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(please, do not quote)

Poverty&Environment Indicators

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Foreword

This report has been prepared for UNEP under the Poverty&Environment Initiative. It is the first report of a sequence that explores different aspects of using and developing Poverty&Environment indicators. The reports are targeted to African policy-makers working with poverty&environment issues. The language used is less academic and most examples are based on the reality of African countries. However, it is expected that some technical language will remain and for this reason it is important to see the reports as part of a capacity-building strategy in which complementary training might be needed.

The objective of this first report is to address the issue of Identification of Poverty&Environment Links. The second report delves into technical aspects in using separately available Poverty *and* Environment Indicators. Finally, the third report covers the use of Poverty&Environment indicators for Policy-Making. Together these reports aim to provide a 'box of tools' to policy-makers, facilitating their use of indicators to mainstream environment into poverty-reduction strategies. They should be seen as a set of theoretical and practical elements inviting readers to think about Poverty&Environment indicators. All reports are accompanied by an annex with an in-depth discussion of the theme in a technical language for those interested in the background questions.

Introduction

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).

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.

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.

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.

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.

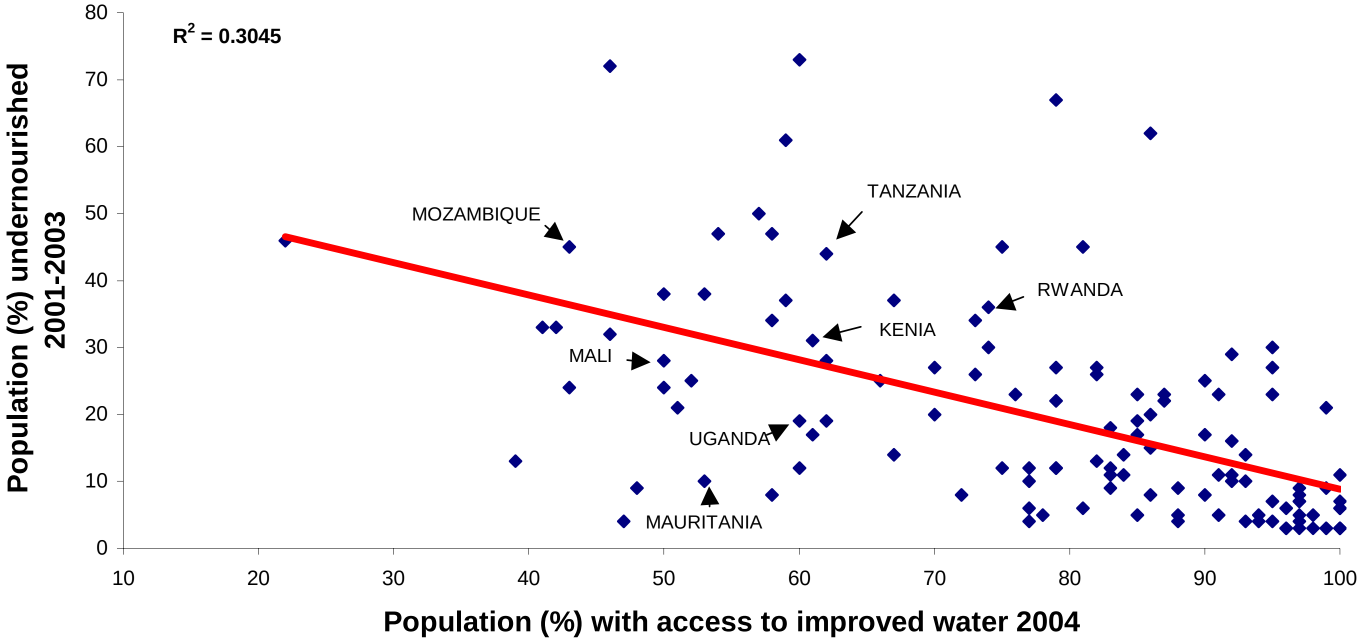
It is important to note that both issues, namely, poverty and environment, are about benchmarks and thresholds. In the first case, what is considered acceptable or not for a human being to be or to do is a question that depends on the values and ethical norms of particular societies. In the second case, 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.

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.

Before we conclude the introduction, it is interesting to consider some general empirical evidence about the association between environmental aspects and poverty features. It is important to confront the widespread felling, still common in some countries, of scepticism towards the essential function of the environment in promoting human well-being and reducing poverty. 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.

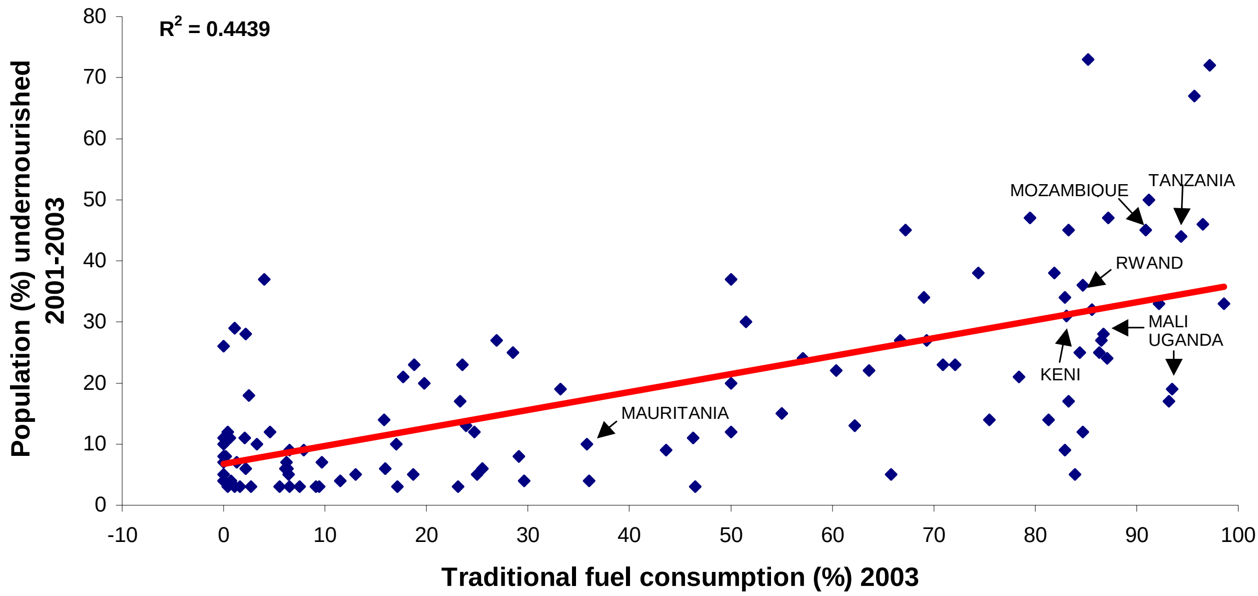
A brief look at the diagram 1 below reveals the existence of an inverse relation between the population with access to improved water and incidence of undernourishment for most countries in the world. The message suggested by the evidence is straightforward: water access is an important component in providing for a good nutrition. This is particularly relevant for countries developing their PRSPs that should consider water management as part of their poverty-reduction strategies.

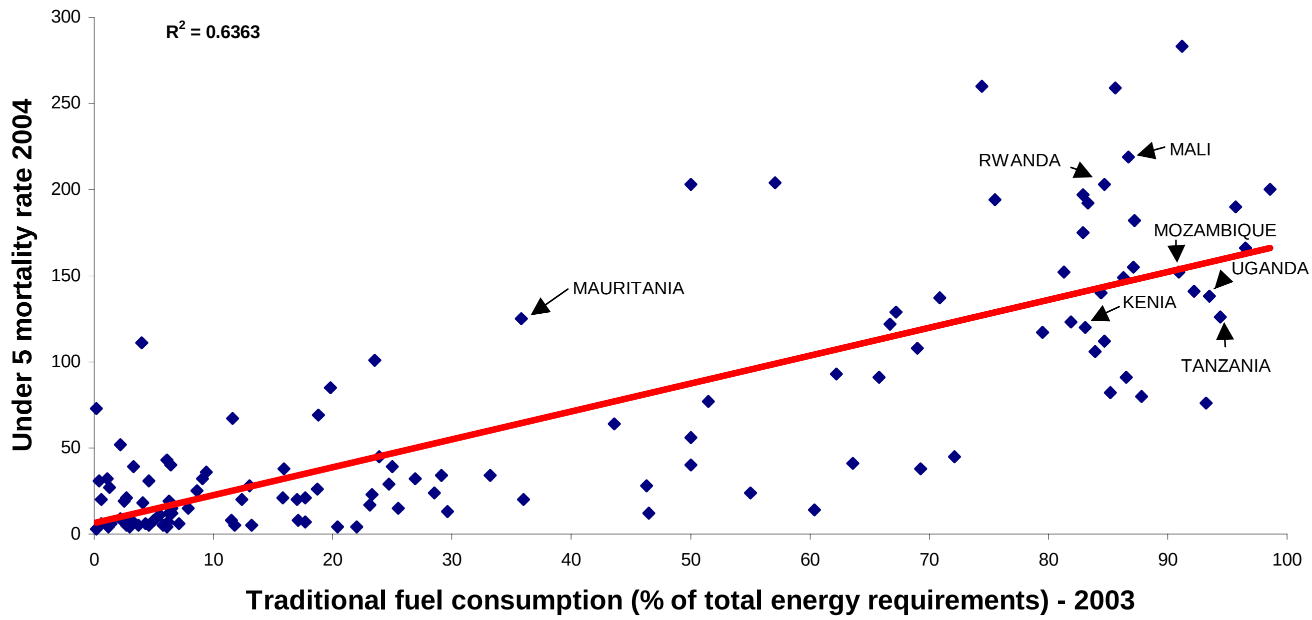
Diagram 1 – Water and Nourishment[3]



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. Thus, the provision of more environmentally-friendly sources of energy is also a step towards poverty-reduction.

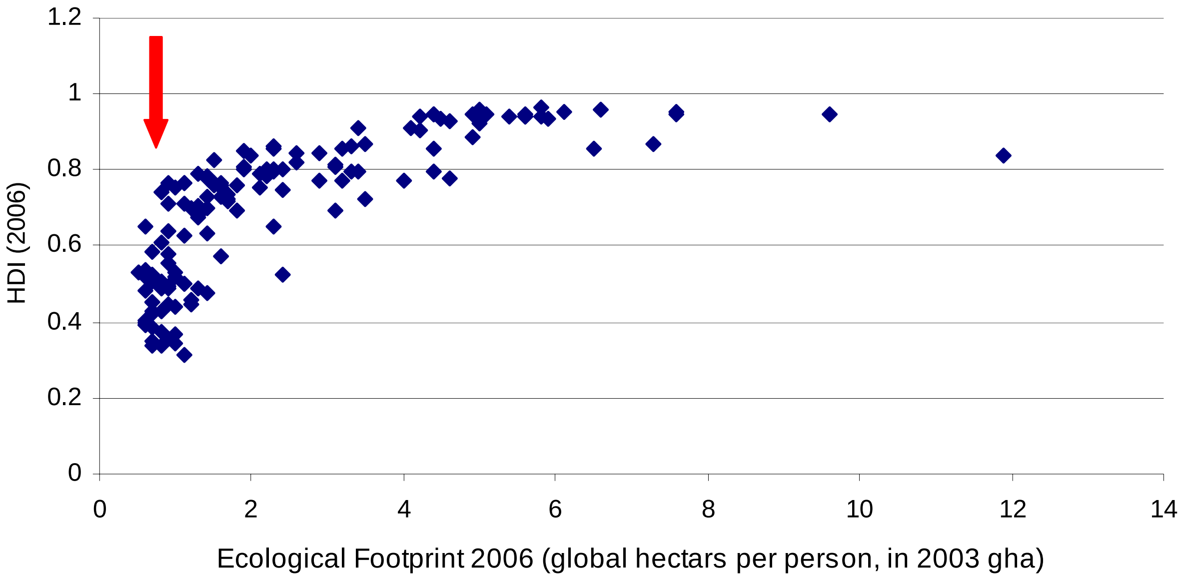
Diagram 2 – traditional fuel consumption, nourishment and under-five mortality rate[4]





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 red arrow in diagram 3 below.

