and the determinants of health and income poverty. Health is understood through the concept of environmental health, as put forward by the World Bank, according to which "environmental health refers to those aspects of human health, including quality of life, that are determined by physical, biological, social, and psychological factors in the environment"[27].

Based on this concept, health risks are divided into two categories, namely i) traditional hazards (involving lack of safe water, inadequate sanitation, waste disposal, indoor air pollution and vector-borne diseases) and ii) modern hazards (comprising urban air pollution, agroindustrial chemicals and waste).

Traditional environmental hazards are much more prevalent in poor countries. They exceed modern hazards by a factor of ten in Africa. It is also the case that these different hazards affect different social groups. For instance, individuals living in rural areas are more concerned with the impact of environmental degradation on arable land, livestock, forest products and biomass for fuel. Conversely, for individuals living in urban areas, issues of water, energy, sanitation and waste removal, might be a priority.

The three most common environment-related illnesses prevalent in poor countries, namely, diarrhoeal diseases, respiratory infections and malaria, are related to water and indoor air pollution. Recent evidence brought up by the 2006 Human Development Report reveals that from the 10.6 millions of people who died in 2004, almost 20% were under-five children. From this total, a little bit more than 2 million died from respiratory infections and around 1.8 million children died from diarrhoea.

While these illnesses are partly related to behavioural practices, they are also fundamentally linked to quantity and quality of water supply and use of traditional energy. The 2006 Human Development Report, entirely dedicated to the issue of water, highlights the importance of power and institutions to understand distributive patterns of natural resources, such as water.

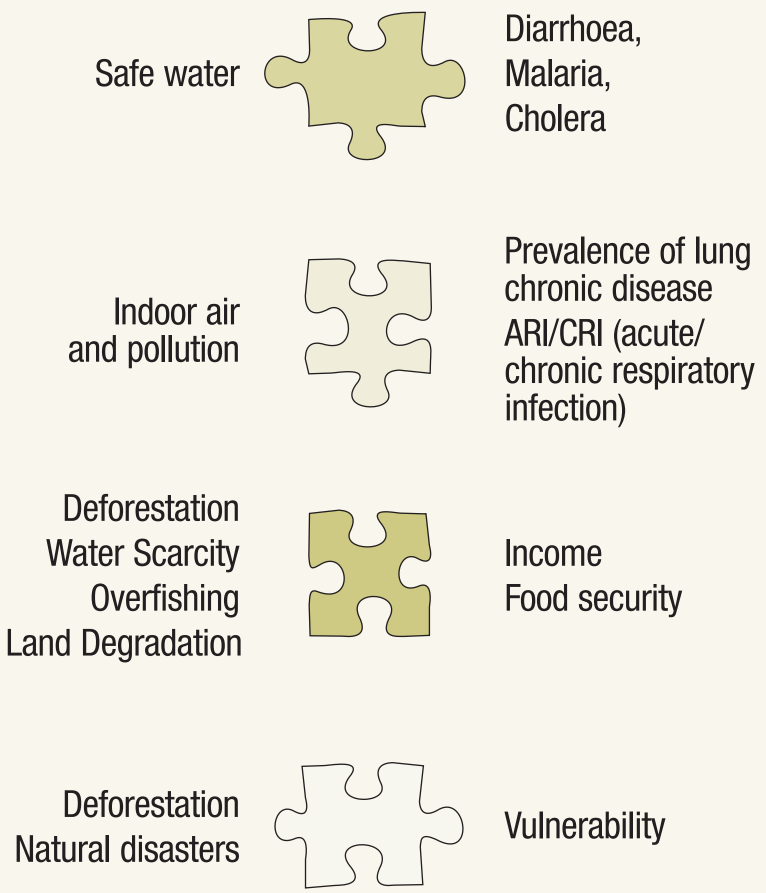
Shyamsundar argues how it is relevant to disaggregate health indicators to understand how the poor are affected. This is because environmental degradation affects more the health of the poor than the health of the rich. Additional factors, such as low nutritional status, or high vulnerability or low access to public health facilities magnify the impact of environmental degradation on the poor.

From an economic perspective, environmental degradation can be seen as resource loss, affecting the poor by decreasing the productivity of the inputs that they use to grow food, or decreasing the amount of goods that they are able to obtain from forests or increasing their vulnerability to natural hazards. The fundamental concept used by Shyamsundar here is of a poverty-natural resource indicator, capturing changes in livelihoods generated by environmental changes.

Where individuals are highly dependent on natural resources for their survival, it should be expected that income poverty will be related to food security and that some aspects will be difficult to be directly quantified. The general categories used by Shyamsundar seem all to be potentially integrated of second order, describing common phenomena associated with both poverty and environmental dimensions. But she does not pursue this strategy of fully integrating the indicators to the end. In any case, this work can be appreciated by the valuable contribution that it gave in highlighting important P&E links, as indicated on Diagram 4.

Diagram 4

Examples of P&E links



Box 5

The Reference Condition

The objective of a good indicator is to tell a good story. Indicators are means to simplify and communicate information and by doing so, to guide actions. P&E indicators need to be 'anchored' before they can tell good stories. The anchors are different because the nature of the concept of poverty and human well-being is different from the category of environment. The issue of poverty cannot be evaluated apart from a proper discussion about the foundations of what one understands by acceptable or unacceptable for a human being to go through. What is the best parameter for assessing poverty? Availability of resources? People's subjective views about their own conditions? The stock of their wealth or primary goods (a measure of general goods with general purpose)? Their human rights? Their capabilities (their autonomy to choose what they are able to be and to do)? Before talking about human poverty and well-being, indicators need to be grounded on proper and consistent normative theories about what is quality of life and what is needed to have a good life.

Similarly, environmental indicators cannot be assessed without a sustainability perspective. Perman[28] et al (2003) explore the various impacts of working with different concepts of sustainability (such as the weak or strong version of sustainability). The sustainability issue is not just a question of degree of substitutability between natural and physical (e.g. machines) factors[29], but of how sustainability reference conditions are established:

Baselines (assessing states) ⇒ Thresholds (identifying problems) ⇒ Targets (evaluation)

The reference condition cannot be solved only technically because it involves normative (that is, related to values and value formation) aspects that need wider consultation and participation to have democratic justification and validity. For this reason indicators need to be grounded not only on the knowledge of different theories of well-being but also on different participatory processes and governance structures.

Ecosystems and Livelihoods

DFID (the Department for International Development of the United Kingdom), the European Commission, UNDP (the United Nations Development Programme) and the World Bank published in 2002 a document called *Linking Poverty Reduction and Environmental Management: policy challenges and opportunities*. The document lives up to its promise focusing mostly on policy issues. However, it also identifies core poverty-environment linkages that are helpful in thinking about national poverty monitoring systems.

In their words[30]: "The poor often depend directly on a wide range of natural resources and ecosystem services for their livelihoods; they are often the most affected by unclean water, indoor air pollution, and exposure to toxic chemicals; and they are particularly vulnerable to environmental hazards (such as floods, prolonged drought, and attacks by crop pests) and environment-related conflict." This report works with five environmental categories and three dimensions of poverty that are widespread around the MDGs (Millennium Development Goals). The key dimensions of human poverty used are:

- livelihoods
- health
- vulnerability

This discussion focuses on the importance of a better understanding of the features of rural poverty and how the lack of access to natural resources and environmental degradation constrain the development of agricultural systems in poor countries. The central environmental problems are soil erosion and water and land degradation, often produced by deforestation and overgrazing. With an acceleration of scarcity of natural resources, longer distances need to be travelled, usually by women, to fetch fuel, fodder and water. This imposes on them a physical burden, exposure to travel risks and time wasted that naturally impact on the energy they can dedicate to crop production and household responsibilities (and that sometimes can be responsible for their ill health).

Inadequate access to safe water, as mentioned above, is also acknowledged here as a main source of water-related diseases. In addition to that, pollutants (indoor air pollution, pesticide poisoning) have wide impacts on the health of the people, directly or indirectly (via depletion of fish stocks or contamination of food crops). Droughts, floods, forest fires and other natural hazards strike harder the poor due to their high exposure and reduced options in coping with them.

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Box 6

Environmental shocks and stresses[31]

In understanding the impact of natural hazards on poverty, a useful distinction can be made between environmental 'shocks' and 'stresses'. An environmental shock happens when environmental disasters occur, such as forest fires or floods or droughts. Alternatively, an environmental stress happens when as a result of gradual processes environmental degradation takes place. As environmental stresses become more prominent, livelihoods for the many individuals living in fragile areas all over the world become more time-consuming, more dangerous and more costly, demanding increasing levels of input.

Environment and Potential Risks

Henninger and Hammond (2002) produced a concept document on *Environmental Indicators Relevant to Poverty Reduction* that focuses on natural resource indicators and spatial analyses to calculate 'potential risk indicators', developed by the World Resources Institute (WRI). They focus on macro level indicators, acknowledging that the conceptual mechanisms that link poverty to environment are micro but that data to elaborate the indicators are only available at a macro level.

They raise a serious problem for moving from P&E links into P&E indicators. In their words[32], "Clearly, lack of an adequate supply of clean water contributes to ill health and the burden of disease; lack of a secure food supply contributes to malnutrition and hunger; and these in turn bear some relationship to levels of pollution and the condition of the natural resource base within a country. But provable, causal relationships between national average statistical indicators of environmental quality or conditions and poverty reduction generally do not exist."

It is possible however to deduce some mechanisms linking food security and livelihood from the general state of ecosystems, in particular the level of degradation of the natural resource base seen locally or spatially. The use of geographic

Conceptual mechanisms that link poverty to environment are often micro but data to elaborate indicators are mostly available at a macro level

coordinates can allow the elaboration of maps revealing spatial patterns of interaction between poverty and environmental dimensions. As an illustration of what Geo-referencing household survey data can provide, the authors discuss the results of the West Africa Spatial Prototype for 12 African countries, showing how child nutritional indicators were related to different degrees of soil aridity (measured through an aridity index that classified the region into six zones, namely, hyper-arid, arid, semi-arid, dry-subhumid, moist subhumid and humid). These nutrition indicators show an improvement towards the richer and more fertile coastal zones.

The report also argues for the development of spatially referenced environmental indicators on the grounds that many traditional ecosystem indicators are highly site-specific on the qualities of ecosystems, needing a more accurate assessment only achieved by geo-referencing. Overall, P&E indicators in the scheme proposed by the authors are integrated by spatially referenced measures, but as such, no further elaboration of P&E indicators is carried out.

As a long-term strategy the recommendations of the report are sound: to invest in spatially referenced ecosystem indicators and highly detailed poverty maps. In the short-term it provides no further guidance about P&E links and how to integrate indicators beyond the geo-referencing strategy.

Environmental Indicators for Local Stakeholders

WWF's approach[33] to developing and using P&E indicators is focused on the provision of information for local stakeholders seeking to improve local conditions through particular interventions. Their primary target public is the population living in rural areas. Their aim is to empower the poor, allowing them to compete for political influence, improving resource management and their livelihoods. Their approach is based on three different categories of P&E indicators, namely, i) status indicators, ii) enabling conditions indicators and iii) social capital indicators. Status indicators provide a qualitative and quantitative assessment of the current state of the environment and of the poverty & environment relations, such as[34]

- indicators about the physical extent, condition and productivity of resources (e.g. size of fish stocks, soil organic matter levels, etc)
- rate of resource degradation (e.g. rate of forest land conversion)
- access to resources
- distance and time to collect forest products
- percentage of income derived from non-timber forest products
- level of vulnerability to natural disasters

It is important to note that no further attention is given to the characterisation of poverty & environment links. More emphasis is given to societal responses behind the second group of indicators, namely, the enabling conditions indicators group. It covers the existence of national sustainability strategies and regulatory mechanisms that establish performance standards that are grouped into the categories of institutional arrangements, economic policies and ecological management capacity.

Finally, they put forward a list of social capital indicators addressing the type of organisations, networks, relationships and norms that are behind communities' collective actions. It is worth quoting from their justification[35] that mentions that "Rural P-E dynamics do not happen in a vacuum. They unfold in a context of competition for resources and opportunities. The rural poor, with few exceptions around the world, have been pushed to the margins of national decisionmaking and have been deprived of the means and mechanisms for influencing the policies and institutions that shape their lives."

As much as their political economy considerations seem very sound and central for accomplishing better resource management strategies and poverty reduction, not much is said in their argument about the nature of the interaction between poverty & environment links.

In the example that they put forward, of a project in a forest reserve in Yunnan Province, China, the status indicators that they use are limited to i) the rate of degradation or improvement of forested area and ii) the change in percentage of family income derived from forest resources. The level of integration of the proposed indicators is very low. On the other hand, the bottow-up strategies suggested by WWF account well for the reference condition since the influence of local stakeholders on the management of environmental systems is promoted as a deliberative process of choosing indicators.

Environment and the MDGs

Finally, a comprehensive study called *Assessing Environment's Contribution to Poverty Reduction*, prepared by UNDP, UNEP, IIED, IUCN and WRI[36], covers the links between the environment and multidimensional aspects of poverty related to the Millennium Development Goals, in particular the goal to 'ensure environmental sustainability' (Goal 7). After analysing some well-known general indicators, including the Environmental Sustainability Index, the Ecological Footprint, Adjusted Net Savings and the World Bank's Measure of Comprehensive Wealth, it concludes that[37] "none of these approaches fully meets the criteria for integrating environmental resources (ecosystem services) within a sustainable development context". As suggested above, the integration condition has become an important element of qualification of HWB/P&E indicators. Building on the previous work by DFID et al (2002), the study puts forward the list of key links between the environment and the MDGs, described by table 3.

However, they emphasise that these general links are not enough to capture the priorities of environmental issues in a given country or region. For that, countries should modify the targets, tailoring them to their specific local conditions and priorities. This, of course, will depend on the availability of data for particular countries. Adjusting the scale seems to be their main solution for providing P&E indicators, given that in their view[39], "there is no blueprint for assessing and measuring the integration of the principles of sustainable development in country policies and programs. Progress on environmental sustainability requires responses at the appropriate scale."

And yet, as pointed out earlier, currently available data is only collected and available at national level. The authors carry out a very useful discussion of current indicators with suggestions for improving them, stressing the importance of not focusing only on the 'loss of environmental resources' but fully using the notion of an ecosystem-based approach to include other ecosystem services. This means interpreting environmental resources as 'the capacity of ecosystems to provide ecosystem services to people' as a sustainability criterion. The study follows the methodology proposed by the Millennium Ecosystem Assessment for indicator development.

Table 3

Links between the environment and the MDGs[38]

MDG	Links to the Environment
1. eradicate extreme poverty and hunger	✓livelihoods and food security depend on functioning ecosystems ✓the poor often have no entitlements to environmental resources and inadequate access to environmental information, markets and decision-making ✓lack of energy services limits productive opportunities for the poorest
2. achieve universal primary education	✓time spent collecting water and fuel wood can reduce time available for schooling ✓lack of energy, water and sanitation discourage teachers to live in rural areas
3. promote gender equality and empower women	✓water and fuel collection reduce the time that women and girls might have available for education, literacy and income-generating activities ✓women do not benefit from equal entitlements to land and other natural resources
4. reduce child mortality	✓water and sanitation-related diseases (e.g. diarrhoea) and respiratory infections are the two most important causes of under-five child mortality ✓lack of clean water and fuels for boiling water contribute to preventable water-borne diseases
5. improve maternal health	✓indoor air pollution and carrying heavy loads of water and fuel wood affect women's health, increasing risks of complication during pregnancy ✓lack of energy (light, refrigeration) and sanitation limit the quality of health services in rural areas
6. combat major diseases	✓environmental health hazards are associated with risk factors (e.g. malaria, parasitic infections)
7. ensure environmental sustainability	✓keeping the resource base (land area covered by forests, biodiversity, water sources) and regulating energy, carbon dioxide emissions and recycling provides the foundation for the links described in this table
8. global partnership for development	✓global environmental problems need the participation of rich countries (that consume more resources) ✓external debt, unfair terms of trade and predatory investment can increase pressure to overexploit environmental assets in developing countries

The list of indicators that they use as an illustration, from the SAfMA assessment study *Ecosystem Services in the Gariep Basin*, shows a very low level of integration, with indicators such as i) natural mean annual runoff by subcatchment, ii) water availability per capita by subcatchment, iii) mean annual cereal production per capita per district, iv) potential mean annual meat production, v) number of species, vi) conservation status of land-types, vii) timing and quantity of water delivery in freshwater systems, etc being provided totally disjointed from the human dimensions. In our classification they are of zero degree of integration (I0), given that indicators from one dimension do not refer to indicators from another. Integration is taken to degree one (I1) when maps are produced and combined to identify spatial patterns. A measure of 'irreversibility' is used to indicate a sustainability criterion for ecosystem service areas.

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Lessons Learned

Lessons learned from these studies are many. Initially, we can see how the integration and reference conditions play a meaningful role in categorising and analysing available P&E indicators. In other words, good P&E indicators need to be integrated and anchored on local values and decision-making processes. Whereas the reference condition plays a role that can only be shaped by political processes, the integration condition can still benefit from analytical improvements. There is still a general lack of integration that pervades the uses of P&E links.

Secondly, we hope that the discussion above has shown what main contributions have been made to clarify the associations between poverty & environment and how the studies and reports addressed above constitute an important source of information that can be consulted by policy-makers in fostering transparent and participatory decision-making processes.

Thirdly, it is important to note the latent tension between different methodological approaches for building P&E indicators that put forward methodologies based on micro and local data, when at the moment it is mostly national level data that is regularly collected and available, in particular for the poorest countries. Nevertheless, these methodologies should be appreciated for their contribution to future achievements.

Finally, the various categories, dimensions and variables reported above from different studies can provide a concrete sense of what one means when one talks about P&E links, and what approaches have been used to operationalise them into usable metrics.

Developing and Using Poverty & Environment Indicators

MARK EDWARDS/STILL PICTURES

Indicators are like flags, used to simplify, measure and communicate information, and to rally support for action. An indicator is nothing mysterious; it is simply a way of measuring and making understandable something that is considered important. ***(James McGilvray)***

Being able to appreciate the work on P&E indicators that international agencies or academics do and to use them is indeed valuable. But it is not the same thing as being able to build indicators (individually or collectively) perfectly suited to the context. It is for this reason that this part addresses some foundational and practical issues in elaborating and using indicators. The objective is to provide the building-blocks for those interested in having a more pro-active attitude towards P&E indicators. Following James McGilvray, the first step is to acknowledge that there is nothing 'mysterious' in building an indicator.

The search for indicators should be seen as part of measurement processes that normally follow guidelines suggested by public action and policies. However, consensus in the selection and pondering of indicators cannot be achieved based uniquely on political agreements. Methodological clarity is also necessary. In measurement processes, numbers or labels are assigned to units of analysis in order to represent a certain phenomenon or variety of phenomena. For instance, we can classify individuals as 'poor' whenever, for instance, they have less than 20 litres of clean water per day. In defining a process of measurement, we have not simply to establish scales and thresholds, but to relate them to different qualitative states. In our current case, we would be interested in relating different numbers to distinct characterizations of poverty and environment links.

Measurement

Measurement begins with thinking about what terms should be translated into empirical counterparts. Unless we are clear about the meaning of the concepts for which we want to develop indicators, we might end up measuring something else. Yet, getting a correct conceptualisation of terms is not enough. Measurement also implies a certain systematisation and ordering of empirical counterparts. Measurement processes involve the following steps

- **Conceptualisation**: identification of the limits and dimensions comprised by the concepts. Once we know how the concepts can be used, working definitions can be chosen. We can then move from abstract ideas into operational definitions with values and categories. This is important in situations where one has to operationalise, for instance, concepts as complex as sustainability or poverty. They are both abstract ideas and need to be turned into working definitions for particular contexts. By doing so, one can satisfy the reference condition, as discussed above. What is poverty? What are the most important ecosystem services that matter for deprived individuals? How can we conceptualise the interaction between poverty and environment?

- **Identification of data**: creating indicators without the existence of corresponding data has limited usefulness. It is important to carry out a collection of basic empirical information that to a certain extent represents the concepts to be measured. Data can be quantified cardinally (in figures) or non-quantified in ordinal scales, giving rise to statistics that are associated with empirical representations called variables. What data is available? Do we have statistics for assessing erosion or air quality? Are our measures of poverty consistent with human development? How can we work with measures that exist, trying at the same time to provide guidance for the production of new measures? The choice of variables reflects a process of model selection, as illustrated by diagram 5;

Diagram 5

Linear PSR model

Data ⇒ Variables ⇒ Indicators ⇒ Composite indicators

⇑

Variables should not be automatically used as Indicators

- **Development of indicators**: choice among different variables in order to represent a particular weighting and aggregation procedure. This means that indicators are made of variables but variables, if taken in isolation, do not always produce indicators automatically. For instance, the variable 'proportion of land area covered by forests' might not be conveying any useful information in a particular context. It might well be that combined with other variables, e.g. 'prevalence of hunger', it can reveal something about the role of forests in providing safety nets for the poorest. Only then it could provide a useful indicator. Thus, variables should not be used automatically as indicators. Quite often grouping the variables and the indicators is not a simple technical process. It should reflect the priorities emerging from political decision-making processes, or at least, should be compatible with them;
- **Elaboration of an index or composite indicators**: combination of indicators in order to consolidate or amalgamate different dimensions that attach complexity to a particular situation. This aggregation might be necessary or not. The whole point about indicators and indices is that they are different from statistics because they are associated with the use of reference points, such as thresholds, benchmarks or targets. It is here that the reference and integration conditions play an important role.

When interpreting or building new indicators it is useful to differentiate not only among data, variables, indicators and indices, but also between different reference conditions, such as thresholds, benchmarks, baselines, norms, targets, standards and lines. Some of these terms can be used interchangeably, but more often than not they obey the following convention:

– **Baselines and benchmarks**: they measure change from a certain state or date (e.g. degree of soil erosion)

– **Thresholds or norms**: they identify the problems by qualifying the change according to certain standards (e.g. concentration of an air pollutant beyond which respiratory illnesses become a serious problem)

– **Targets**: they are used to evaluate progress in achieving objectives. They are part of a decision-making sequence and progress is expected to be measurable or observable (e.g. MGDs).

Levels of Measurement

Indicators can be qualitative or quantitative. The concept of indicators is usually associated with quantification. However, ultimately, what an indicator does is to put the available information into a scale that can be either quantitative or qualitative. We use different empirical rules to sort out cases into categories, where each category has a different interpretation and different levels of measurement.

The lowest level of measurement, the nominal measurement, involves classification of a variable into two or more categories. For instance, drivers' impacts on biodiversity over the last century can be classified into 'low', 'moderate', 'high' and 'very high' in the MA's assessment of Main Direct Drivers of Change in Biodiversity and Ecosystems[41].

The second level of measurement, the ordinal measurement, indicates only the rank order of a variable. Most performance indices, like the HDI or the ESI provide rankings of individual countries regarding particular dimensions. In this scale we cannot make a precise judgment about an absolute situation. Instead, the measurement reveals comparability standards among countries or individuals.

Indicators are variables with reference points

Finally, the third level of measurement, the interval measurement, is one in which it is possible to quantify with precision the differences between categories. It applies to categories that are naturally numeric. For instance, the rising temperature levels in the oceans due to global warming effects are interval measures. What allows us this inference is the existence of a standard measurement unit, or metric. Whereas most qualitative variables can be measured nominally, quantitative variables can be measured either in an ordinal or interval scale.