Diagram 3 – human development and ecological footprint[6]



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 summary measure that resumes 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]).

$$\frac{\Delta\% HPI_1}{\Delta\% BC} = -0.26$$

when environment degrades in 1% poverty increases in 0.26%

This formula shows the percentage change of poverty divided by the percentage change in biocapacity

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. This issue is addressed in the last part of this report. In what follows we analyse previous attempts at handling the links between poverty and environment in order to produce indicators.

Reviewing Studies on Human Well-Being&Environment Indicators

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 better understanding them) 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, this category of 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. Without trying to be comprehensive, it is possible to classify the indicators into five basic categories, as illustrated by the table 1 below. These groups 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. It is important to emphasise that these are just some of aggregate type indicators among the most prominent and that a comprehensive list is out of the scope of this work[11] .

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 of 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

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 taken 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, "In the 11 years after Rio, between 1992 and 2003, measured in constant global hectares, the average per person footprint in low and middle-income countries, changed little, while the average per person footprint in high-income increased by 18 per cent. Over the last 40 years, the average footprint in low-income countries hovered just below 0.8 global hectares per person." So, one problem with the Ecological Footprint measure is that is seems best adapted to address sustainability issues that might emerge from developed countries. Most poor countries's 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.

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 data sets) 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 tough 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 below).

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."

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 below). The lower the scores, the lower are the levels of sustainability in the different dimensions.

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

Source: 2005 ESI

Individual performances are best understood by looking at the different dimensions. For instance, it is possible to see in the table above the high 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[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. Overall, 36 indicators are used for HWI and 51 indicators are used for EWI respectively. 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].

Indicators should be arranged hierarchically to tell a coherent story

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 '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 is 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*.

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 value 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 form of integrating the human and the environmental dimensions

To conclude this item, 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 an 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 being integrated. For this matter, the Ecological Debt indicator does just that. There are many forms 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 form of integrating the human and the environmental dimensions. Box 4 below looks at the integration issue in depth. The third part of this report explores the concept of adjustment factors.

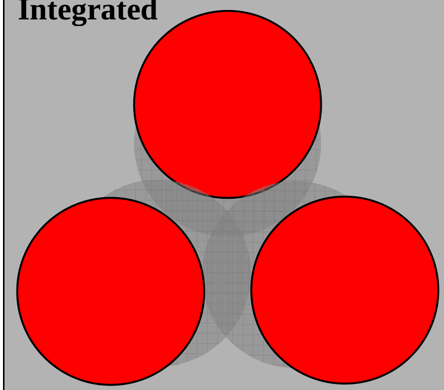
Box 4 – The Integration Condition

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:

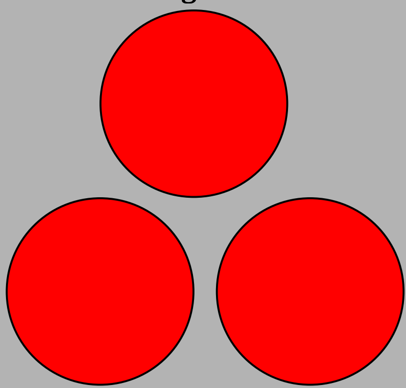
- Monetisation of dimensions: money is used as a common denominator as in 'green accounting'
- Use of diagrams, such as AMOEBA[23] (where several indicators are plot into a circular presentation)
- Use of weights for aggregating different dimensions into a single index
- Use of mathematical models to 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 don't produce new variables that represent the phenomenon of their association (indicated by the shadow 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:

Integrated



Non-Integrated



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 is 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 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

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 physical 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 the box 5 below. 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, in the third part of this report. A full academic discussion about the literature on poverty and environment links is presented in the Appendix 1. Methodological analyses will be left to the second part of this report.

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 that of 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, individuals living in urban areas, issues of water, energy, sanitation and waste removal, might be a priority.

The three most common environment-related illnesses faced 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 among 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. It is true that these illnesses depend on behavioural practices, but 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, as water.

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

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.

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.

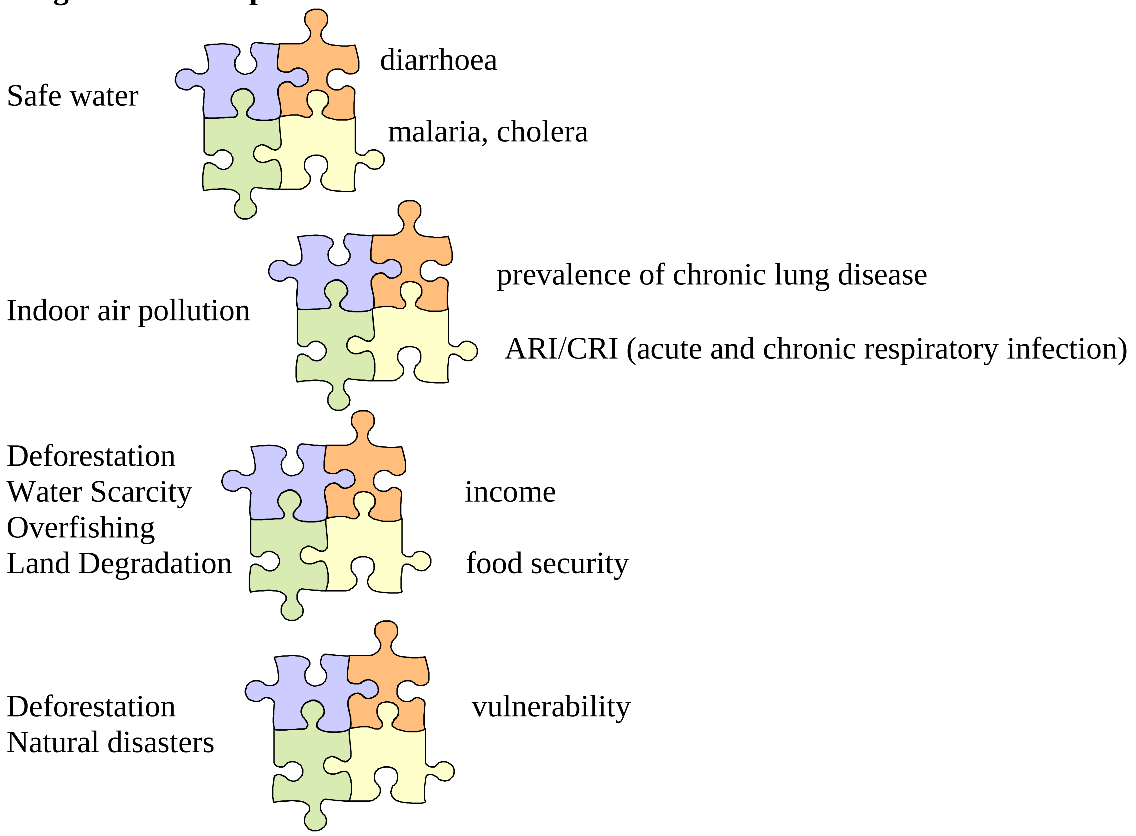
Similarly, environmental indicators cannot be assessed without a sustainability perspective. Perman[28] et al (2003) explore the different impacts of working with different concepts of sustainability (such as the weak or strong version of sustainability). More than a question related to degrees of substitutability of factors[29], the most important issue refers to the how sustainability reference conditions are set to:

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.

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 at the end this strategy of fully integrating the indicators was not chosen. In any case, this work can be appreciated by the valuable contribution that it gave in highlighting important P&E links, as indicated below:

Diagram 4 – examples of P&E links



DFID (the Department for International Development of the United Kingdom), the European Commission, UNDP (the United Nations Development Programme) and the World Bank have published in 2002 a document called *Linking Poverty Reduction and Environmental Management: policy challenges and opportunities*. The document lives up to its promise and indeed focuses more 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.” They work 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 by them 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, the role of pollutants (indoor air pollution, pesticide poisoning) has 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.

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. This has become the situation of hundreds of individuals living in fragile areas all over the world. As environmental stresses become more prominent, livelihoods become more time-consuming, more dangerous and more costly, demanding increasing levels of input.

Henninger and Hammond (2002) have 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 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.

They also argue 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 is provides no further guidance about P&E links and how to integrate indicators beyond the geo-referencing strategy.

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

WWF-MPO’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 detail 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 as the influence of local stakeholders on the management of environmental systems is promoted as a deliberative process of choosing indicators.

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 following list of key links between the environment and the MDGs, as described by table 3 below.

Table 3 – links between the environment and the MDGs[38]

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

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 the 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 data. They 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.

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 I(0), given that indicators from one dimension do not refer to indicators from another. Integration is taken to degree one I(1) 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.

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 how important 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 should 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 there are mostly international data that are regularly collected and available, in particular for the poorest countries. Nevertheless, these methodologies should be appreciated for their contribution for future achievements. Finally, the different 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 P&E Indicators

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 than one being able to build his or her own indicators (individually or collectively). It is for this reason that this part addresses some foundational and practical issues in elaborating and using indicators. Its 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.

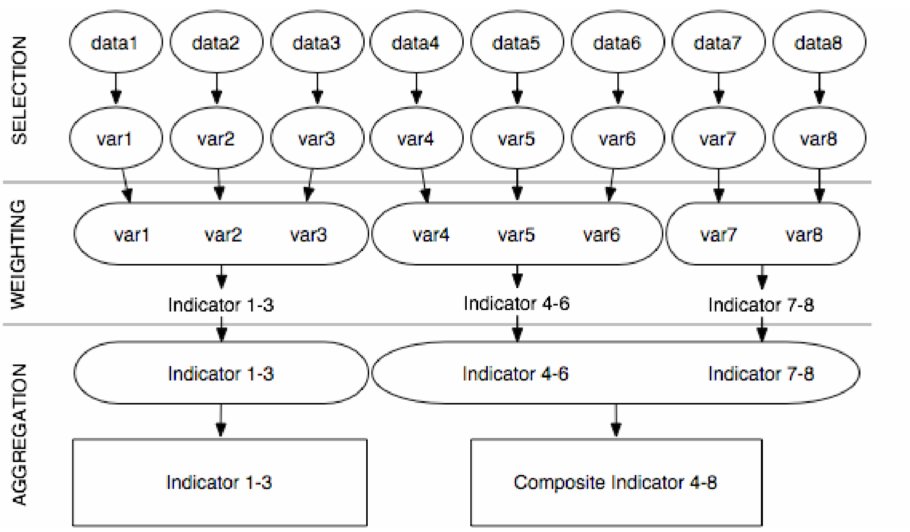
Search for indicators should be seen as part of measurement processes that normally follow guidelines suggested by public action and policies. However, consensus cannot be achieved based uniquely on political agreements[40]. Methodological clarity is also necessary. In measurement processes, numbers or labels are assigned to units of analysis in order to represent a certain phenomenon or variety of phenomena. 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;
- **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*. The choice of variables reflects a process of data selection, as illustrated by diagram 5 below;
- **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 not always variables, if taken in isolation, automatically produce indicators. 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 indices**: 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.