It can be argued that in some situations, qualitative indicators can be better than quantitative indicators. First, when quantitative information is not available (what is frequent considering the lack of micro data on poverty & environment), it is better to have a qualitative indicator of the situation than nothing. Secondly, when the particular attribute in question is inherently non-quantifiable, it is better to include a qualitative representation than leaving it aside. Finally, quantitative information might be too costly and it might be cheaper (and more feasible) to estimate indicators based on qualitative information.

From what has been described above, it can be argued that the process of elaborating new indicators is more complex than simply making a list of disjointed variables. ‘Complex’ here has a very definite meaning: it implies the satisfaction of a sequence of particular criteria for capturing poverty & environment links (like the reference condition, the integration condition), and general criteria for building indicators using a coherent language. An application of these criteria will be carried out in the next part of this report.

Criteria for Choosing Indicators

One particular source of difficulty regards how to proceed to choose among different indicators when there are many possibilities that could be realised. The standard procedure is to elaborate a list of criteria for choosing indicators in the search of more objective ways of evaluating the quality of the indicators. This issue is particularly important to policy-makers from developing countries who need to choose among many indicators produced by international organisations or by foreign academics.

What criteria to use? In using secondary indicators or in formulating primary indicators, it is possible to choose which (and how many) indicators to select according to a list of ‘desirable properties’, based on to which indicators should be

1. Measurable: indicators should be expressible in numbers or labels in units, assigning categories to empirical counterparts. If this basic condition is not fulfilled, it is not even worth trying to formulate an indicator. For instance, MDG 8 on a ‘Global Partnership for Development’ is not measurable per se. It has to be complemented by other indicators to receive operational meaning;

2. Reliable: indicators should be stable and consistent. They should not change every time that a repeat measurement is carried out. In other words, indicators should give at least approximate answers every time, so when they are used information provided is trusted. Thus, when the presence of E.coli/100 ml is used to assess the quality of the water and the likelihood of diarrhoea, the answer it provides should not change (randomly or not) every time that the test is run on the same sample;

3. Valid or relevant: indicators should provide measures that reflect the concept or purpose that it is intended to be reflected. This criterion refers to the extent of matching between the situation an indicator intends to reflect and an operational definition of that indicator. For instance, we should not be using a measure of safe water to assess prevalence of respiratory infections. For that, measures of ventilation in cooking area and use of traditional fuels are more valid or relevant;

4. Policy-relevant: indicators can be used to expose problems and are useful for policy-formulation and decision-making, allowing agents to make informed decisions, what facilitates the implementation of policy-goals. For instance, indicators on percentage of the population residing in disaster prone areas are relevant for government planning and housing policies. Similarly, indicators of deaths by water-borne diseases are useful in planning water and sanitation policies;

5. User-friendly: indicators should not be obscure. They should be easy to understand and to communicate. Usually indicators about chemical components found in the air or in water are difficult to understand. Whereas much is known about the impact of carbon dioxide on climate change, not much is said about the effect of PM10 on human health;

6. Sensitive to changes: indicators should respond to changes in circumstances, so that they are useful to detect changes. Poverty line measures, based on headcounts, are insensitive to changes below the poverty line. Since the headcount index only counts the number of people below a certain poverty line, the poor can become even poorer and the indicator does not change;

7. Analytically sound: indicators must be clearly elaborated and structured along logical principles, collected by using standard and accepted technical methods. Lack of safe water, for instance, as suggested by the 2006 HDR, is measured according to criteria put forward by the World Health Organisation, that takes into account, water quality, quantity and frequency in consumption, providing a logical framework for using safe water as an indicator;

8. Comparable: indicators should facilitate assessment between different circumstances and time-scales. One indicator that has, on the one hand, a very specific meaning has, on the other, low applicability. Comparability can however be achieved at different levels. For instance, one can have a general comparable category as ‘drinking water’ that could be operationalised using different particular indicators, such as % population with safe water, or % incidence of diarrhoea, or under-five mortality rates. The important thing is to ensure that comparability is achieved at some level;

9. Cost-effective: indicators should be measured in an affordable way according to the perceived value of the information produced;

10. Context-dependent: indicators should be valid to the reality in which they are supposed to be applied. Often this involves a geographic limitation of the scope of the indicator. For instance, Target 9 of MDG 7, the general indicator of 'proportion of land area covered by forests' can become context-dependent targets according to different percentage of forest cover that one wishes to keep (e.g. 60% for Cambodia, 9% for Buthan), or can even be translated into afforestation rates (35% for Romania)[42];

11. Able-to-articulate-a-world-view: indicators should ultimately convey a message about something that needs to be monitored or carefully assessed. Indicators about erosion and hunger convey a very simple message when jointly articulated: agricultural systems need to be improved to prevent under-nutrition and its manifestations.

Now, if all these criteria seem desirable, a legitimate question is how can one compare indicators when some satisfy some criteria and others satisfy a different set of criteria? One possibility for allowing a more objective comparison among (sometimes) incommensurate criteria is the use of scale scores. In simple words, scale scores are answers that are addressed by combining scores or points. They refer to an indicator's position on the multidimensional space created by all different criteria. There are two basic ways for elaborating scales using the information produced by criteria for choosing indicators:

- Unweighted scale scores
- Weighted scale scores

Table 4

Illustration of unweighted scale scores

Examples of P&E indicators and criteria	measurable	reliable	valid	policy-relevant	user-friendly	sensitive to changes	analytically sound	*any other criteria could be used* comparable	etc	scale
Diarrhoea from unsafe water	1	1	1	1	1	1	1	0	1	8
Respiratory infections from indoor air pollution	1	1	1	1	1	0	1	1	0	7
Low income from land degradation	1	0	0	1	1	1	1	0	0	5
Undernutrition from deforestation	1	1	1	0	0	0	1	1	0	5
Vulnerability from natural disasters	1	0	0	0	1	0	1	1	0	4

1 = criteria considered relevant / 0 = criteria considered irrelevant

Table 5

Illustration of weighted scale scores

Examples of P&E indicators and criteria	measurable		reliable		valid		policy-relevant		user-frinedly		sensitive to changes		analytically sound		comparable		etc		scale
	s	w	s	w	s	w	s	w	s	w	s	w	s	w	s	w	s	w	sum s X w
Diarrhoea from unsafe water	1	X 1	1	X 1	1	X 2	1	X 8	1	X 2	1	X 5	1	X 3	0	X 9	1	X 4	26
Respiratory infections from indoor air pollution	1	X 3	1	X10	1	X 2	1	X 9	1	X 1	0	X 7	1	X 6	1	X 5	0	X 8	36
Low income from land degradation	1	X 2	0	X 1	0	X 4	1	X 8	1	X 9	1	X10	1	X 7	0	X 5	0	X 3	36
Undernutrition from deforestation	1	X10	1	X 8	1	X 9	0	X 1	0	X 2	0	X 3	1	X 7	1	X 6	0	X 4	40
Vulnerability from natural disasters	1	X 3	0	X 1	0	X 2	0	X 3	1	X10	0	X 4	1	X 9	1	X 7	0	X 8	29

s = scores / 1 = criteria considered relevant / 0 = criteria considered irrelevant / w = weights from 1 to 10 / X = multiplication

a) unweighted scale scores

it involves the construction of a rough scale, adding unitary scores for each criterion to provide each indicator with an overall score. This will signal the extent to which a particular indicator satisfies the general criteria. Those criteria that are not satisfied receive a score of 0. The use of an additive scale is the easiest procedure to follow, as illustrated by a fictional example on table 4.

In this hypothetical example, P&E indicators would be chosen based on an attribution of scores given to different criteria. A score scale is built and can be used to make the process of choice of indicators more objective and comprehensive. This means that policy-makers can jointly deliberate on sets of multiple levels and criteria, assessing their convenience. The same technique can be used for the construction of qualitative indicators for policy purposes.

b) weighted scale scores

here, instead of simply adding up scores on each of the criteria, we can weight scores according to the importance attached to them (by policy-makers or local stakeholders). We can then multiply each score by its weight and add them up to have the scale score of each indicator. Here, for the sake of illustration, we have to assume that through decision-making processes, stakeholders gave weights from 1 to 10 to the importance of different dimensions (the more important, the higher).

We can then proceed with the previous example modified, as illustrated by table 5. We have kept all original scores, assuming that all judgments about the attributes remain the same, but now the importance attached to them changes. We can see how this can produce some changes in scale scores. In this other hypothetical example, the ranking of most desirable indicators changes because the value (the importance) attached to the different criteria changes as well. Of course, this is only an illustration, but it conveys an important message about P&E indicators: one should try to anchor the choice of indicators, systematising them if possible as suggested above, on choices made by stakeholders or policy-makers. There is no technical fix for this problem, but the techniques described above can help in organising the information.

Theoretical Models

To conclude this part, it is important to note that as much as conceptual and practical clarifications are crucial for the use and elaboration of P&E indicators, as shown above, it is within theoretical models that indicators are consolidated. Indicators are best seen as part of a system, rather than of a disjoint list of different aspects. The most widely used approach to produce environment indicators is the Pressure-State-Response (PSR) indicator model. It has given rise to variations, such as the Pressure-State-Impact-Response (PSIR) model or the Driving force-State-Response (DSR) model (or the extension known as DPSIR).

The original PSR model, developed by OECD (1993)[43], is based on an assumption of causality going from pressures on the environment, to changes in its state, and society's responses to reduce the pressure (see diagram 6). Thus, responses indicate 'the response of society' (and not of ecosystems as one might think). The DSR model evolved from a substitution of the concept of pressure by that of driving force, or

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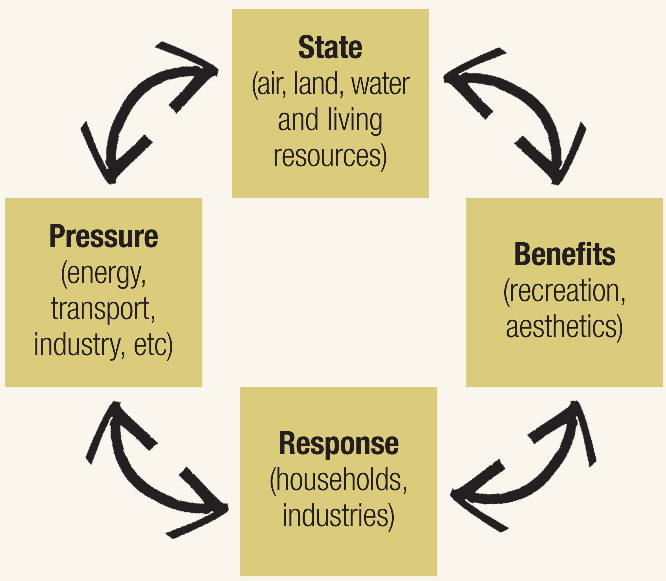
Diagram 6

Cyclical PSR model



drivers, broadening the scope of the causes of environmental pressure. In the early formulations of PSR, pressures relate linearly to responses. Later, feedback loops to pressures were added (diagram 6).

The main benefit of the PSR model is that it provides a systematic way of thinking about environmental indicators within a framework. This generic version is behind many integrated environmental policy models. They give rise to different categories of indicators, namely

- Pressure indicators
- State indicators
- Response indicators
- Impact indicators (in DPSIR models)

Having said that, it should be acknowledged that the PSR model is not free from criticisms. It might be used mechanically, dismissing important complexities within ecosystems and between ecosystems and individuals. Thus, multiple causality is simply eliminated in this formulation. Emphasis on responses can also encourage short-term policies instead of long-term solutions.