Diagram 5 – from data to composite indicators



Data ⇒ variables ⇒ indicators ⇒ indices

⇧

Variables should not be automatically used as Indicators

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 progress and progress is expected to be measurable or observable (e.g. MGDs).

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 into two or more categories on some variable. 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 cases on some 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. 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.

Indicators are variables with reference points

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 to capturing poverty&environment links (like the reference condition, the integration condition), and general criteria for building indicators that implies using a coherent language, as suggested above. An application of these criteria will be carried out in the next part of this report.

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', according to which indicators should be

1. Measurable: indicators should be expressible in numbers or labels to 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 new 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;
3. Valid or Relevant: indicators should provide measures that reflect the concept or purpose that it is intended to reflect. This criterion refers to the extent of matching between the situation it intends to reflect and an operational definition of the 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 is more valid or relevant;
4. Policy-relevant: indicators can be used to expose problems and are useful to 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 that 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: in order to be used, 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% to 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 about how one can 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 *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

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 below.

any other criteria could be used

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**	**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**

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, but this is object of the third report of this series.

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 to 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 below. 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. Weights are described within brackets.

Table 5 – illustration of weighted scale scores

Examples of P&E indicators and criteria	**measurable**	**reliable**	**valid**	**policy-relevant**	**user-friendly**	**sensitive to changes**	**analytically sound**	**comparable**	**etc**	**Scale**
Diarrhoea from unsafe water	**1 (x1)**	**1 (x1)**	**1 (x2)**	**1 (x8)**	**1 (x2)**	**1 (x5)**	**1 (x3)**	**0 (x9)**	**1 (x4)**	**26**
Respiratory infections from indoor air pollution	**1 (x3)**	**1 (x10)**	**1 (x2)**	**1 (x9)**	**1 (x1)**	**0 (x7)**	**1 (x6)**	**1 (x5)**	**0 (x8)**	**36**
Low income from land degradation	**1 (x2)**	**0 (x1)**	**0 (x4)**	**1 (x8)**	**1 (x9)**	**1 (x10)**	**1 (x7)**	**0 (x5)**	**0 (x3)**	**36**
Undernutrition from deforestation	**1 (x10)**	**1 (x8)**	**1 (x9)**	**0 (x1)**	**0 (x2)**	**0 (x3)**	**1 (x7)**	**1 (x6)**	**0 (x4)**	**40**
Vulnerability from natural disasters	**1 (x3)**	**0 (x1)**	**0 (x2)**	**0 (x3)**	**1 (x10)**	**0 (x4)**	**1 (x9)**	**1 (x7)**	**0 (x8)**	**29**

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 can convey 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.

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 (also 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 below). 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 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 (see diagram 7 below).

Diagram 6 – Linear PSR model

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.

Diagram 7 – Cyclical PSR model

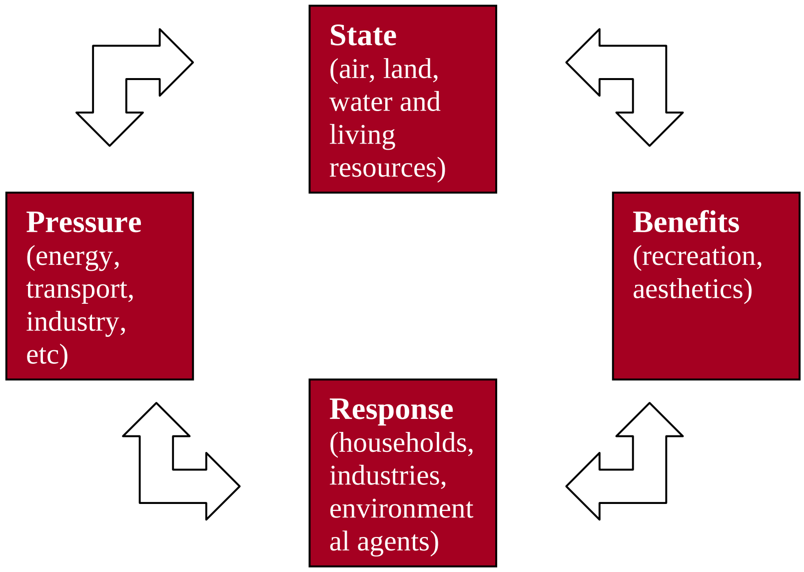


Table 6 – DPSIR illustration for Mozambique

	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 (so they would be integrated of degree zero), with a commitment to fill empty spaces in matrices like the one above in table 6, even they are not very relevant to the particular poverty&environment links of a particular country or local.

A New Methodology for elaborating P&E 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?

a) the theoretical model

The conceptual basis of the proposed system is grounded on the creation of new variables that represent the *links* between poverty&environment. These new variables can be created 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 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:

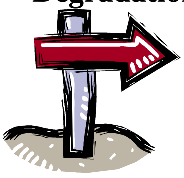
i) relational: that is, they have at least two dimensions, one for poverty and one for the environment. As such they reflect the same phenomenon causally and not simply some statistical coincidence. The association must be causal and logical, based on empirical evidence;

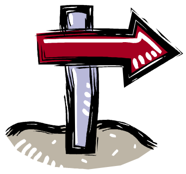
ii) objective: indicators based on subjective metrics (people's subjective view of the reality) are often biased. So, poverty should be described in objective terms to avoid biases of interpretation. This does not mean that poverty dimensions should not be elected by participatory processes, but that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

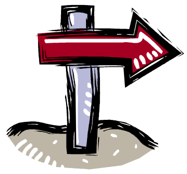
iii) multidimensional: because many dimensions are uncommensurable, indicators cannot (and should not) be reduced to a common scale (such as a monetary metrics). Important information is lost during this procedure and to avoid this problem, the solution is to describe indicators in their multifaceted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

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 factors 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.

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



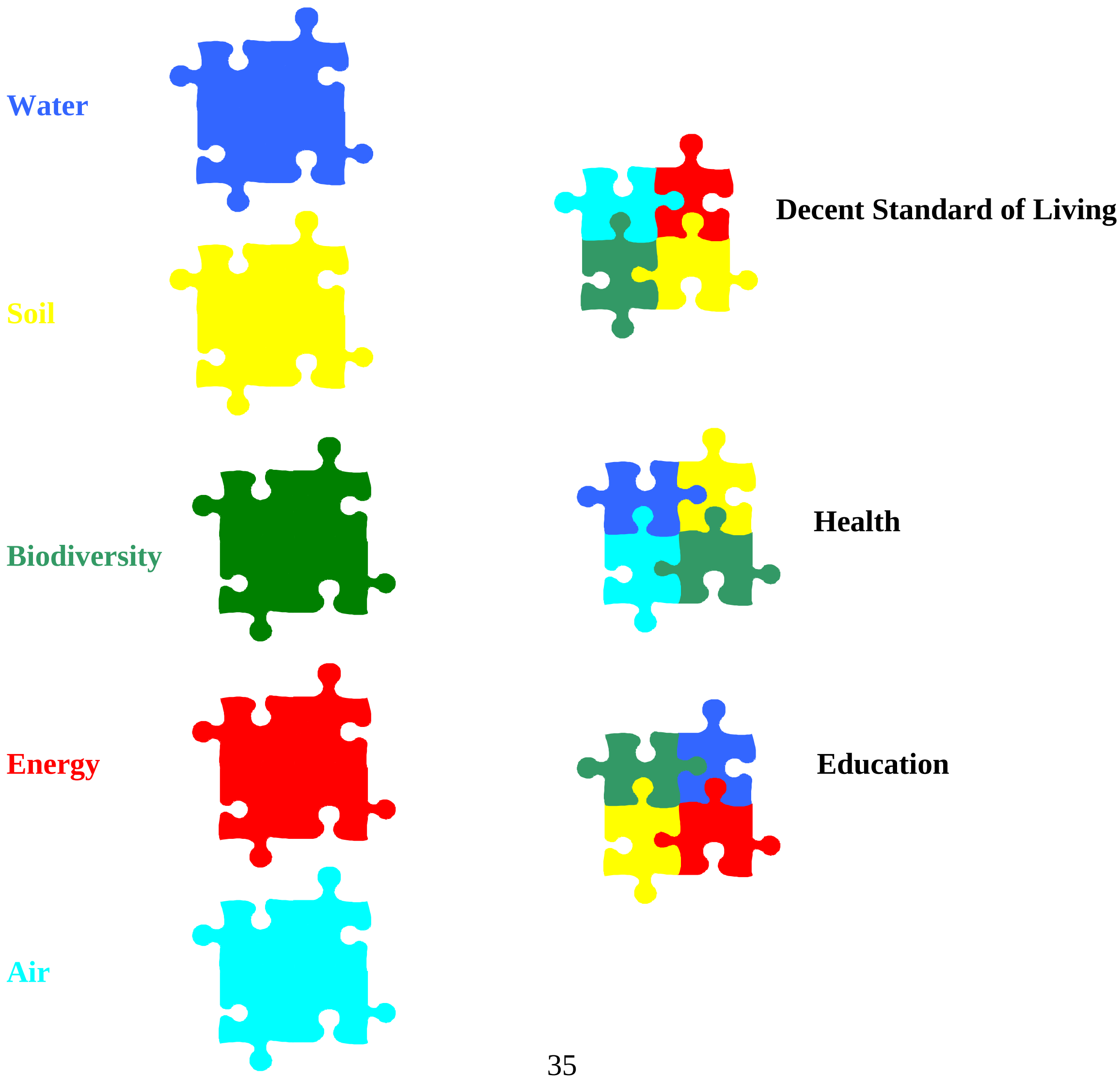




Adjustment factors can then be positive or negative, according to the combination of circumstances. Once the poverty variables are corrected by adjustment factors, new indicators are produced. It is important to note that these indicators will satisfy the integration condition to up to the second level, 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.

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 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 followed different practical methodological principles as discussed below. To summarise the conceptual model, diagram 8, 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).

Diagram 8 – Building blocks for P&E indicators



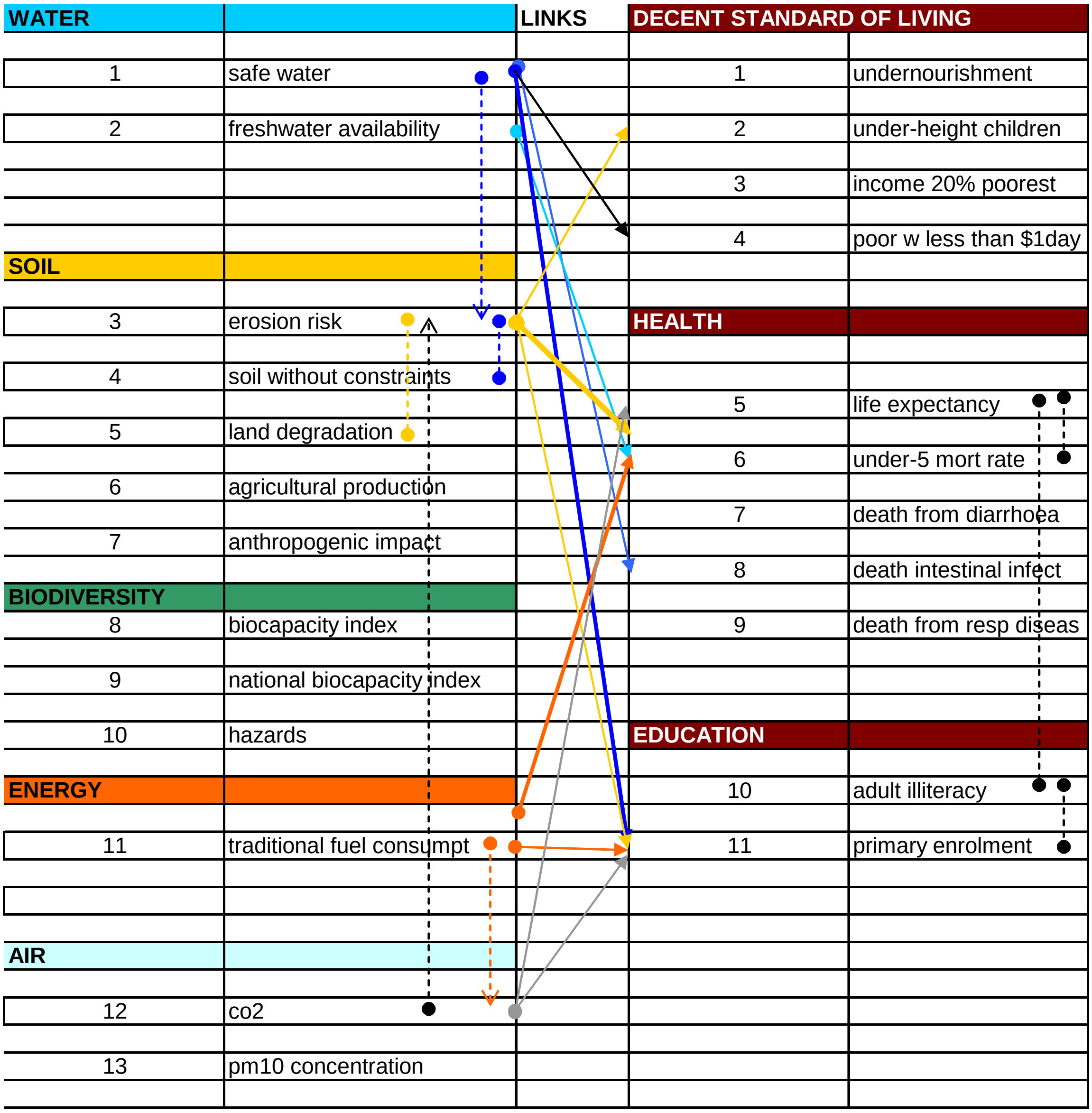
So, for instance, education would suffer the impacts from biodiversity, energy, water and soil. And so on. The selection of the particular five environmental dimensions used above is not important. Selection should be part of a public reasoning process where local or national stakeholders identify the 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. 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.

b) 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 9 below, was built:

Diagram 9 – Mapping P&E links



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

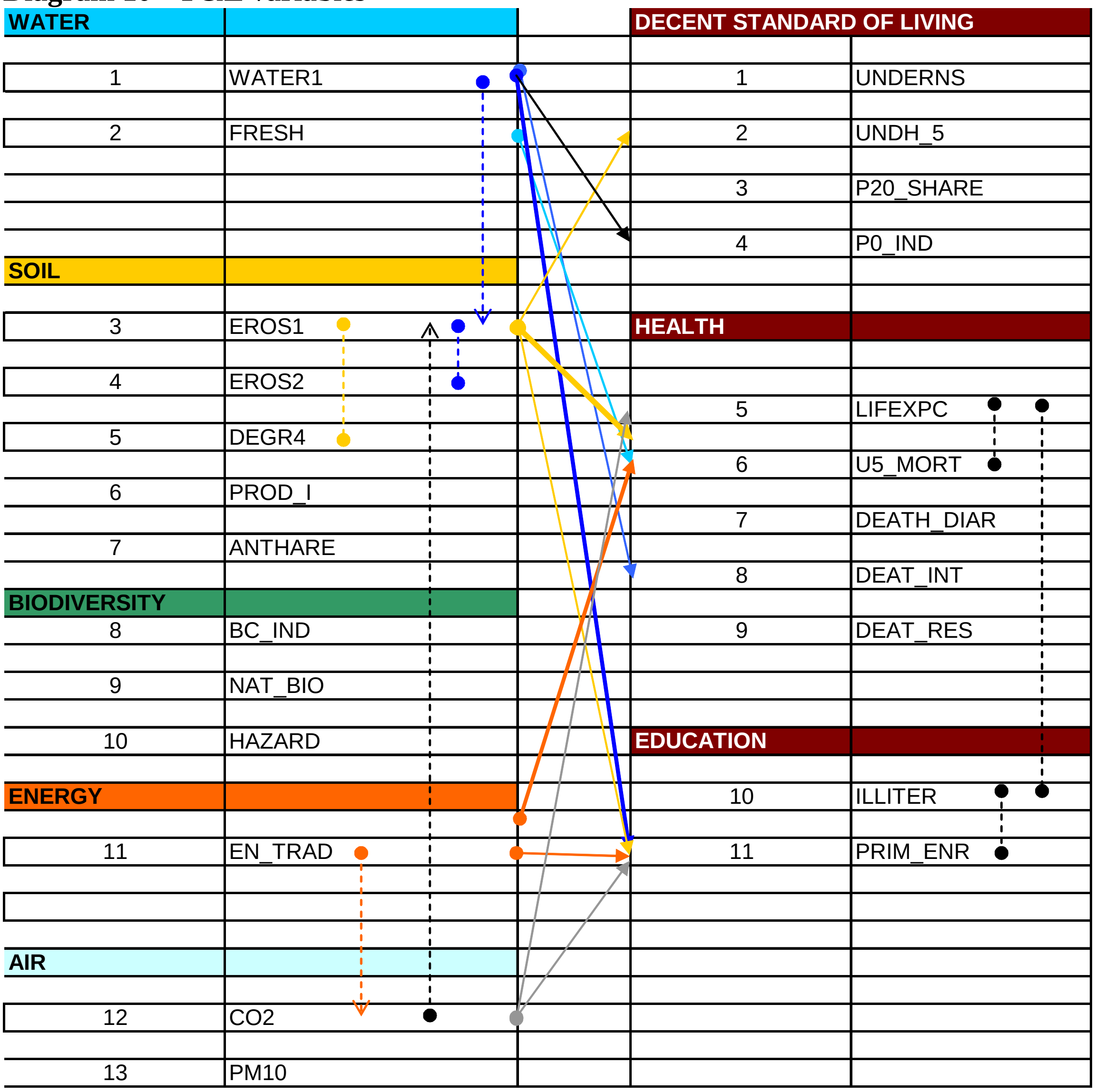
At this stage, it would be important to define whether ecosystem services are sustainable or not. Many different sustainability criteria could be used to classify the environmental variables into different degrees of environmental danger. However, these criteria are better defined by local communities 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 (if lower than 1) or unsustainable (if higher than 1). 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 Mali, 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.

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.

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. 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, as show in the diagram 10 below, in the same order described by diagram 9.

Diagram 10 – P&E variables



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.

Table 7 – Regression Results for Africa

coef assoc qualif

t>2 is stat signif

Codes of new P&E indicators

Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	57.13458	23.61489		2.41943	0.020439		
UNDERNS_1	**PROD_I**	0.54	0.216944	-0.29561	-2.48609	0.017428	0.898635	1.112798
UNDERNS_2	**EN_TRAD**	0.35	0.072917	0.568192	4.778449	2.65E-05	0.898635	1.112798
A	Dependent Variable: UNDERNS							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	29.53447	8.837366		3.341999	0.001989		
UNDH_5_1	**WATER1**	0.19	0.090687	-0.30245	-2.14221	0.039212	0.558442	1.790696
UNDH_5_2	**EROS1**	0.25	0.088277	0.313393	2.796587	0.008334	0.886443	1.128104
UNDH_5_3	**EN_TRAD**	0.16	0.055057	0.418935	2.850404	0.007272	0.515338	1.940476
A	Dependent Variable: UNDH_5							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	13.13727	2.538416		5.175379	2.12E-05		
P20_SHARE_1	**WATER1**	0.06	0.024611	-0.46913	-2.31989	0.028463	0.555034	1.801693
P20_SHARE_2	**DEGR4**	0.05	0.018352	-0.45666	-2.87939	0.007871	0.902369	1.108194
P20_SHARE_3	**EN_TRAD**	0.04	0.014698	-0.53494	-2.58325	0.015764	0.529289	1.889328
P20_SHARE_4	**BC_IND**	0.26	0.109824	-0.36541	-2.38809	0.02449	0.969416	1.031549
A	Dependent Variable: P20_SHARE							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	15.22689	14.60922		1.042279	0.310364		
P0_IND_1	**FRESH**	0.09	0.038439	0.364126	2.445077	0.024399	0.884513	1.130565
P0_IND_2	**EN_TRAD**	0.68	0.13449	0.882486	5.028505	7.46E-05	0.636918	1.570061

P0_IND_3	**NAT_BIO**	63.66	34.4982	-0.35393	-1.84539	0.080625	0.533304	1.875102
P0_IND_4	**HAZARD**	23.53	13.12456	0.29115	1.793078	0.088896	0.744021	1.344048
A	Dependent Variable: P0_IND							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	77.27821	4.500812		17.16984	1.69E-19		
LIFEXPC_1	**EN_TRAD**	0.35	0.050374	-0.98504	-7.03809	2.18E-08	0.51239	1.951639
	GDP_PC	0.00	0.000982	-0.33939	-2.42495	0.020173	0.51239	1.951639
A	Dependent Variable: LIFEXPC							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	119.0841	53.09995		2.24264	0.030997		
U5_MORT_1	**EN_TRAD**	1.22	0.312776	0.556975	3.906356	0.000384	0.580463	1.722761
U5_MORT_2	**WATER1**	0.97	0.536296	-0.25836	-1.81199	0.07811	0.580463	1.722761
A	Dependent Variable: U5_MORT							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	24.72259	2.032923		12.1611	9.74E-14		
DEATH_DIAR_1	**WATER1**	0.08	0.030905	-0.25562	-2.49828	0.017638	0.564047	1.772902
DEATH_DIAR_2	**FRESH**	0.01	0.005741	-0.21611	-2.23327	0.032428	0.630625	1.585728
DEATH_DIAR_3	**EROS2**	0.09	0.030754	-0.23611	-2.85267	0.007428	0.862027	1.160056
DEATH_DIAR_4	**DEGR4**	0.06	0.022885	-0.19405	-2.43511	0.020457	0.929943	1.075335
DEATH_DIAR_5	**BC_IND**	0.39	0.189346	0.219867	2.068423	0.04651	0.522629	1.913403
	GDP_PC	0.00	0.000409	-0.75442	-6.33469	3.61E-07	0.416349	2.401833
A	Dependent Variable: DEATH_DIAR							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	32.27573	3.805931		8.480377	3.35E-10		
	GDP_PC	0.00	0.001643	-0.3624	-2.58372	0.013859	0.959823	1.041859
DEAT_INT_1	**DEGR4**	0.27	0.138306	-0.27289	-1.93215	0.061026	0.946638	1.05637
DEAT_INT_2	**FRESH**	0.06	0.028726	0.275295	1.938793	0.060183	0.93659	1.067703
A	Dependent Variable: DEAT_INT							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	128.272	13.93584		9.204473	3.04E-10		