It may also prove difficult sometimes to convey the PSR message to local stakeholders, who tend to view the model as a top-down and technical solution to their practical problems[44]. Nevertheless, if understood as a classificatory device, it can prove very useful in the organisation of some causal relations between different environmental and poverty dimensions. As a mechanism for assisting in the identification of causes, it should not be replaced by mechanic solutions.

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Table 6
DPSIR illustration for Mozambique

	Drivers	**Pressure**	**State**	**Impact**	**Response**
Erosion	• lack of land planning • use of traditional fuel • natural hazards	• forest fire • population growth • destruction of mangroves	• water polution • loss of soil fertility • forest fire	• reduction in arable land • loss of biodiversity • increase in hunger	• plans for better using the land • proper agricultural practices • environmental education
Deforestation	• overexploitation of timber • population growth	• housing demand • agricultural development	• forest without coverage • risk of erosion • desertification	• climate change • decrease in biological resources	• legislation and forest management • development of sustainable sources of energy
Water	• navigation • population growth • sanitation	• biological pollution • contamination by excrement drainage out of control	• pH in water • E.coli in fresh water	• access to safe water • diarrhoea • water-borne diseases	• improving sanitation • improving clean water supply
Air	• burning of fossil fuels	• toxic gases	—	• destruction of ozone layer	• development of safe energy • environmental education

Other models have been developed on the basis of the Linear and Cyclical PSR models. For the policy-makers or local-stakeholders, these variations can provide ‘entry-points’ in categorising long lists of disjointed poverty and environment indicators. However, using PSR models is no guarantee of solving the integration and reference conditions, given that chosen indicators can still represent only one dimension of the problem (integrated of degree zero), filling empty spaces in matrices like the one above in table 6, even when they are not very relevant to the particular poverty & environment links of a particular country or local.

A New Methodology for Elaborating Poverty & Environment Indicators

Much can be learned from existing studies and methodologies on P&E indicators. But more could be achieved by trying to overcome some shortcomings that are common to many indicators. First, with few notable exceptions, most indicators are not fully integrated. They either refer to environmental features or to poverty characteristics, but not to both in talking about the constitution of their variables. Geo-referencing is a good way to integrate indicators, but much still needs to be done in this direction when today for poor countries the most basic human and environmental statistics are still not available.

Secondly, the reference condition is not totally solved by most indicators since they do not allow, methodologically, the inclusion of different sustainability criteria and different informational spaces[45] for assessing poverty. However, the use of sustainability criteria to assess the use of physical indicators and the establishment of threshold values and critical loads is fundamental. This should comprise criteria of[46]

- environmental resilience
- functions of ecosystems
- environmental viability or carrying capacity
- environmental integrity
- safe minimum standards

Or any other criteria judged relevant by national policy-makers and local stakeholders. The same applies to the use of poverty lines and multidimensional criteria for assessing what concrete living conditions should be considered unacceptable by human beings in a particular social context. Poverty needs a value (normative) foundation and the environment needs sustainability criteria. How can we build indicators that respect these conditions?

The Theoretical Model

The conceptual basis of the proposed system is grounded on the generation of new variables that represent the links between poverty & environment. These new variables can be obtained by a diversity of methods, but here we explore the possibility of using adjustment factors, because it seems to provide a convenient way to proceed in the face of data scarcity. Before describing how it works, it is useful to refer to the main features of these proposed P&E variables. They are:

i) relational
that is, they have at least two dimensions, one for poverty and one for the environment. As such they reflect the same phenomenon causally and not simply some statistical coincidence. The association must be causal and logical, based on empirical evidence;

ii) objective
indicators based on subjective metrics (people's subjective view of reality) are often biased. So, poverty should be described in objective terms to avoid biases of interpretation. This does not mean that poverty dimensions should not be elected by participatory processes, but that results of decision-making processes can be framed in objective ways, if possible, to avoid distortions;

iii) multidimensional
because many dimensions are uncommensurable, indicators cannot (and should not) be reduced to a common scale (such as a monetary metrics). Important information is lost during this procedure and to avoid this problem, the solution is to describe indicators in their multifaceted aspects.

Adjustment Factors

The rationale for using adjustment factors is simple: we integrate poverty & environment dimensions by 'adjusting' (up or down) poverty levels according to the nature and extent of environmental problems. Three data elements are needed to use this method: the indicator on environmental degradation, the degree of qualified association between environment and poverty (more on that below), and the indicator on poverty.

So, if environmental degradation is high, and poverty is high, it should produce one P&E indicator with high value. The joint impact will naturally depend on the degree of association between these two dimensions. A certain environmental degradation can be high, and a particular dimension of poverty can be high, but if the degree of association between them is low, then the P&E indicator should not be high.

Of course, environmental degradation and poverty are both multidimensional and we should provide a broad framework that accounts for a diversity of combinations between links.

Adjustment factors can then be positive or negative, according to the combination of

Indicator Environmental Degradation (x) Degree of P&E qualified association = Adjustment Factors

circumstances. Once the poverty variables are corrected by adjustment factors, new indicators are produced. It is important to note that these indicators will satisfy the integration condition up to the second level, once they will reveal the valid interactions between the two dimensions. In other words, it can be said that the adjustment factor captures the joint impact of environmental degradation and the association of the degradation with poverty dimensions. The higher the two factors (environmental degradation and association), the higher will be the adjustment factor, suggesting that poverty is also higher when seen from an environmental perspective.

Summary of the New Methodology for Poverty & Environment Indicators

STEP 1 – Data Collection

STEP 2 – Selection of relevant data (criteria: choice of data relevant to the characterisation of the variable aimed at; data coverage; avoidance of duplication, etc)

STEP 3 – Harmonisation of Environmental Scales, aligning the direction of environmental variables (e.g. for traditional energy, the higher, the worse, but for water supply, the higher, the better. In this case, one of the scales could be inverted in order to harmonise them)

STEP 4 – Division of the environmental variables by sustainability criteria. In the absence of these criteria, get averages to know their relative position

STEP 5 – Running one regression for each component of poverty, including as explanatory factors all environmental variables plus control variables

- ✓selection of statistically significant indicators
- ✓verification of coefficients of association (from regressions)
- ✓check especially for: multicollinearity, best fist (R2), heteroscedasticity and t values of statistical significance

STEP 6 – After running the regression, go back to the consolidated dataset and build new columns with those variables that are statistically significant

STEP 7 – Put variables into [0-1] scales (normalisation) in order to be able to integrate them

STEP 8 – Calculate the adjustment factors

- ✓get the relevant environmental variables from step 5
- ✓get the coefficients of regression from step 5
- ✓multiply environmental variables times the coefficients of regressions to obtain new relational P&E variables

STEP 9 – Aggregation of indicators into dimensions

- ✓after putting all P&E indicators into [0-1] scales, take simple averages according to different regions for relevant indicators

STEP 10 – Elaboration of rankings and interpretation (P&E: the closer to 1, the worse)

The resulting P&E indicators reflect the joint qualified association (the links) between poverty and environmental performance. They show the degree to which the environment affects poverty.

They are indicators of relative performance and are not meant to be an indicator of comprehensive social well-being. Quite the opposite, they focus on the P&E links. In its current formulation the method is based on cross-section data. The above technique needs to be adapted to time-series or panel-data.

The Conceptual Model

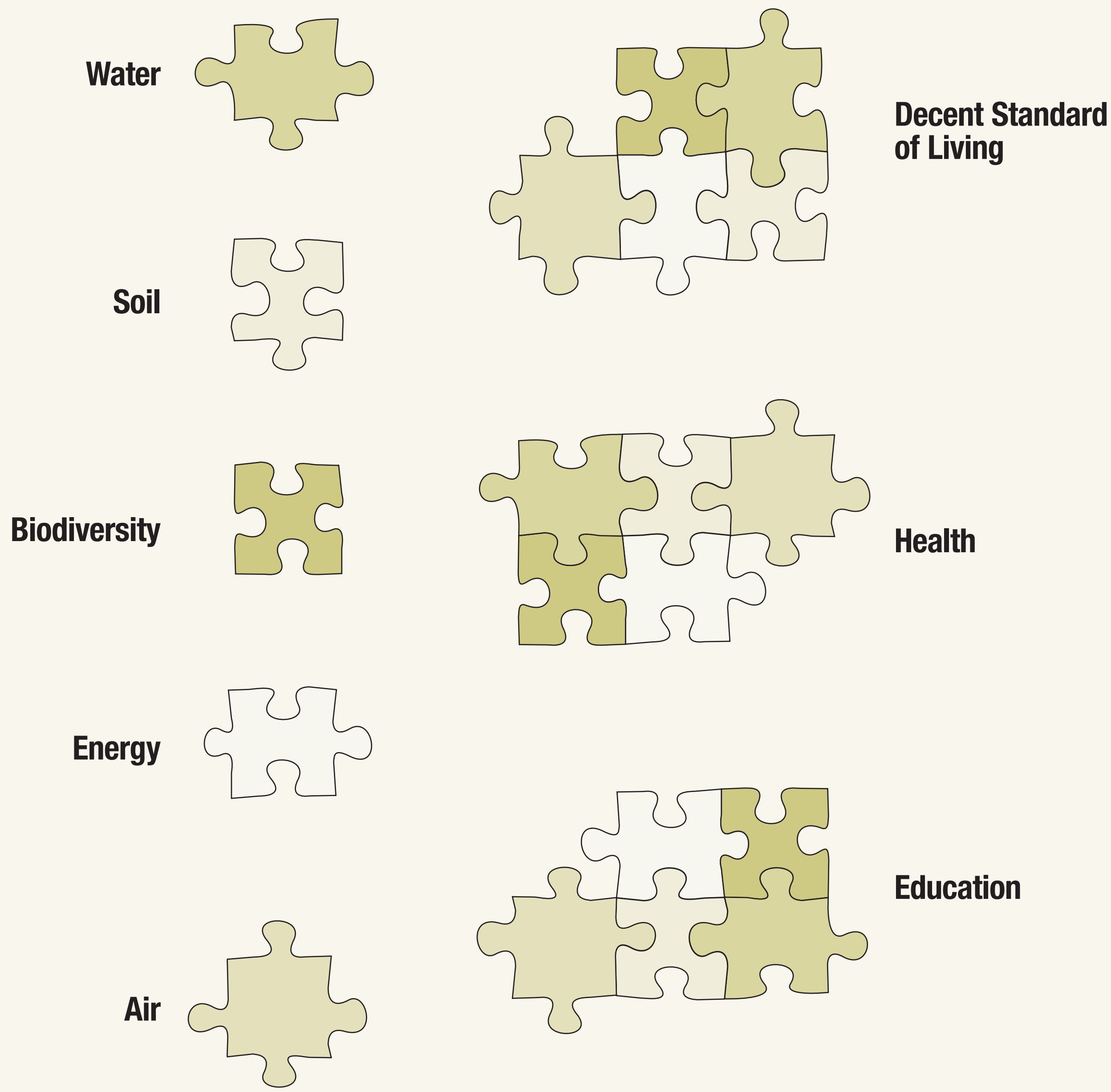
The conceptual model, inspired by the MA's scheme of Ecosystems Services and Determinants and Constituents of Well-Being[47], was tailored according to two principles: i) ecosystem data availability: that limited the focus of analysis on provisioning rather than on regulating or cultural ecosystem services and ii) the human development perspective: that provided a different structure for contextualising the impact of environment on human poverty. This implied a categorisation of poverty following the human-development dimensions, namely, in terms of the categories of 'decent standard of living, health and education'.

However, differently from the Human Development Index or the Human Poverty Index, the proposed P&E index follows different practical methodological principles as discussed below. To summarise the conceptual model, diagram 7 presents the main building blocks of the indicator, with an illustration of what environmental components could affect the constitution of poverty indicators (colours refer to different ecosystem services and their hypothetical impact).