DEAT_RES_1	**WATER1**	0.26	0.085235	-0.36637	-3.03269	0.004964	0.457193	2.18726
DEAT_RES_2	**EROS2**	0.21	0.084466	-0.24375	-2.50466	0.01792	0.704543	1.419359
DEAT_RES_3	**PROD_I**	0.37	0.106238	-0.30476	-3.51194	0.001431	0.886077	1.12857
DEAT_RES_4	**EN_TRAD**	0.43	0.067042	-1.03597	-6.35845	5.14E-07	0.251359	3.978368
DEAT_RES_5	**BC_IND**	1.54	0.414849	0.370097	3.712056	0.000837	0.671248	1.489763
DEAT_RES_6	**NAT_BIO**	23.40	11.02292	-0.24228	-2.12287	0.042129	0.51227	1.952094
	GDP_PC	-0.01	0.001193	-0.90308	-6.07468	1.13E-06	0.301911	3.312239
A	Dependent Variable: DEAT_RES							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	90.58156	11.32982		7.994972	1.79E-08		
ILLITER_1	**EROS1**	0.49	0.206416	-0.36764	-2.398	0.023957	0.562345	1.778267
ILLITER_2	**EROS2**	0.54	0.218549	0.396752	2.451716	0.021248	0.504724	1.981279
ILLITER_3	**ANTHARE**	8.18	2.758341	-0.38398	-2.96618	0.006388	0.788742	1.267841
ILLITER_4	**NAT_BIO**	69.47	22.23692	-0.46227	-3.12411	0.004345	0.6037	1.656451
	GDP_PC	-0.01	0.001564	-0.59239	-4.72744	6.9E-05	0.841758	1.18799
A	Dependent Variable: ILLITER							
Coefficients(a)								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	107.3009	6.014764		17.83959	1.61E-17		
PRIM_ENR_1	**EN_TRAD**	0.32	0.069986	-0.54514	-4.60217	7.15E-05	0.996495	1.003517
PRIM_ENR_2	**PM10**	0.18	0.043146	-0.50103	-4.22985	0.000202	0.996495	1.003517
A	Dependent Variable: PRIM_ENR							

The table above shows all variables that have been created for Africa. Regressions were run with the purpose of finding out which environmental factors were important to define poverty. As mentioned above, given the scarcity of data, we have calculated regressions for regions. But in principle, we should emphasise, the same methodology can be used by national policy-makers to run regressions for provinces or cities. The important thing, after the specification of the model, is to find out which coefficients can be used and find out what associations are valid.

c) results: P&E indicators

Based on the list of selected indicators (see table 8 below), 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	POVERTY VARIABLE	ENVIRONMENT VARIABLE	GEO-RELEVANCE
Undernutrition Group			
Undernutrition from erosion risk	UNDERNS	EROS1	America
Undernutrition from soil without constraints	UNDERNS	EROS2	Europe
Undernutrition from severe land degradation	UNDERNS	DEGR4	America
Undernutrition from traditional fuel consumption	UNDERNS	EN_TRAD	America, Africa
Undernutrition from carbon dioxide	UNDERNS	CO2	America, Europe
Undernutrition from unsafe water	UNDERNS	WATER1	Asia
Undernutrition from lack of fresh water	UNDERNS	FRESH	Asia, Europe
Undernutrition from low agricultural production	UNDERNS	PROD_I	Europe
Undernutrition from loss of biodiversity	UNDERNS	BC_IND	Europe
Under-height children Group			
Under-height from traditional fuel consumption	UNDH_5	EN_TRAD	America, Asia, Africa
Under-height from loss of biodiversity	UNDH_5	BC_IND	America
Under-height from loss of biocapacity	UNDH_5	NAT_BIO	America
Under-height from lack of fresh water	UNDH_5	FRESH	Asia
Under-height from erosion risk	UNDH_5	EROS1	Asia, Africa
Under-height from soil without constraints	UNDH_5	EROS2	Asia
Under-height from carbon dioxide	UNDH_5	CO2	Asia
Under-height from unsafe water	UNDH_5	WATER1	Africa
Under-height from natural hazards	UNDH_5	HAZARD	Asia
Income 20% Poorest Group			
Income of the poorest from severe land degradation	P20_SHARE	DEGR4	America, Africa
Income of the poorest from	P20_SHARE	EN_TRAD	America, Africa

traditional fuel consumption			
Income of the poorest from loss of biodiversity	P20_SHARE	NAT_BIO	America
Income of the poorest from unsafe water	P20_SHARE	WATER1	Asia, Africa
Income of the poorest from lack of fresh water	P20_SHARE	FRESH	Asia
Income of the poorest from soil without constraints	P20_SHARE	EROS2	Asia
Income of the poorest from PM10 concentration	P20_SHARE	PM10	Asia
Income of the poorest from loss of biocapacity	P20_SHARE	BC_IND	Africa
Income of the Poor Group			
Income poverty from unsafe water	P0_IND	WATER1	America
Income poverty from low agricultural production	P0_IND	PROD_I	Asia
Income poverty from traditional fuel consumption	P0_IND	EN_TRAD	America, Africa
Income poverty from carbon dioxide	P0_IND	CO2	America
Income poverty from loss of biocapacity	P0_IND	BC_IND	America
Income poverty from lack of fresh water	P0_IND	FRESH	Asia, Africa
Income poverty from natural hazards	P0_IND	HAZARD	Asia, Africa
Income poverty from loss of biodiversity	P0_IND	NAT_BIO	Africa
Life expectancy Group			
Reduction in life expectancy from unsafe water	LIFEXPC	WATER1	America, Asia
Reduction in life expectancy from erosion risk	LIFEXPC	EROS1	Europe
Reduction in life expectancy from soil without constraints	LIFEXPC	EROS2	America, Europe
Reduction in life expectancy from traditional fuel consumption	LIFEXPC	EN_TRAD	America, Asia, Africa
Reduction in life expectancy from carbon dioxide	LIFEXPC	CO2	America, Europe
Reduction in life expectancy from loss of biocapacity	LIFEXPC	BC_IND	America, Europe
Reduction in life expectancy from loss of biodiversity	LIFEXPC	NAT_BIO	America
Reduction in life expectancy from anthropogenic impact	LIFEXPC	ANTHARE	Europe
Under-5 Mortality Group			
Under-5 mortality from unsafe water	U5_MORT	WATER1	America, Asia, Africa, Europe
Under-5 mortality from lack of fresh water	U5_MORT	FRESH	America, Asia
Under-5 mortality from erosion risk	U5_MORT	EROS1	Europe

Under-5 mortality from soil without constraints	U5_MORT	EROS2	America, Europe
Under-5 mortality from severe land degradation	U5_MORT	DEGR4	America
Under-5 mortality from traditional fuel consumption	U5_MORT	EN_TRAD	America, Africa
Under-5 mortality from anthropogenic impact	U5_MORT	ANTHARE	Europe
Under-5 mortality from loss of biocapacity	U5_MORT	BC_IND	America, Europe
Under-5 mortality from loss of biodiversity	U5_MORT	NAT_BIO	America
Under-5 mortality from carbon dioxide	U5_MORT	CO2	America
Under-5 mortality from PM10 concentration	U5_MORT	PM10	America
Death from Diarrhoea Group			
Death from Diarrhoea from unsafe water	DEATH_DIAR	WATER1	America, Asia, Africa
Death from Diarrhoea from traditional fuel consumption	DEATH_DIAR	EN_TRAD	America, Asia
Death from Diarrhoea from loss of biodiversity	DEATH_DIAR	NAT_BIO	America, Europe
Death from Diarrhoea from lack of fresh water	DEATH_DIAR	FRESH	Asia, Africa
Death from Diarrhoea from anthropogenic impact	DEATH_DIAR	ANTHARE	Asia
Death from Diarrhoea from erosion risk	DEATH_DIAR	EROS1	Europe
Death from Diarrhoea from soil without constraints	DEATH_DIAR	EROS2	Africa
Death from Diarrhoea from severe land degradation	DEATH_DIAR	DEGR4	Africa
Death from Diarrhoea from loss of biocapacity	DEATH_DIAR	BC_IND	Africa
Death from Intestinal Infectious Disease Group			
Death from Intestinal Infections from traditional fuel consumption	DEAT_INT	EN_TRAD	America
Death from Intestinal Infections from unsafe water	DEAT_INT	WATER1	Asia
Death from Intestinal Infections from lack of fresh water	DEAT_INT	FRESH	Asia, Africa
Death from Intestinal Infections from erosion risk	DEAT_INT	EROS1	Europe
Death from Intestinal Infections from severe land degradation	DEAT_INT	DEGR4	Africa
Death from Intestinal Infections from loss of biodiversity	DEAT_INT	NAT_BIO	Europe
Death from Respiratory Disease			

Group			
Death from respiratory disease from unsafe water	DEAT_RES	WATER1	America, Asia, Africa
Death from respiratory disease from lack of fresh water	DEAT_RES	FRESH	Asia
Death from respiratory disease from erosion risk	DEAT_RES	EROS1	Europe
Death from respiratory disease from soil without constraints	DEAT_RES	EROS2	America, Africa
Death from respiratory disease from traditional fuel consumption	DEAT_RES	EN_TRAD	Asia, Africa
Death from respiratory disease from low agricultural production	DEAT_RES	PROD_I	Africa
Death from respiratory disease from loss of biodiversity	DEAT_RES	NAT_BIO	Africa, Europe
Death from respiratory disease from loss of biocapacity	DEAT_RES	BC_IND	Africa
Adult Illiteracy Group			
Adult illiteracy from unsafe water	ILLITER	WATER1	Asia
Adult illiteracy from lack of fresh water	ILLITER	FRESH	Asia
Adult illiteracy from erosion risk	ILLITER	EROS1	Africa, Europe
Adult illiteracy from soil without constraints	ILLITER	EROS2	Africa
Adult illiteracy from low agricultural production	ILLITER	PROD_I	Asia
Adult illiteracy from anthropogenic impact	ILLITER	ANTHARE	Asia, Africa
Adult illiteracy from traditional fuel consumption	ILLITER	EN_TRAD	Asia
Adult illiteracy from carbon dioxide	ILLITER	CO2	Asia
Adult illiteracy from PM10 concentration	ILLITER	PM10	Asia
Adult illiteracy from loss of biocapacity	ILLITER	BC_IND	Asia
Adult illiteracy from loss of biodiversity	ILLITER	NAT_BIO	Africa
Primary Enrolment Ratio Group			
Decrease in primary enrolment from unsafe water	PRIM_ENR	WATER1	Asia
Decrease in primary enrolment from lack of fresh water	PRIM_ENR	FRESH	America
Decrease in primary enrolment from severe land degradation	PRIM_ENR	DEGR4	America, Europe
Decrease in primary enrolment from erosion risk	PRIM_ENR	EROS1	Europe
Decrease in primary enrolment from soil without constraints	PRIM_ENR	EROS2	Asia
Decrease in primary enrolment from low agricultural production	PRIM_ENR	PROD_I	Asia

Decrease in primary enrolment from anthropogenic impact	PRIM_ENR	ANTHARE	Asia, Europe
Decrease in primary enrolment from traditional fuel consumption	PRIM_ENR	EN_TRAD	Africa, Europe
Decrease in primary enrolment from PM10 concentration	PRIM_ENR	PM10	America, Africa
Decrease in primary enrolment from loss of biocapacity	PRIM_ENR	BC_IND	Asia
Decrease in primary enrolment from loss of biodiversity	PRIM_ENR	NAT_BIO	Asia, Europe
Decrease in primary enrolment from natural hazards	PRIM_ENR	HAZARD	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. 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 calculate themselves 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 currently used simulation models for estimating health risks by Cox models[48].