So, for instance, education would suffer the impacts from biodiversity, energy, water and soil. And so on. The selection of the particular five environmental dimensions used above is not important because

Diagram 7

Building blocks for P&E indicators



other could be used. Selection should be part of a public reasoning process where local or national stakeholders identify the dimensions according to their problems and priorities. However, the dimensions chosen here provide an illustration about how poverty and environmental dimensions could be integrated.

By doing so, we can follow the practical steps in specifying the applied model so that the main results of integration can be demonstrated. This model can then be applied by national policy-makers or stakeholders in creating their own P&E indicators. As a theoretical exercise, in the absence of their voice, we use proxies for addressing the necessary reference conditions.

Reference condition 1

Environmental and poverty dimensions should be selected as part of a process of public reasoning and involvement of national or local stakeholders.
PROXY: In the absence of this process, it remains to use indicators based on international consensus according to data availability, such as those provided by MDGs or the HDI.

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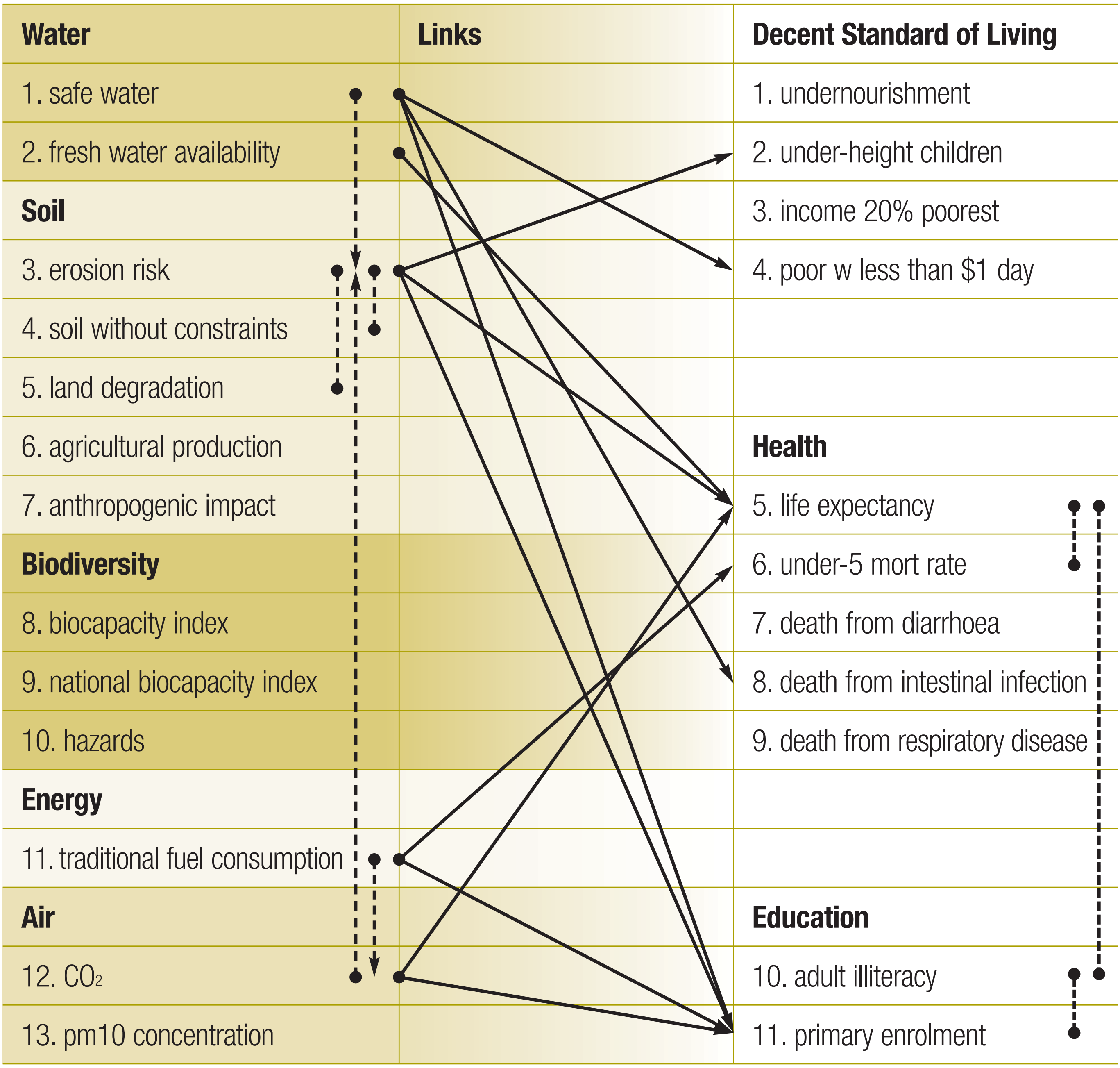
Diagram 8
Mapping P&E links



The Applied Model

In the applied model we carry out a transformation from disjointed environmental and poverty variables into P&E variables, that are, first and foremost, relational, as discussed above. The first step entails a construction of a particular set of building blocks for showing the possibilities of integration between different P&E links. Ideally, countries would be in a position to build a consolidated set of building blocks for their regions.

We checked data availability for three African countries (that participate in the PE Initiative) but were unable to put together a coherent set of poverty & environmental variables for districts or provinces. This does not mean that it cannot be done, but simply that in this opportunity we were unable to access the necessary data. In fact, this exercise can be better carried out by national academics and policy-makers. What is developed here is a suggestion about how they could proceed in using and elaborating P&E indicators.

Step 1 – Organising data

We started collecting data from international organisations and international institutes, within the categories defined by the framework above. Overall, we grouped more than 60 variables into the environmental and human categories suggested above. (Local stakeholders can do the same with local data.)

Then, we 'talked' about the significance of each variable for the model that we had especified. Correlations matrices were used, but in the absence of any statistical means, public discussion (that is, discussion among policy-makers or stakeholders) could bridge this gap. After a process of selection of variables, the following 'map', as described by diagram 8 above, was built:

The arrows are only illustrative here. They suggest relations of causality between different dimensions.

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Reference condition 2

Environmental data needs a 'reference point', as argued above, to become an indicator. Sustainability criteria provide this reference point. They must be defined as part of technical studies and understood by national or local stakeholders. PROXY: In the absence of a consensus about sustainability criteria, other estimators can be used, such as averages or more comprehensive measures.

The lines with dots reveal associations between variables within dimensions. Please, note that the variables presented above are either environmental variables or poverty variables, with a couple of exceptions. They are not relational variables, as defined earlier. The arrows summarise a conceptual investigation of the links between the different sub-components into five categories for the environment and three categories for poverty.

After selecting the variables, we return to the data basis to homogenise all scales of environmental variables, so to ensure that all of them would flow in the same direction. This is not always the case. For instance, 'safe water' is a variable that the higher, the better. Alternatively, 'traditional fuel consumption' is a variable that the higher, the worse, in terms of poverty. We inverted the scales of those 'positive reading' variables, as safe water, so to allow the degradation of all environmental variables being reflected by higher values. This simplifies matters, facilitating reading. We then eliminate the situation of one bad effect being cancelled by the other, elaborating an indicator in which ecosystem degradation will always produce higher levels of environment-induced poverty.

At this stage, it would be important to define whether ecosystem services are sustainable or not. Many different sustainability criteria could be used to classify the environmental variables into different degrees of environmental danger. However, these criteria are better defined by local communities and national policy-makers than simply technically.

For this reason, we chose to simply express the environmental values in terms of their averages as a way of indicating future application of sustainability criteria. The parameter one (1) was used to indicate what is sustainable or unsustainable. If lower than 1, this means that degradation is lower than average and therefore the status of the ecosystem is sustainable. If higher than 1, it means that degradation is higher than average and therefore the status of the ecosystem is unsustainable. For instance in the case of traditional fuel consumption, these averages were 2.50 for Kenya, 2.61 for Mali, 1.08 for Mauritania, 2.74 for Mozambique, 2.55 for Rwanda, 2.84 for Tanzania and 2.82 for Uganda. Apart from Mauritania, all others seem to be in a typical unsustainable path regarding the use of traditional fuel consumption.

Now, it must be emphasised that the use of averages is simply a proxy in the absence of concrete sustainability criteria pointed out by national and local stakeholders. The proposed indicator is, however, very general to allow users to include their own sustainability criteria in classifying their environmental variables.

Step 2 – Running regressions

Once environmental indicators have been homogenised, the next step is to obtain what has been named by 'qualified associations'. In principle, we could use coefficients of correlation to assess the different degrees of association between poverty & environment variables. Correlation coefficients are measures that describe the direction and strength of a linear relationship between any two variables. However, there is no assumption of causality in correlations about the variables. For this reason, it is possible to get good correlations among conceptually unrelated phenomena, such as the level of soil erosion and the number of goals scored by African countries in the last world cup. Therefore, it is important that one qualifies the associations that one assumes by specifying a model of links among different explanatory variables. We can do that through the use of regressions.

Regressions

A regression is an equation, specified by conceptual or empirical reasons, that provides the best linear fit to the observed data. Without entering too much on aspects that might be too technical, we note that many statistical softwares as SPSS or STATA, calculate automatically coefficients for these regressions, showing what is the impact of the independent variable (s) (that is, explanatory variables) on the dependent variable (the variable that one tries to explain).

In our case, the calculated coefficients can show the impact of environmental variables on poverty measures. More specifically, the degree of 'qualified' association is explained by a regressor, calculated under the hypothesis that all other variables remain constant. Variables were codified in the same order described by the diagram 8 above.

Ideally, we could calculate regressions for localities or for nations in order to obtain these coefficients of qualified association between poverty & environment variables. However, scarcity of reliable data has not allowed the implementation of this strategy, even for a small subset of Sub-Saharan countries.

The alternative was to calculate regional coefficients of qualified association, showing the P&E links within continents. As mentioned, this was far from ideal, but given the serious restriction of data availability, it was the best option to demonstrate the workings of the proposed methodology and its adaptability to data restrictions. The same methodology can be applied at national contexts, with the unit 'countries' being substituted for 'provinces' or 'cities'.

Estimated equations were used to explain separately all dimensions of human poverty based on all aspects of environmental degradation. We run 11 complete equations for each continent and for each of those four continents (to allow larger datasets we grouped the countries into the clusters, Americas, Europe, Asia and Africa), running 44 different equations that were used to identify which variables were statistically significant.

By doing so, we did not have to define a priori the number of variables, as most indicators do. Once the categories have been defined, we let statistical analysis to illuminate which particular variables were relevant to particular contexts. Then, short equations were estimated only with those variables considered statistically significant. Table 7 below reports these results for Africa. Before we look at particular figures, it is important to know what they mean. A summary box can help with some guidelines and rules-of-thumb for being able to interpret the results.

Box 7

Basic parameters for interpreting regressions

The specification of the model and its validity is the first thing to note in a regression. The specification followed in all regressions that we run had the form

Poverty = f (environmental variables + control variables)

Control variables are variables that are held constant during the regression. They are not the ones that we are most interested in, but we know that they help to explain the dependent variable. In our case, we have included GDP (Gross Domestic Product) and Public spending on health and education. In the model specified above, we have for instance, for the variable undernutrition:

UNDERNS = f (water1, fresh, eros1, eros2, degr4, prod_i, anthare, bc_ind, nat_bio, hazard, en_trad, co2, pm10, gdp_pc, pe_health, pe_educ)

We can then check for each environmental variable, the value of the coefficient of the regression, known as Beta. Beta is the value that shows the impact (or the degree of qualified association, as we called it) of a particular environmental component on a specific dimension of poverty. If the coefficients are statistically significant, we run again the same regression only with the variables that proved to be significant. In the case of undernutrition we have

UNDERNS = f (prod_i, en_trad)

Thus, two new variables can be created: undernutrition from low agricultural production and undernutrition from the use of traditional energy. These variables are totally integrated and are used for the calculation of adjustment factors for undernutrition.