Table 9 – 2006 P&E Indicators

COUNTRY	P&E INDICATOR	RANK P&E[1]	RANK HDI 2006	RANK HPI 2006 (HPI-2 in bold)
Low Poverty&Environment				
Mauritius	0.02	1	63	24
Japan	0.05	2	7	11
Chile	0.06	3	38	2
Canadá	0.06	4	6	**8**
Argentina	0.07	5	36	3
Costa Rica	0.08	6	48	4
Korea, Rep. Of	0.08	7	26	..
Cuba	0.08	8	50	6
Botswana	0.09	9	131	93
Sweden	0.09	10	5	**1**
México	0.10	11	53	9
Norway	0.10	12	1	**2**
France	0.10	13	16	**10**
South África	0.10	14	121	53
Austrália	0.10	15	3	14
Uruguay	0.10	16	43	1
Ecuador	0.11	17	83	18
New Zealand	0.11	18	20	..
Namíbia	0.11	19	125	57
Armênia	0.11	20	80	
Latvia	0.12	21	45	...
Malaysia	0.13	22	61	15
Syrian Arab Republic	0.13	23	107	29
Gabon	0.13	24	124	50
Denmark	0.13	25	15	**5**
Finland	0.13	26	11	**4**
Kazakhstan	0.13	27	79	
Israel	0.14	28	23	
Jordan	0.14	29	86	11
Lebanon	0.14	30	78	20
Spain	0.14	31	19	**13**
Geórgia	0.15	32	97	
Belgium	0.15	33	13	**12**
Áustria	0.15	34	14	**...**
Libya	0.15	35	...	...
Kuwait	0.15	36	33	..
Italy	0.15	37	17	**18**
Turkey	0.16	38	92	21
Thailand	0.16	39	74	19
Venezuela, RB	0.17	40	72	16
United States	0.17	41	8	**16**
Peru	0.17	42	82	25
Kyrgyzstan	0.17	43	110	
Netherlands	0.17	44	10	**3**
Slovenia	0.18	45	27	...
Panama	0.18	46	58	12

United Kingdom	0.18	47	18	**15**
China	0.18	48	81	26
Iran, Islamic Rep. of	0.18	49	96	35
Algeria	0.18	50	102	46
Greece	0.18	51	24	...
Ireland	0.19	52	4	**17**
Brazil	0.19	53	69	22
Sri Lanka	0.19	54	93	38
Germany	0.20	55	21	**6**
Poland	0.20	56	37	...
Azerbaijan	0.20	57	99	
Czech Republic	0.20	58	30	...
Portugal	0.20	59	28	...
Moderate Poverty&Environment				
Tunisia	0.21	60	87	39
Switzerland	0.22	61	9	**7**
Indonesia	0.22	62	108	41
United Arab Emirates	0.22	63	49	34
Morocco	0.23	64	123	59
Paraguay	0.23	65	91	14
Lithuania	0.23	66	41	...
Viet Nam	0.24	67	109	33
Congo	0.25	68	140	51
Egypt	0.25	69	111	44
Belarus	0.25	70	67	...
Philippines	0.26	71	84	31
Mongolia	0.27	72	116	42
Swaziland	0.28	73	146	97
Cameroon	0.28	74	144	61
Estonia	0.29	75	40	...
Colombia	0.30	76	70	10
Gambia	0.30	77	155	86
Uzbekistan	0.30	78	113	
Turkmenistan	0.31	79	105	
Bolivia	0.31	80	115	28
Zimbabwe	0.31	81	151	88
Myanmar	0.31	82	130	47
Czech Republic	0.20	58	30	...
Portugal	0.20	59	28	...
Tunisia	0.21	60	87	39
Switzerland	0.22	61	9	**7**
Indonesia	0.22	62	108	41
United Arab Emirates	0.22	63	49	34
Morocco	0.23	64	123	59
Paraguay	0.23	65	91	14
Lithuania	0.23	66	41	...
Viet Nam	0.24	67	109	33
Congo	0.25	68	140	51
Egypt	0.25	69	111	44
Belarus	0.25	70	67	...
Philippines	0.26	71	84	31
Mongolia	0.27	72	116	42
Swaziland	0.28	73	146	97
Cameroon	0.28	74	144	61
Estonia	0.29	75	40	...
Colombia	0.30	76	70	10
Gambia	0.30	77	155	86
Uzbekistan	0.30	78	113	
Turkmenistan	0.31	79	105	
Bolivia	0.31	80	115	28
Zimbabwe	0.31	81	151	88

Myanmar	0.31	82	130	47
Côte d'Ivoire	0.31	83	164	82
Ghana	0.31	84	136	58
Lesotho	0.32	85	149	89
Togo	0.32	86	147	72
Kenya	0.32	87	152	60
Russian Federation	0.32	88	65	...
Hungary	0.32	89	35	...
Iraq	0.32	90	...	
Trinidad and Tobago	0.33	91	57	17
Romania	0.34	92	60	...
Benin	0.34	93	163	90
High Poverty&Environment				
Ukraine	0.35	94	77	...
Luxembourg	0.35	95	12	**9**
Saudi Arabia	0.35	96	76	..
Senegal	0.35	97	156	84
Angola	0.36	98	161	79
Malawi	0.36	99	166	83
Jamaica	0.37	100	104	30
Tajikistan	0.38	101	122	
Guinea-Bissau	0.38	102	173	92
Tanzania, U. Rep. of	0.38	103	162	64
Papua New Guinea	0.38	104	139	75
Sudan	0.38	105	141	54
Mauritania	0.38	106	153	81
Bangladesh	0.39	107	137	85
Slovakia	0.39	108	42	...
Central African Republic	0.40	109	172	91
Madagascar	0.40	110	143	66
Uganda	0.40	111	145	62
India	0.40	112	126	55
Mozambique	0.41	113	168	94
Zambia	0.41	114	165	87
Albania	0.41	115	73	...
Rwanda	0.42	116	158	67
Guinea	0.43	117	160	96
El Salvador	0.43	118	101	32
Dominican Republic	0.43	119	94	27
Lao People's Dem. Rep.	0.44	120	133	63
Croatia	0.44	121	44	...
Congo, Dem. Rep. of the	0.44	122	167	80
Burkina Faso	0.46	123	174	101
Yemen	0.47	124	150	77
Korea, Dem People's Rep.	0.47	125	...	
Pakistan	0.47	126	134	65
Nepal	0.47	127	138	68
Burundi	0.47	128	169	78
Bulgaria	0.48	129	54	...
Cambodia	0.49	130	129	73
Very High Poverty&Environment				
Moldova, Rep. of	0.50	131	114	...
Honduras	0.50	132	117	37
Guatemala	0.51	133	118	48
Nigeria	0.51	134	159	76
Liberia	0.52	135	...	...

Chad	0.53	136	171	100
Eritrea	0.55	137	157	70
Macedonia	0.55	138	66	...
Sierra Leone	0.56	139	176	95
Nicaragua	0.58	140	112	40
Ethiopia	0.58	141	170	98
Bosnia and Herzegovina	0.60	142	62	...
Mali	0.61	143	175	102
Somalia	0.63	144	...	...
Niger	0.65	145	177	99
Haiti	0.71	146	154	74
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.

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 (0.69 in comparison to 0.65 from the 2006 HDI). The thresholds will then be fixed, as illustrated by the blue lines, in the table above.

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]
- high poverty&environment [0.49 to 0.35]
- moderate poverty&environment [0.34 to 0.20]
- low poverty&environment [0.19 to 0.02]

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. In the following reports we should systematise comparisons with alternative poverty and environmental indicators (separately), exploring empirical evidence from countries, and discuss how this information can be used in the preparation of PRSPs and other policy-driven documents.

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 $\leq$ 0,50
Medium Human Development: 0,51 $\leq$ HDI $\leq$ 0,80
High Human Development: 0,81 $\leq$ HDI $\leq$ 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

$$HPI1_{it} = \beta_0 + \beta_1 BC_{it} + \beta_2 Po_{it} + \beta_3 TFC_{it} + u_{it}$$

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, please consult for good introductions
- Arellenano M. *Panel data econometrics*. New York: Oxford University Press, 2003. Chaps.1, 2.
-Wooldridge, J. M. *Econometric analysis of cross section and panel data*. London: MIT press. Chaps. 7, 9 e 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."

[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.

ANNEX 1

Poverty Environment Linkages

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Summary

This policy paper makes an assessment of findings on linkages of poverty and environment. This issue has been explored from some of the evidences from Asia and Africa. The paper evaluates the existing indicator for poverty and environmental condition linkages. The paper finds that while poverty has been discussed in a less holistic sense than what it deserves to, conservation strategy has paid attention to poverty in a perfunctorily way only. The paper suggests response strategy for addressing environment-poverty nexus in a synergistic manner.

1. Background

The relationship of poverty and status of environmental condition is complex. The phenomenon of poverty can influence the rate of extraction of natural resources like forestry, fisheries, topsoil, biological resources, ground and surface water. This might lead to erosion of these resources faster than what one can ordinarily expect. Conversely, if the condition of environmental resources worsens like degradation of forest canopy, depletion of ground water, exploitation of biodiversity at species level, they can make the people who depend on these resources, as poor and deprived. The first and foremost assumption behind this two way relationship between poverty and environment is the fact that through its various functions and subsequent benefits, natural resources and environmental condition contributes to the well being of people. This assumption of about contribution of environmental / natural resources/ ecosystems has been tested in many ways through scientists and development practitioners and it has been found to be a fundamental truth (Dasgupta and Maler, 2004, MA 2005, WRI 2005).

There is a general consensus that poverty is a major cause of environmental degradation. The poor have traditionally taken the brunt of the blame for causing society's many problems including the more recent, environmental degradation. The idea behind the "vicious circle" is that poor resource access triggers environmental degradation, which aggravates poverty and reinforces degradation.

In one of the conclusions of the Bruntland Commission Report (1987), it was explicitly stated that poverty is a major cause of environmental problems. The report clearly stated that "Poverty reduces people's capacity to use resources in a sustainable manner; it intensifies pressure on the environment" (World Commission on Environment and Development, 1987, p49). The World Bank joined the consensus with the 1992 World development Report. The Bank Explicitly stated that, "poor families who have to meet short term needs, mine the natural capital by excessive cutting of trees for firewood and failure to replace soil nutrients" (World Bank, 1992 in Duraiappah, 1996, p 1).

The linkages between poverty and the environment are far too complex. And this has been acknowledged by many national governments. For example, in its National Environmental Policy 2004 prepared by the Ministry of Environment and Forests of India, begins with the assertion- “The key environmental challenges that the country faces relate to the nexus of environmental degradation with poverty in many dimensions, and economic growth”. It empasises that on one hand, degradation of natural resources makes both the rural and urban poor, poorer, while poverty itself can accentuate environmental degradation on the other. (NEP, 2004, p p 4307).

The poor are both the agents and victims of environmental damage. The poorest of the poor occupy the least resilient, most threatened environmental areas of the world (Pearce and Warford, 1993, p 270, 272). There is some evidence to show that in the absence of capital resources, the poor are more dependent upon common property resources than the rich. An argument is generally made that poor people have a tendency of over-using resources like land, forests and water, thereby degrading them. They deplete the natural resources faster as they have no real prospects of gaining access to other types of resources (Nagdeve, 2002, p 5). Poorer people who cannot meet their subsistence needs through purchases are forced to use the common property resources such as forests for food and fuel (Sharma and Gulati, 2000, p 17). The very poor struggling at the edge of subsistence level of consumption and pre-occupied with day-to- day survival have limited scope to plan ahead and make natural resource investments (e.g. soil conservation) that give positive return after a number of years. Thus the poor have little choice but to overexploit any available natural resources. Thus low incomes cause environmental degradation.

The growing concentration of poor people in precarious environments, i.e., ecologically fragile areas, is a major cause of the severe environmental destruction that has been documented in developing countries by numerous recent studies. The problems of poverty and environmental degradation are both complicated and made vastly more urgent by the relentless increase in the sheer number of people living in developing countries. Poor people inevitably have to degrade the environment a little more each day just to make ends meet. But in doing so, they take not only from nature's bounty but also from the well being of the future generations.