Results: P&E indicators

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Based on the list of selected indicators (see table 8), adjustment factors can be calculated for each country (or any other unit, e.g. provinces) and each environmental dimension by multiplying the homogenised value of the environmental dimension (the one that expresses environmental variables in relation to the average world performance, but that, ideally, should use sustainability criteria for establishing environmental thresholds) times the (beta) coefficients from the regressions. The calculated adjustment factors can then be used to correct the poverty dimensions. In order to harmonise all human poverty dimensions into a comparable basis, they were fit into a [0-1] scale. The closer to 1, the higher the poverty; the closer to 0, the lower.

P&E indicator

⇓

(environmental dimension x coefficient regr) x poverty dimension

Table 8

Poverty & Environment Indicators

	Poverty & Environment Indicators	Geo-relevance
	Undernutrition Group	
Decent Standard of Living	Undernutrition from erosion risk	America
	Undernutrition from soil without constraints	Europe
	Undernutrition from severe land degradation	America
	Undernutrition from traditional fuel consumption	America, Africa
	Undernutrition from carbon dioxide	America, Europe
	Undernutrition from unsafe water	Asia
	Undernutrition from lack of fresh water	Asia, Europe
	Undernutrition from low agricultural production	Europe
	Undernutrition from loss of biodiversity	Europe
	Under-height children Group	
	Under-height from traditional fuel consumption	America, Asia, Africa
	Under-height from loss of biodiversity	America
	Under-height from loss of biocapacity	America
	Under-height from lack of fresh water	Asia
	Under-height from erosion risk	Asia, Africa
	Under-height from soil without constraints	Asia
	Under-height from carbon dioxide	Asia
	Under-height from unsafe water	Africa
	Under-height from natural hazards	Asia
	Income 20% Poorest Group	
	Income of the poorest from severe land degradation	America, Africa
	Income of the poorest from traditional fuel consumption	America, Africa
	Income of the poorest from loss of biodiversity	America
	Income of the poorest from unsafe water	Asia, Africa
	Income of the poorest from lack of fresh water	Asia
	Income of the poorest from soil without constraints	Asia
	Income of the poorest from PM10 concentration	Asia
	Income of the poorest from loss of biocapacity	Africa
	Income of the Poor Group	
	Income poverty from unsafe water	America
	Income poverty from low agricultural production	Asia
	Income poverty from traditional fuel consumption	America, Africa
	Income poverty from carbon dioxide	America
	Income poverty from loss of biocapacity	America
	Income poverty from lack of fresh water	Asia, Africa
	Income poverty from natural hazards	Asia, Africa
	Income poverty from loss of biodiversity	Africa
	Life expectancy Group	
Health	Reduction in life expectancy from unsafe water	America, Asia
	Reduction in life expectancy from erosion risk	Europe
	Reduction in life expectancy from soil without constraints	America, Europe
	Reduction in life expectancy from traditional fuel consumption	America, Asia, Africa
	Reduction in life expectancy from carbon dioxide	America, Europe

	Poverty & Environment Indicators	Geo-relevance
	Life expectancy Group (cont.)	
Health	Reduction in life expectancy from loss of biocapacity	America, Europe
	Reduction in life expectancy from loss of biodiversity	America
	Reduction in life expectancy from anthropogenic impact	Europe
	Under-5 Mortality Group	
	Under-5 mortality from unsafe water	America, Asia, Africa, Europe
	Under-5 mortality from lack of fresh water	America, Asia
	Under-5 mortality from erosion risk	Europe
	Under-5 mortality from soil without constraints	America, Europe
	Under-5 mortality from severe land degradation	America
	Under-5 mortality from traditional fuel consumption	America, Africa
	Under-5 mortality from anthropogenic impact	Europe
	Under-5 mortality from loss of biocapacity	America, Europe
	Under-5 mortality from loss of biodiversity	America
	Under-5 mortality from carbon dioxide	America
	Under-5 mortality from PM10 concentration	America
	Death from Diarrhoea Group	
	Death from Diarrhoea from unsafe water	America, Asia, Africa
	Death from Diarrhoea from traditional fuel consumption	America, Asia
	Death from Diarrhoea from loss of biodiversity	America, Europe
	Death from Diarrhoea from lack of fresh water	Asia, Africa
	Death from Diarrhoea from anthropogenic impact	Asia
	Death from Diarrhoea from erosion risk	Europe
	Death from Diarrhoea from soil without constraints	Africa
	Death from Diarrhoea from severe land degradation	Africa
	Death from Diarrhoea from loss of biocapacity	Africa
	Death from Intestinal Infectious Disease Group	
	Death from Intestinal Infections from traditional fuel consumption	America
	Death from Intestinal Infections from unsafe water	Asia
	Death from Intestinal Infections from lack of fresh water	Asia, Africa
	Death from Intestinal Infections from erosion risk	Europe
	Death from Intestinal Infections from severe land degradation	Africa
	Death from Intestinal Infections from loss of biodiversity	Europe
	Death from Respiratory Disease Group	
	Death from respiratory disease from unsafe water	America, Asia, Africa
	Death from respiratory disease from lack of fresh water	Asia
	Death from respiratory disease from erosion risk	Europe
	Death from respiratory disease from soil without constraints	America, Africa
	Death from respiratory disease from traditional fuel consumption	Asia, Africa
	Death from respiratory disease from low agricultural production	Africa
	Death from respiratory disease from loss of biodiversity	Africa, Europe
	Death from respiratory disease from loss of biocapacity	Africa
	Adult Illiteracy Group	
Education	Adult illiteracy from unsafe water	Asia
	Adult illiteracy from lack of fresh water	Asia
	Adult illiteracy from erosion risk	Africa, Europe
	Adult illiteracy from soil without constraints	Africa
	Adult illiteracy from low agricultural production	Asia
	Adult illiteracy from anthropogenic impact	Asia, Africa
	Adult illiteracy from traditional fuel consumption	Asia
	Adult illiteracy from carbon dioxide	Asia
	Adult illiteracy from PM10 concentration	Asia
	Adult illiteracy from loss of biocapacity	Asia
	Adult illiteracy from loss of biodiversity	Africa
	Primary Enrolment Ratio Group	
	Decrease in primary enrolment from unsafe water	Asia
	Decrease in primary enrolment from lack of fresh water	America
	Decrease in primary enrolment from severe land degradation	America, Europe
	Decrease in primary enrolment from erosion risk	Europe
	Decrease in primary enrolment from soil without constraints	Asia
	Decrease in primary enrolment from low agricultural production	Asia
	Decrease in primary enrolment from anthropogenic impact	Asia, Europe
	Decrease in primary enrolment from traditional fuel consumption	Africa, Europe
	Decrease in primary enrolment from PM10 concentration	America, Africa
	Decrease in primary enrolment from loss of biocapacity	Asia
	Decrease in primary enrolment from loss of biodiversity	Asia, Europe
	Decrease in primary enrolment from natural hazards	America

The above list of P&E indicators is important per se. In a fashion different from previous P&E indicators, it shows how indicators can satisfy both the reference and integrated conditions. It is true that the proposed methodology only satisfies the reference condition conceptually by allowing a role for normative and technical thresholds in the constitution of environmental indicators. But at least there is reference condition component in the methodology that is ready to be used. In fact, to use here different sustainability criteria as a way of solving the reference condition would entail pre-empting the agency and powers of deliberation of local stakeholders from different countries.

The objective of the proposed methodology is to facilitate a possible way for elaborating P&E indicators and the particular data employed is used with this purpose. In addition, it should be noted that the methodology of using adjustment factors allows the creation of two-dimensional relational indicators that are irreducible to their original meaning. The indicators are also objective.

Moreover, the formula used articulates multiple dimensions and produces a focused way (without indulging into a large variety of primary indicators) of assessing poverty & environment links in developing countries. Other institutional and environmental factors were not included not because they are not important, but simply because they are not part of the core relationships between poverty & environment being investigated.

After aggregating all P&E indicators across dimensions and categories a general P&E indicator was built. The indicator ranges from 0 [low poverty & environment] to 1 [high poverty & environment]. The indicators represent an aggregation of the P&E variables showed above for each country. Table 9 presents the aggregated P&E indicators for all countries and some rough comparisons with the HDI (Human Development Index) and HPI (Human Poverty Index). More important than the particular rankings described below, is the set of possibilities opened by the proposed methodology.

By combining environmental variables and poverty variables through adjustment factors, national or local policy-makers and stakeholders can themselves calculate the indicators for their regions. It must be acknowledged that the estimation of the beta coefficients is not a trivial matter. But it is also true that running ordinary regressions is a well-established and conventional activity in many areas of knowledge. They are much simpler than simulation models currently used for estimating health risks by Cox models[48].

Table 9

2006 P&E Indicators

Country	P&E Indicator	Rank P&E	Rank HDI 2006	Rank HDI minus Rank P&E	Rank HPI 2006	Rank HPI minus Rank P&E
Low Poverty & Environment						
Mauritius	0.02	1	47	46	19	18
Japan	0.05	2	6	4	—	—
Chile	0.06	3	31	28	2	-1
Canada	0.06	4	5	1	—	—
Argentina	0.07	5	29	24	3	-2
Costa Rica	0.08	6	38	32	4	-2
Cuba	0.08	7	40	33	5	-2
Korea. Rep. Of	0.08	8	23	15	—	—
Botswana	0.09	9	100	91	80	71
Sweden	0.09	10	4	-6	—	—
Uruguay	0.10	11	35	24	1	-10
Mexico	0.10	12	41	29	6	-6
South Africa	0.10	13	92	79	43	30
Australia	0.10	14	2	-12	—	—
France	0.10	15	15	0	—	—
Norway	0.10	16	1	-15	—	—
Ecuador	0.11	17	65	48	14	-3
Namibia	0.11	18	96	78	46	28
Armenia	0.11	19	62	43	—	—
New Zealand	0.11	20	19	-1	—	—
Latvia	0.12	21	37	16	—	—
Malaysia	0.13	22	45	23	10	-12
Syrian Arab Republic	0.13	23	80	57	24	1
Gabon	0.13	24	95	71	41	17
Denmark	0.13	25	14	-11	—	—
Finland	0.13	26	8	-18	—	—