At the same time, there is some evidence that degrading the environment hurts the poor themselves. It is the poorest that suffer most from the consequences of pollution and environmental degradation; degraded environment can accelerate the process of impoverishment because the poor depend directly on natural assets and common property resources (Kadekodi, 2001 p 195). They draw a large art if their livelihood from unmarketed environmental resources, common grazing lands, for example, or forests where food fuel and building materials have traditionally been gathered. The loss of such resources may particularly hurt the poorest and undermine future productivity. Moreover, shortage of drinking water or fuel wood affects the poor more than the rich. Environmental degradation depresses poor people's income by diverting more time to routine household tasks such as fuel wood collection and by decreasing productivity of the natural resources from which the rural poor are most likely to wrest a living. It jeopardizes the prospects of earning future income. They also become very vulnerable to natural calamities, environmental degradation and ecological disasters. Thus, deteriorating environment induces poverty (Pearce and Warford, 1993, p 149).

The interaction o poverty and environmental destruction sets off a downward spiral of ecological deterioration that threatens the physical security, economic well-being and health of many of the world's poorest people (Ekbom and Bojo, 1999 in Contreeas-Hermosilla, 2000, p 18). They suffer from malnutrition, illiteracy, disease, short life expectance and high rates of infant mortality. Men, women and children live along the subsistence margin that, while not life-threatening, precludes attainment of much beyond the minimal necessities.

Partha Dasgupta & Karl-Goran Maler (1998) ravels into poverty environmental linkages in a more fundaments manner. They argue that Degradation of the environmental resource base also challenge their resilience i.e., their capacity to recover from shocks. Moreover, ecosystems have limited resilience. Ecosystems have a carrying capacity, which is the maximum stress that it is capable of absorbing without changing into a vastly different state. Secondly biodiversity provides the ecosystem its functional properties and resilience. Thus, due to its carrying capacity and biodiversity, ecosystems change and evolve continually.

Poverty can cause environmental degradation, though there appears to be a cumulative causation wherein poverty, high fertility rates and environmental degradation feed upon one another. Environmental problems present themselves differently to different people. Some identify it with wrong sorts of economic growth while others relate them to poverty.

Economic growth can be the cause as well as solution to environmental degradation. It becomes a cause when industrialization produces large-scale industrial waste. However, it becomes a key to environmental protection when a better national income leads to people having greater access to say potable water, better cooking fuel.

2.Evidences Across the World

The relationship of poverty and environment / ecosystems has commanded significant amount of attention by academicians, Non governmental Organizations (NGOs), Development Practioners and Civil Society. Some of the widely acknowledge surveys on poverty and environment include Dasgupta and Maler (1998), Durraiappah (1998), Barbier (199), Markendaya (2000), Bromley (1991), De Janvry and R Garcia (1998); Heath and Binswanger (1996), Jodha (1986), Lopez (1997), Stern, Common and Barbier (1996), Shyam Sunder (2002) and IUCN (2005a, 2005b) Reddy and Chakarvorty (1999). The attempt here is not to review them all again and produce another review but synthesize them and discuss key messages emerging from those studies. These studies dispel the usual belief on the relationship than establish anything profoundly. Conventionally, it is assumed that poor discount future and can not think much about the interest of their own or future generation in distant future and hence one would held them responsible for mining the soil, depleting the ground water, thinning/ cleaning the forest more than their rich counterpart. In some corridor of thinking, affluence has greater proclivity for forestry products, air pollution generating gadgets and their life style is more inimical to the existence of wild lives. Both the thoughts are right as well as wrong as they happen to be purely context and culture specific and are accelerated or halted by the property right regime prevailing political economy climate, historical trend of resource use, social and religious practices and aspiration level of consumption fuelled by the global market and investment conditions. While these sets of drivers of change remain relevant for poverty – environment relationship, one can expect the degree and dimensions of association or causality in various ways, the resources or attribute of environment one is linking with poverty is also important. Poverty can influence forest or soil or biodiversity differently from what it can do to ambient air and water quality. Similarly these constituents of natural and natural resources can impact the incidence of poverty very differently.

It would be important here to mention that while natural resources remain self-explanatory, the poverty refers to absolute poverty where the material condition of people is below a line defined as a cut off mark or income, which can enable them to buy food enough for minimum calorie intake. Evidently, it is very conservative estimate of poverty and many aspects of well being fall outside its review. Therefore the poverty here says how far the people are from well and not from well-being.

One environmental condition, it is the physical condition of natural resources or robustness and resilience of various ecosystems, which are the focus here. Development and Environment literature basically flags the findings on poverty –environment relationship in the following ways.

1. Poverty causes Environmental degradation e.g. Cleaning of forest.
2. Affluence or consumption pattern cause environmental deterioration e.g. Ozone layer depletion, deforestation through cattle ranching (Brazilian beef)
3. Lack of property rights or weak governance can cause environmental damage e.g. forest degradation, desertification.
4. If the forces and supply and demand do not capture the scarcity value of resource then the resources might get depleted e.g. Loss of biological diversity.
5. Erosion of the stock of natural resources can cause or aggravate the incidence of poverty

While these stylised relationships remain valid, it is hard to find evidence on some corollary to them. Fore example first, the ambient environment of poor is more deterioted as degraded than that of rich, is not clearly established. Jaganathan (1989) studied poverty and deforestation in Indonesia. He also studied poverty and land use change in Nigeria. In both the cases poverty was not the driving force of land use change including deforestation. Dlininger and Minten (1996) found little causality between poverty and forest cover for Chiapas and Oaxaca in Mexico.

Second, direct drivers like demand for food grains and indirect drivers like population dynamics; institutional and other social changes have resulted in greater incidence of poverty and environmental degradation in many countries. De Janvry and Gracia (1988) suggest that for Latin America the causes of environmental degradation by the poor cause be

(i) Soil erosion by small –holders as a rational strategy of survival
(ii) Collapse of local institution
(iii) Migrants cause deforestation

These phenomenon were either triggered off or perpetuated by economic policies encouraging unsustainable agriculture, in a comprehensive paper, Heath and Binswanger (1986) establish that in Ethiopia population density has caused land degradation where farming has got started is fragile ecosystem. The institutional changes impact poverty – environment relationship and it is evident from studies by Lopez (1997) and Mortimore (1989), Mortimore shows that for Nigeria small farmers adopted sustainable management strategy in land.

Third degradation of environmental resources hurts the poor the most (Dasgupta, 1995). Also policies meant to address environmental amelioration would hurt the poor more than the rich. This is truer for the pollution related issues Brooks and Sethi (1997). Finally, major macroeconomic policies specifically designed for development have combined effect on income and environmental improvement this is known as environmental Kuznets curve (Grossman and Krueger, 1991, Barbier 1997).

Deforestation is one form of environmental degradation, which has got accentuated in the last century, economic growth has led to concentration of wealth and income in the hands of few economically and politically powerful groups and nations. They have exerted very high demands on environment and nature. Myopic and materialistic policies for maximizing satisfaction have led to the degradation of the environment including forests.

Poverty and reliance of the poor on forest is an age-old practice. But this did not lead to environmental degradation prior to the twentieth century. Therefore deforestation may not actually be caused by poverty. The real underlying cause is the unequal political and economic power structures, which in turn are rooted in the foundations of the society. Poverty is nothing but the effect of such power structures. The alleged link between poverty and deforestation might have been artificially constructed and as a counter to common sense and lessons of history.

In Thailand, landless and small-scale farmers, among others encroach on forest reserves in search of a better livelihood. They either clear the land themselves usually following legal or illegal loggers, or they purchase the land from influential persons who claim control over large areas of forest reserves. During the first few years after encroachment, crop yields are relatively thigh because of the nutrients in the slashed-and-burned forestland. Once these nutrients are exhausted yields begin to drop. The hostile environment and low productivity of lands often prove these conversions illusive. Lack of necessary inputs to sustain productivity of and the limited access to good lands often force the shifting cultivators towards further clearing of forests. Except in areas where off-farm employment is abundant, farmers sooner or later are forced by declining productivity to mover deeper into the forest in search of new, more productive land. (Tongpan et al., 1990, p 6). In Brazil, there was some "push" coming from landless peasants for whom "migration is basically motivated by the possibility of accumulating wealth (and, with luck, becoming a landowner) through the clearing of lands in a frontier area where property rights are still undefined" (Reis and Margulis, 1990 in Beckerman, 1992, p 18).

Very large numbers of households generate some of their income from selling forest products. People can fall back upon such income sources in times of crop failure or shortfall, or in order to cope with some other from of emergency. Forests are therefore often very important as an economic buffer and safety net for poor households (Byron and Arnold, 1997, p 4). The needs of the poor for income from forest product activities can result in the diversion of supplies from own consumption to the market. A study in Vietnam fund that forest vegetables, bamboo shoots and mushrooms that were collected and eaten by the households had to be sold in order to buy rice (Nguyen Thi Yen et al., 1994 in Arnold and Byron, 1998, p 5).

Dasgupta (1982, p 180) observed that the greatest cause of global deforestation is not the market for wood products but rather the need for wood, fuel and agricultural land. The poorest countries rely heavily on fuel wood for energy. A critical resources supplied by the forest is energy for lighting, cooking and small industry. In rural areas, fuel wood contributes 66 % to household energy-use among all income groups, and a much higher percentage to the most disadvantaged-the poorest of whom use mostly twins and leaves for cooking (Poffenberger and Mc Gean, 1996, p 274-277). The only feasible substitutes are crop residues and animal dung, which also have value as sources of organic and nutrient inputs to the soil (Newcombe, 1989 in Pearce and Warford, 1993, p 25). As population grows, so does the demand for fuel wood until, eventually, it outstrips the rate of growth of forests and woodlands. Fuel wood becomes an even more important commercial good and is sold to other areas, especially urban areas (Pearce and Warford, 1993, p 276). The commercial role of fuel wood is also significant. Rural peasants switch from using fuel wood to using dung and straw for fuel. Progressive deforestation and further commercialization of dung as a fuel accelerates soil erosion and crop output declines. Eventually, farming systems collapse and migration occurs (Pearce and Warford, 1993, p 276). As agricultural land is lost through soil erosion, new lands are being opened up through further deforestation.

Persistence of rural poverty has exerted pressure on forest resources. Since the price of fuel wood has risen in urban areas at a faster rate than those of substitute fuels like soft coke and kerosene, felling of trees has become an attractive source of income for the rural poor. For them, the only cost of felling trees is the family labour-time spent. They use fuel wood themselves and they sell it to contractors. The fuel needs of the poor has been met from trees or plants from forests causing deforestation because in the developing world, wood production is insufficient to provide fuel to the current population. Firewood is still the most prevalent primary source of energy for cooking used by 78% of the rural and around 30% of the urban households in India (NSSO, 1997, in Sharma and Gulati, 2000, p 13). TERI's estimates for annual consumption for firewood in India turn out to be around 325 million cubic meters, which is much above the carrying capacity of forests (TERI, 2000, p 264). Production of fuel wood was around 281 million cubic meters in 1994 (Sharma and Gulati, 200, p 13). Over harvesting of fuel wood relative to the rate of regeneration accentuates depletion of forest.

Therefore, the fact remains that unsustainable use of natural resources causes poverty and on the other hand, environmental degradation can be caused by poverty too. To solve the problem, the objective is to focus on both poverty alleviation policies and environmental policies. Most developing countries suffer from the problem which us reported as – improved management of natural resources requires an attack on underlying causes of degradation and depletion, specifically excessive population growth and poverty, which are the main sources of migratory "push" into the uplands and coastal areas. A strong programme to reduce population growth rates and measures to create jobs for unemployed and underemployed rural residents will be crucial to the long-run prospects for reducing the rate of environmental degradation/ this is needed in order to reduce pressure to clear forests, especially in upland areas (World Bank, 1980, p XVI).