Country	P&E Indicator	Rank P&E	Rank HDI 2006	Rank HDI minus Rank P&E	Rank HPI 2006	Rank HPI minus Rank P&E
Low Poverty & Environment (cont.)						
Kazakhstan	0.13	27	59	32	—	—
Jordan	0.14	28	67	39	8	-20
Lebanon	0.14	29	60	31	16	-13
Israel	0.14	30	21	-9	—	—
Spain	0.14	31	18	-13	—	—
Austria	0.15	32	13	-19	—	—
Belgium	0.15	33	11	-22	—	—
Georgia	0.15	34	74	40	—	—
Italy	0.15	35	16	-19	—	—
Kuwait	0.15	36	27	-9	—	—
Libya	0.15	37	49	12	—	—
Thailand	0.16	38	55	17	15	-23
Turkey	0.16	39	69	30	17	-22
Venezuela. RB	0.17	40	56	16	13	-27
Peru	0.17	41	64	23	20	-21
Kyrgyzstan	0.17	42	83	41	—	—
Netherlands	0.17	43	9	-34	—	—
United States	0.17	44	7	-37	—	—
Panama	0.18	45	43	-2	9	-36
China	0.18	46	63	17	21	-25
Iran. Islamic Rep. of	0.18	47	73	26	30	-17
Algeria	0.18	48	77	29	38	-10
Greece	0.18	49	22	-27	—	—
Slovenia	0.18	50	24	-26	—	—
United Kingdom	0.18	51	17	-34	—	—
Brazil	0.19	52	53	1	18	-34
Sri Lanka	0.19	53	71	18	32	-21
Ireland	0.19	54	3	-51	—	—
Azerbaijan	0.20	55	75	20	—	—
Czech Republic	0.20	56	26	-30	—	—
Germany	0.20	57	20	-37	—	—
Poland	0.20	58	30	-28	—	—
Portugal	0.20	59	25	-34	—	—
Moderate Poverty & Environment						
Tunisia	0.21	60	68	8	33	-27
United Arab Emirates	0.22	61	39	-22	29	-32
Indonesia	0.22	62	81	19	35	-27
Switzerland	0.22	63	10	-53	—	—
Paraguay	0.23	64	70	6	11	-53
Morocco	0.23	65	94	29	48	-17
Lithuania	0.23	66	33	-33	—	—
Viet Nam	0.24	67	82	15	28	-39
Egypt	0.25	68	84	16	37	-31
Congo	0.25	69	107	38	42	-27
Belarus	0.25	70	52	-18	—	—
Philippines	0.26	71	66	-5	26	-45
Mongolia	0.27	72	89	17	36	-36
Cameroon	0.28	73	110	37	50	-23
Swaziland	0.28	74	112	38	84	10
Estonia	0.29	75	32	-43	—	—
Colombia	0.30	76	54	-22	7	-69
Gambia	0.30	77	120	43	73	-4
Uzbekistan	0.30	78	86	8	—	—
Bolivia	0.31	79	88	9	23	-56
Myanmar	0.31	80	99	19	39	-41
Ghana	0.31	81	103	22	47	-34
Côte d'Ivoire	0.31	82	129	47	69	-13
Zimbabwe	0.31	83	116	33	75	-8
Turkmenistan	0.31	84	78	-6	—	—
Kenya	0.32	85	117	32	49	-36
Togo	0.32	86	113	27	59	-27
Lesotho	0.32	87	114	27	76	-11
Iraq	0.32	88	—	—	—	—

Country	P&E Indicator	Rank P&E	Rank HDI 2006	Rank HDI minus Rank P&E	Rank HPI 2006	Rank HPI minus Rank P&E
Moderate Poverty & Environment (cont.)						
Hungary	0.32	89	28	-61	—	—
Russian Federation	0.32	90	50	-40	—	—
Trinidad and Tobago	0.33	91	44	-47	12	-79
Benin	0.34	92	128	36	77	-15
Romania	0.34	93	46	-47	—	—
High Poverty & Environment						
Senegal	0.35	94	121	27	71	-23
Luxembourg	0.35	95	12	-83	—	—
Saudi Arabia	0.35	96	58	-38	—	—
Ukraine	0.35	97	61	-36	—	—
Angola	0.36	98	126	28	66	-32
Malawi	0.36	99	131	32	70	-29
Jamaica	0.37	100	79	-21	25	-75
Sudan	0.38	101	108	7	45	-56
Tanzania. U. Rep. of	0.38	102	127	25	55	-47
Papua New Guinea	0.38	103	106	3	62	-41
Mauritania	0.38	104	118	14	68	-36
Guinea-Bissau	0.38	105	138	33	79	-26
Tajikistan	0.38	106	93	-13	—	—
Bangladesh	0.39	107	104	-3	72	-35
Slovakia	0.39	108	34	-74	—	—
India	0.40	109	97	-12	44	-65
Uganda	0.40	110	111	1	52	-58
Madagascar	0.40	111	109	-2	53	-58
Central African Republic	0.40	112	137	25	78	-34
Zambia	0.41	113	130	17	74	-39
Mozambique	0.41	114	133	19	81	-33
Albania	0.41	115	57	-58	—	—
Rwanda	0.42	116	123	7	56	-60
Dominican Republic	0.43	117	72	-45	22	-95
El Salvador	0.43	118	76	-42	27	-91
Guinea	0.43	119	125	6	83	-36
Lao People's Dem. Rep.	0.44	120	101	-19	51	-69
Congo. Dem. Rep. of the	0.44	121	132	11	67	-54
Croatia	0.44	122	36	-86	—	—
Burkina Faso	0.46	123	139	16	88	-35
Pakistan	0.47	124	102	-22	54	-70
Nepal	0.47	125	105	-20	58	-67
Yemen	0.47	126	115	-11	64	-62
Burundi	0.47	127	134	7	65	-62
Korea. Dem People's Rep.	0.47	128	—	—	—	—
Bulgaria	0.48	129	42	-87	—	—
Cambodia	0.49	130	98	-32	60	-70
Very High Poverty & Environment						
Honduras	0.50	131	90	-41	31	-100
Moldova. Rep. of	0.50	132	87	-45	—	—
Guatemala	0.51	133	91	-42	40	-93
Nigeria	0.51	134	124	-10	63	-71
Liberia	0.52	135	—	—	—	—
Chad	0.53	136	136	0	87	-49
Eritrea	0.55	137	122	-15	57	-80
Macedonia	0.55	138	51	-87	—	—
Sierra Leone	0.56	139	141	2	82	-57
Nicaragua	0.58	140	85	-55	34	-106
Ethiopia	0.58	141	135	-6	85	-56
Bosnia and Herzegovina	0.60	142	48	-94	—	—
Mali	0.61	143	140	-3	89	-54
Somalia	0.63	144	—	—	—	—
Niger	0.65	145	142	-3	86	-59
Haiti	0.71	146	119	-27	61	-85
Serbia and Montenegro	0.80	147	—	—	—	—
Afghanistan	n.d.	148	—	—	—	—

Looking at the performance of selected countries (in red), it is possible to see that the P&E rank offers a new perspective, in contrast to some established measures of human poverty, namely, the HPI and the HDI. The situation of some countries remains unchallenged, such as the situation of Mali and Kenya. Mali has the worst value independently from the chosen rankings. Kenya has the best situation according to HPI and the P&E indicator.

However, the P&E indicator reveals that the distance among the other countries, such as Rwanda, Mozambique, Uganda, Mauritania and Tanzania is not as big as suggested by the HPI, showing that the environmental condition in other countries is also worth of concern. Some changes in the P&E ranking point out that environmentally-induced poverty is higher in Rwanda than in Mozambique and much higher in Uganda than suggested by a simple reading of the HDI.

When considered as a group, it is evident that the general level of poverty and environment in the seven African countries that are part of the P&E Initiative is much higher than what can be found for other groups, as shown by table 10.

Following the standard procedures established by the HDI and HPI, a categorisation of countries could be suggested. In the HDI countries are divided into 'high human development', 'medium human development' and 'low human development'. This classification is followed to report the HPI figures as well. Here, countries could be similarly classified, with thresholds fixed at approximate percentages used by the 2006 HDI, 29% and 25% for the lowest and highest groups, respectively.

We would add an intermediate dimension to increase the categories of classification of the P&E indicator (see box 8 below). This is measured in terms of the goalposts for minimum and maximum values. Considering Mauritius and Haiti as the P&E goalposts, we would have a range similar to the HDI. The thresholds will then be fixed, as illustrated by the blue lines, in the table above.

Results of this classification suggest that Kenya is the only country with 'moderate' poverty & environment pressure, but it should be noted that it is not very far away from the 'high' poverty & environment group, where most countries participating in the PE initiative in Africa are. The only country in a situation of 'very high' poverty & environment pressure is Mali.

Having said that, it is worth mentioning again that the particular empirical results presented here serve primordially as illustrations in order to make the proposed methodology more concrete and accessible for readers. This report was designed to support initiatives by countries to produce P&E indicators.

But how can these indicators be used to guide policy and planning processes at country level? The first issue to be addressed is that for many countries this methodology can be a chimera because of problems of data availability. Indeed, part of our experience with fieldwork in Mozambique and Rwanda was the lack of reliable environmental data needed for a methodology like the one proposed here. In this case, an important recommendation put forward by this report is the strengthening of data collection and statistical work in countries interested in developing P&E indicators. The minimum data sets recommended would contemplate:

- **data about water access and quality**
- **data about land degradation (including erosion risk)**
- **estimates of biocapacity and vulnerability to natural hazards**
- **data about energy availability and use**
- **data about air quality**
- **data on undernourishment and anthropocentric measures**
- **mortality rates data**
- **education data**

As much effort as there is being made currently to expand these datasets in most countries participating in the PE Initiative, more needs to be done in terms of the construction of more spatially accurate data sets and their relation to human development variables.

Once this initial effort has born fruit, the resulting indicators can be used as important inputs in the definition of human development strategies and in the elaboration of plans such as the PRSPs (Poverty Reduction Strategy Papers). In particular, attention should be given to the 'reference condition', as discussed in this report, emphasizing the relevance of participation and public reasoning in the construction of governance structures able to carry out on a sustainable basis the collection of data and production of statistics. It must be noted that only by a close monitoring of the links between poverty and environmental dimensions, will governments be able to face the challenges of further environmental degradation predicted for this century, at the same time that they strive to improve the well-being of their populations –a large part living in poverty.

Box 8

Poverty & Environment categories

Following a classification suggested by the MA's analysis of the Drivers of Changes in Biodiversity and Ecosystems, we divide the impact of P&E associations into four categories:

- **very high poverty & environment [0.71 to 0.50]**
  countries in this category have very high levels of poverty combined with very high levels of degradation of their ecosystems. This is the case of Mali.
- **high poverty & environment [0.49 to 0.35]**
  countries in this category have high levels of poverty associated with high levels of degradation of their ecosystems. It is the case of Rwanda, Mozambique, Uganda, Mauritania and Tanzania.
- **moderate poverty & environment [0.34 to 0.20]**
  countries in this category have moderate levels of poverty partially associated with environmental degradation. It is the case of Kenya.
- **low poverty & environment [0.19 to 0.02]**
  countries here are characterized by relatively lower levels of poverty associated with environmental degradation.

An important caveat: because we are working here with 'national averages' it might well be that given the dispersion of national averages across different provinces in a country, we obtain indicators that are not representative of problems faced by particular countries. In this case, the problem is with the lack of representativeness of 'averages' and not with the method presented here, once it can be applied at province level. Ideally, it was conceived to be applied at local level.

Table 10

P&E Regional Averages

	Standard of Living	Health	Education	General
Africa	0.38	0.38	0.30	0.36
America	0.22	0.20	0.39	0.26
Asia	0.32	0.22	0.20	0.25
Europe	0.34	0.20	0.24	0.27
P&E Countries	0.47	0.48	0.31	0.42
OECD	0.25	0.11	0.13	0.16

Notes

[1] Millennium Ecosystem Assessment (2005: 13), Synthesis Report.

[2] DFID et al (2002: v), Linking Poverty Reduction and Environmental Management: policy challenges and opportunities.

[3] Source: “Population with sustainable access to an improved water source (%) 2004” in United Nations Development Programme, Human Development Report 2006, accessed November 2006: http://hdr.undp.org/hdr2006/statistics/countries/data_sheets/cty_ds_NOR.html. (Millennium Indicators Database. Department of Economic and Social Affairs, Statistics Division, New York.[http:// mdgs.un.org.]. Accessed July 2006. , based on a joint effort by the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO))

“Population undernourished (% total) 2001-2003” (data refer to the average for the years specified) in United Nations Development Programme, Human Development Report 2006, accessed November 2006: http://hdr.undp.org/hdr2006/statistics/countries/data_sheets/cty_ds_NOR.html. (Millennium Indicators Database. Department of Economic and Social Affairs, Statistics Division, New York.[http:// mdgs.un.org.]. Accessed July 2006. , based on data from the Food and Agriculture Organization (FAO))

[4] Source: “Traditional fuel consumption (% of total energy requirements) 2003” in United Nations Development Programme, Human Development Report 2006, accessed November 2006: http://hdr.undp.org/hdr2006/statistics/countries/data_sheets/cty_ds_NOR.html. Estimated consumption of fuel wood, charcoal, bagasse (sugar cane waste) and animal and vegetable wastes.

“Population undernourished (% total) 2001-2003” (data refer to the average for the years specified) in United Nations Development Programme, Human Development Report 2006, accessed November 2006: http://hdr.undp.org/hdr2006/statistics/countries/data_sheets/cty_ds_NOR.html. (Millennium Indicators Database. Department of Economic and Social Affairs, Statistics Division, New York.[http:// mdgs.un.org.]. Accessed July 2006. , based on data from the Food and Agriculture Organization (FAO))

[5] The concept of ecological footprint will be discussed in the next section, but it can be anticipated that it measures the area of productive land and aquatic ecosystems needed to produce the resources used, plus wastes, for a certain population.

[6] Source: Human Development Index (HDI) 2006, em www.undp.org Ecological Footprint (EF) 2003, em Living Planet Report, 2006; www international.
Just for clarification, it is useful to mention the HDI grouping:
Low Human Development: HDI 0.50
Medium Human Development: 0.51 HDI 0.80
High Human Development: 0.81 HDI........................1.00
This exercise updated a similar calculation run by Professor Morse. Please, see for reference:

Morse, S. Greening the United Nations Human Development Index?, Sust. Dev. 11, 183-198 (2003)

Published online 15 July 2003 in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/ sd.219

[7] A model based on panel data was used to estimate the impact of biocapacity on the human development index. A monetary poverty measure (P0) based on US$1 and the indicator of traditional fuel consumption (TFC) were used as controls for three periods for 46 countries (the number of countries with HPI-1). The model estimated was $HPI1_{it} = \beta_0 + \beta_1 BC_{it} + \beta_2 Po_{it} + \beta_3 TFC_{it} + \mu_{it}$
Kenya, Mali, Mozambique, Rwanda and Tanzania were included in this sample. Uganda and Mauritania were not included because did not have data available for at least one of the periods.
The equation was estimated in logarithms in order to obtain coefficients with elasticity information. The statistical programme used was STATA. The results were: $\ln HPI1_{it} = 0.2977505 - 0.2636731 \ln BC(it) + 0.5556385 \ln PO_{it} + 0.2148206 \ln TFC_{it}$
All coefficients were statistically significant at 1% level.
For those interested in the technique used, good introductions can be found in
- Arellenano M. Panel data econometrics. New York: Oxford University Press, 2003. Chapters 1 & 2.
- Wooldridge, J. M. Econometric analysis of cross section and panel data. London: MIT press. Chapters 7, 9 & 10.

[8] Biocapacity, as defined in the Living Planet Report (2006: 2) is “the amount of biologically productive area – cropland, pasture, forest, and fisheries- that is available to meet humanity’s needs.” They calculate the impact on freshwater consumption separately.

[9] Formally, we calculate an elasticity by the ration of percentage change in poverty divided by percentage change in biocapacity.

[10] A good illustration is provided by the work of Ness, B., Urbel-Piirsalu, E., Anderberg, S. and Olsson, L. (2007) ‘Categorising tools for sustainability assessment’, Ecological Economics, 60, pp. 498-508.

[11] For instance, there is a long and established line of economic indicators that have not been explored, such as ‘Genuine Savings’ or ‘NNP’ (Net National Product) for not being easily translated into a multidimensional view of poverty. For a discussion on NNP and the links between wealth and well-being, more can be found on chapter 9 of Dasgupta, P (2001) Human Well-Being and the Natural Environment. Oxford: Oxford University Press. For another account, please see ‘Where is the Wealth of Nations? Measuring Capital for the XXI Century’. Washington: The World Bank, 2006.

[12] Quoted from 2005 Environmental Sustainability Report (p. 13). The report is available on-line at www.yale.edu/esi.

[13] In UNDP, UNEP, IIED, IUCN and WRI (2005) Assessing Environment’s Contribution to Poverty Reduction. New York: UNDP, the Environmental Sustainability Index is criticised. They argue that (p. 38) “The ESI does not include measures of poverty or economic conditions nor does it define environmental sustainability. So it does not provide a strong model for linking environmental conditions to social and economic development. Countries are ranked against one another but not against a standard or set of criteria that would lead to environmental sustainability. So, in the terminology of this paper, there is no defined target.”

[14] Source: Prescott-Allen, Robert (2001) The Well-Being of Nations. Island Press and International Development Research Centre.

[15] See the Report on the 2005 Environmental Sustainability Index, p. 17 for a critique of the WBI.

[16] See Raworth, K. And Stewart, D. (2003) “Critiques of the Human Development Index: a review”. In: Fukuda-Parr, S and Kumar, A.K (2003) Readings in Human Development. Oxford: Oxford University Press. pp. 164-176.

[17] For instance, Sagar and Najam (1998: 263) argue that “So far, the HDI has neglected links to sustainability by failing to investigate the impact on the natural system of the activities that potentially contribute to national income –and hence to HDI. The question that needs to be asked is: human development, but at what cost? (...) For the HDI to capture the sustainability dimension of human development, it will need to incorporate some mechanism for accounting over-exploitation of natural resources.” Source: Sagar, A. and Najam, A. (1998) “The Human Development Index: a critical review” Ecological Economics, 25, pp. 249-264.

[18] For further discussion on these critiques, see Neumayer, E. (2001) "The Human Development Index and Sustainability –a constructive proposal". Ecological Economics, 39, pp. 101-114.

[19] Source: De La Vega, M.C. and Urrutia, A.M. (2001) "HDPI: A Framework for Pollution-Sensitive Human Development Indicators" Environment, Development and Sustainability, 3, pp. 199-215.

[20] Source: Morse, S. (2003) "Greening the United Nations' Human Development Index?" Sustainable Development, 11, pp. 183-198.

[21] Source: Neumayer, Eric. (1999) "The ISEW – Not an Index of Sustainable Economic Welfare". Social Indicators Research, 48, pp. 77-101. See his critiques of ISEW on p. 78.

[22] Bell and Morse (2003: 39) argue that "Indicator integration is basically a means by which individual and quite different indicators in a framework can somehow be viewed together to provide an holistic view of SD[sustainable development]". (Bell, S. and Morse, S. (2003) Measuring Sustainability. London: Earthscan.) Ness et al (2007: 501) suggest that "The tools in the category of indicators and indices are either non-integrated, meaning that they do not integrate nature-society parameters, or integrated, meaning the tools aggregate the different dimensions."

[23] For more information please see Bell and Morse (2003: 40-41).

[24] Kruiif and Van Vuuren (1998) emphasise the importance of satisfying the integration condition in sustainability indicators. This requirement is not simply a question of communicating better the information provided by complex statistics, but mainly a question of coherence and choice of integration tools. In any case, the relevance of the task is mandatory in their view. As they argue (1998: 8), "Because the concept of sustainable development calls for an integrated consideration of processes and impacts in all relevant domains of life (social, economic, and environmental domains), there is a need for indicator systems that reflect this integration." (H.A.M. De Kruijf and D.P. Van Vuuren (1998) "Following Sustainable Development in Relation to the North-South Dialogue: Ecosystem Health and Sustainability Indicators". Ecotoxicology and Environmental Safety, 40, pp. 4-14).

[25] For instance, Shyamsundar (2002: 2) argues that "The poverty-environment relationship is complex and dynamic, and difficult to comprehend in all of its dimensions". Source: Shyamsundar, P. (2002) Poverty-Environment Indicators. Environmental Economics Series. Paper no 84. Washington: World Bank.

[26] This is the case of all contributions discussed in the section on poverty & environment indicators.

[27] Source: Shyamsundar (2002: 5) and World Bank (2000) "Health and Environment" Environment Strategy Background paper. Washington: World Bank.

[28] Source: Perman, R., Ma, Yue, McGilvray, J and Common, M (2003) Natural Resource and Environmental Economics. London: Pearson & Addison Wesley. 3rd Edition. See Chapter 4 for a discussion on sustainability.

[29] An in-depth discussion of these concepts will be the object of the second report of this series, exploring the implications of working with different sustainability criteria for the elaboration of poverty & environment indicators.

[30] Source: DFID, EC, UNDP and the World Bank (2002) Linking Poverty Reduction and Environmental Management: policy challenges and opportunities. Washington: The World Bank. Quotation is from p. 2.

[31] Based on DFID, EC, UNDP and the World Bank (2002) Linking Poverty Reduction and Environmental Management: policy challenges and opportunities. Washington: The World Bank, p. 18.

[32] Source: Henninger, N. And Hammond, A (2002) "Environmental Indicators Relevant to Poverty Reduction" Environment Strategy Papers, n. 3, part 1, January. Quotation from page v.

[33] Source: Reed, D. and Tharakan, P. (2004) Developing and Applying Poverty Environment Indicators. Washington: WWF Macroeconomics Program Office.

[34] See Reed and Tharakan (2004:10-11) for a complete description of the three categories of indicators.

[35] Quoted from Reed and Tharakan (2004: 12).

[36] Source: UNDP, UNEP, IIED, IUCN and WRI (2005) Assessing Environment's Contribution to Poverty Reduction. New York: UNDP

[37] Quotation from UNDP, UNEP, IIED, IUCN and WRI (2005: 7).

[38] From Table 3, UNDP, UNEP, IIED, IUCN and WRI (2005: 17), based on DFID et al (2002).

[39] Quotation from UNDP, UNEP, IIED, IUCN and WRI (2005: 22). In the sequence they also argue that (p. 27) "National indicators are also useful for policy-makers and civil society to gauge performance for the goals and targets that have been agreed upon. But, to undertake substantial planning and investment strategies in a country, there need to be quantifiable and useful indicators at the sub-national level." The main obstacle here, as they acknowledge, is that countries do not monitor and measure their provision, regulating and cultural services.

[40] This important point is raised by Gallopin, G. (1997: 13). The full quotation is: "Some clarity and consensus is required about the definition of what an indicator is, as well as in the definition of related concepts such as threshold, index, target and standard. This consensus cannot be based solely on political agreement; logical and epistemological soundness is also necessary." Gallopin, G. (1997) "Indicators and their use: information and decision-making". In: Moldan, B., Bilharz, S. and Matravers, R. (eds) Sustainable Indicators: a report on the project on indicators of sustainable development. Chechester: John Wiley and Sons, pp. 13-27.

[41] Source: Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-Being: synthesis. Washington: Island Press. See reference on p. 68.

[42] For more examples see UNDP, UNEP, IIED, IUCN and WRI (2005: 19).

[43] Source: OECD (Organisation for Economic Cooperation and Development) (1993) Core Set of Indicators for Environmental Performance Reviews: a synthesis report by the group on the state of the environment. Paris: OECD.

[44] For a good summary of these critiques see Bell and Morse (2003), chapter 2.

[45] An informational space is an informational basis for evaluative assessments. It refers to particular aspects of a person or state-of-affairs that are used for comparisons. For more on that, see Sen, A (1992) Inequality Re-examined. Oxford: Oxford University Press. Introduction.

[46] Source: Rennings, Klaus and Wiggering, Hubert (1997) "Steps towards indicators of sustainable development: linking economic and ecological concepts" Ecological Economics, 20, pp. 25-36.

[47] Source: Alcamo, J. et al (2003) Ecosystem Services and Human Well-Being: a framework for assessment. Washington: Island Press. See summary, figure 1 (p. 5).

[48] See the HDR (2006: technical note 3), pp. 402-403 for an illustration of this methodology.


MARK EDWARDS/STILL PICTURES

CSC

Capability and Sustainability Centre
Von Hügel Institute, St.Edmund's College, Cambridge CB3 0BN, UK
www.st-edmunds.cam.ac.uk/csc