There are a growing number of literatures across the world stressing a strong link between environmental degradation and poverty. The idea goes back to Myrdal in 1957. The underlying theme of the Bruntland Commission Report (1987) was that the problems of the developing countries stem from poverty and underdevelopment. According to the report, poverty reduces people's capacity to use resources in a sustainable manner. Holmberg (1991) argued that the poor are forced to forego future needs to meet present needs. In the

1992 World Development Report, it was stated that poor families mine the natural capital to meet their short-term needs. According to Leonard (1995), poverty and environmental degradation are inseparable twins. The National Environment Policy (2004) begins with the assertion that the key environmental challenges faced by India relate to the nexus of environmental degradation and poverty. It also states that degradation of natural resources makes the poor people even poorer and that poverty itself can accentuate environmental degradation.

A prime example of poverty-environment nexus is the poverty-deforestation-poverty cycle. Attempts have been made to link the two together in a downward spiral. Poverty is viewed as a cause of forest loss and forest loss contributes to maintain or even increase poverty. The widely accepted notion is that tropical deforestation is associated with the poverty of its inhabitants. In absence of capital resources, the poor are more dependent upon common property resources than the rich. Rural people overuse and hence degrade and destroy forest resources because they are poor and have no viable alternative, and that this progressive erosion of the forest resource contributes to them becoming even poorer. Tropical deforestation has been an item on the agenda of the environmentalists for a long time and has received a great deal of international publicity because it affects the world by threatening extinction of many valuable plants and animals and by contributing to the green house effect.

Amita Shah (2001) evaluates some of the interesting aspects of the linkages of poverty and environment from western Indian states (primarily dryland). She finds that

Poor mainly depend on the environment for their livelihoods. With the absence of proper distribution of resources and overuse of natural resources aggravates the situation.
On one hand too much dependence on primary activities degrades the environment and on the other hand a total neglect of land also causes a negative impact on the environment. It is therefore necessary to work out strategies through which people can find employment and income from a combination of activities without harming the environment.

Since the poor depend heavily on primary activities, they are seen as both causes and the victims of environmental degradation. This vicious circle of poverty and resource degradation has been contested in recent literature wherein it has been argued that there exists a plurality of interface between the two. For developing countries it may be said that the poor do not initially or indirectly degrade environment, the interface is contingent upon the other groups not degrading the environment and also on absence of market or institutional failures. However, most studies lend support to two basic propositions:

1. Poverty does not damage the environment
2. Environmental degradation does hurt the poor.

In western India, the highest incidence of poverty is in Maharashtra followed by MP, Gujarat and Rajasthan. High poverty levels in industrially developed states such Maharashtra and Gujarat is due to out migration from less developed state like Rajasthan. MP is an outlier. Its high poverty levels are because there has been comparatively less out migration from here than Rajasthan.

Rural poverty is more in Maharashtra and Gujarat whereas urban poverty is more in MP and Rajasthan. Rural poverty is high where there are forest based economies facing multiple disadvantages of degradation and smaller land holdings on the one hand and physical remoteness and social marginalization on the other like having tribal population.

Incidence of Poverty among Drought Prone Areas: Hidden vs. Explicit.

Shah et al in 1998 tried to identify dryland regions by focusing on misture deficiency by considering 3 sets of factors. They found a high proportion of dryland regions in Western India. The incidence of rural poverty is relatively higher in the areas with better land productivity within the non-drought prone areas. However, it is less in the drought prone areas. This may suggest significant outmigration and the resultant low density of population in the relatively low productivity areas. As pointed before urban poverty is high in the dryland areas. This because larger proportions of the rural work force has to depend on non-farm employment within or outside the rural areas. There is great loss of ground water due to pressure of poverty. In the dryland states the ground water resources are depleting due to over exploitation. Tube well irrigation has replaced canal irrigation, which is also accounting for this depletion. Thus groundwater resources are not sustainable for containing poverty in dryland areas of the western regions.

At macro level, the relationship of poverty and environmental degradation is channeled through the 'inverted U shaped' curve known as Environmental Kuznets Curve (EKC). There have been several studies linking pollutants and income level across countries. There are some studies showing deforestation and income level (Brun1998; Kumar and Aggarwal, 2002).

According to the EKC environmental quality declines during early stages of economic development but improves in the later stages. However there is no conclusive agreement on existence of the EKC.

The EKC applies only to those environmental problems that are easy to solve and are well documented like human welfare or health impacts and certain kinds of air pollutants and particulates. However, a study compared some EKC studies and the state of the environment evaluated by the OECD and the EC and it was found that aggregate environmental pressure actually rises when economies get richer. In these countries some environmental indicators like air pollutants may be improving but not all. Moreover, due to material substitution new and unlisted substances may enter the environment the consequences of which might still not be known.

For some developed countries longer time-series data are available for pollutants such as NO2 and SO2, which show to be decreasing over time. However this may not be due to economic growth as has been proposed by the EKC, since higher growth rates in developed countries are often associated with lower emission reductions

In case of developing countries, whether pollution will decrease after these countries reach PCY turning points is speculative. Moreover, majority of the world's population have a standard of living below estimated turning points Thus emissions worldwide are therefore expected to continue to increase due to economic growth.

The EKC assumes that the initial increases in environmental pressure are temporary, but their subsequent decline in later stages of development is permanent. Some however have talked about and 'N' shaped curve too. This upswing of the EKC in the 'N' shaped curve is due to creeping up of inefficiencies in the existing production systems with time.

The EKCs represent the patterns of flow of pollutants and not the environmental impacts, which are basically a stock problem. Optimal levels of pollution depend on costs and benefits of pollution abatement, which differ among countries. This limits the policy relevance of an estimated collective turning point for a whole sample of countries.

3. Indicator of Poverty -Environment Linkages

Indicator showing the poverty-environment linkages helps in designing effective response strategy for poverty reduction and environmental amelioration. Indicators are important tools for designing and evaluating poverty reduction strategies, projects and outcomes. Indicators are needed to monitor *inputs* or resources provided by the project, *outputs* that refer to goods and services that result from the project, *outcomes* or the short term results from the project and the *impacts* that are long term changes that at least partially result from the project. Input and output indicators are called *intermediate* indicators while outcome and impact indicators are called *final* indicators. Recently, *geo-referenced* indicators have gained prominence with the use of poverty-environment maps. Data for these are obtained from satellite images and GIS.

Two aspects of the environment that could affect the poor are:

(i) Environmental conditions that impact the health of the poor and

(ii) (ii) Natural resource conditions that affect the income and security of poor households.

Environment and Health:

Environmental health risks fall into two broad categories:

(i) Traditional hazards related to poverty and lack of development, such as safe water, inadequate sanitation, and waste disposal, indoor air pollution, and vector borne diseases.

(ii) Modern hazards such as urban air pollution and exposure to agro-industrial chemicals and waste that are caused by development that lack environmental safeguards.

Global evidence suggests that the 2 most important ways in which environmental quality has a negative impact on health of the poor is through water and indoor air pollution. In the following Table1 change in ecosystem health and its impact on human has been shown

Table1: Examples of Ecosystem Disruption and environmental Health Indicators

Ecosystem	Service	Change	Hazard	Human health outcome	Indicators
Coastal	Waste processing	Organic Overload	Microbes	Diarrheas, Cholera	Incidence
Urban	Air quality regulation	Air Pollution	CO, NO_x, SO_2	Asthma	Morbidity; Body burden of metals
Freshwater	Water filtration	Depletion	Poor hygiene	Diarrhea	Childhood mortality
Tropical Forest	Regulation of water and nutrients cycles	Deforestation	Infections	Malaria, arbovirus infections	Incidence
Agro ecosystem	Food production	Pesticides	Toxic exposure	Reproduction problems	Fertility rates
Freshwater/marine	Provision of Fish	Over harvesting	Depletion of fish resource	Reduced consumption of fish protein	Protein deficiency

To monitor the extent to which poor people depend on clean water and have access to sanitation facilities, it is useful to disaggregate these indicators, and monitor them by income or wealth quintile groups. Access to water and sanitation are indirect indicators of health outcomes. An important impact indicator of health is under 5 mortality rates (U5MR). The results using this methodology i.e., of monitoring indicators by wealth quintile groups show a wide gap between health outcomes between the rich and the poor. The environmental component in the total burden of disease is about 18% in all LDCs that is much higher than those for industrialized countries.

Now it is important to know whether policies in place favour the poor and support better health outcomes. A good proxy indicator of policies is government expenditures on health. It was found that in African countries richer people benefit much more than the poor in terms of public support for health.

To know which of the indicators are more prominent for monitoring environmental health outcomes, the answer is;

- Data availability
- Cost and ease of measurement and monitoring
- Stakeholder perceptions on what is important to monitor and acceptance of indicators
- Final purpose for which the indicator is used.

In the context of Poverty and Natural Resources, it is important to understand how resource loss can act as determinant of poverty. Natural resources are sometimes the only assets to which poor people have access. Thus degradation can decrease their wealth. However, it is also true that, under certain circumstances, degradation can help the poor if they are able to use income obtained from depleting natural resources to improve their lives in other ways.

Natural systems are extremely complex, and it would not be cost effective to monitor all the different ways in which the poor are affected by their natural environment. The local diversity of natural resource problems may also render any list of all global poverty-natural resource indicators irrelevant. The sometimes-circular connection between poverty and natural resource degradation also makes the monitoring of poverty-environmental indicators and their interpretation very challenging.

Because of the strong need for local natural resource-poverty indicators, it may be useful to think about a common framework for identifying these indicators than a list of indicators. The OECD Pressure-State-Response (PSR) model offers a framework for monitoring the impact of resource degradation on the poor and identifying policy measures to stem the problems faced by the poor. A slightly different model the Pressure-State-Poverty-Response (PSPR) model allows us to track the impact of pressure factors not only on natural resources t also on the poor. Under this framework the author then provides indicators for deforestation and income impacts on the poor and soil fertility and income impacts on the poor.

4. Synthesis

After the Rio Summit in 1992 and Johanesburg Summit in 2002 the global community has felt the strong need to understand and address the twin goals of environmental conservation and poverty reduction. This has also brought added impetus to understand the linkages of poverty and environmental degradation. Poor people in developing countries are mostly dependent on their natural resource base and primary production sources as other sectors of the economy are very less.

Long-term economic growth rates of poor countries are much less than those of rich countries. The conventional explanation for this situation has been attributed to failed policies and weak institutions which in turn inhibits the use of technical innovation thereby curtailing economic growth & development in these poor countries. What conventional studies have overlooked in this case is the dependence of these poor economies on their natural resource base.

The developing countries are highly dependent on primary economic activities and this causes many land use changes like:

1. Forest area get converted to agricultural land

Low agricultural productivity with prolonged farming

2. Land degradation
3. Population carrying capacity constraints.

These land use changes endanger the environment, which also affects the economy of these countries.

In these developing countries the depletion of natural resources also contribute in social processes that destabilize the institutional and economic conditions necessary for innovation and growth. This instability in institutional processes causes resource scarcity and conflicts over resource use allocation. These social unrests once again disrupt any existing institutional and economic processes. Thus these developing countries are also characterized by socio-political instability.

More than 60% of the developing world's poor live in ecologically fragile zones, which are easily prone to degradation and which in turn puts such poor people's livelihoods into greater risk (Barbier, 1999). In the peripheral urban areas of developing countries there exist slums or squatter settlements wherein dwell the urban poor. About 30%-60% of the population in large cities live in such squatter settlements which are characterized by complete lack of basic infrastructure facilities thereby endangering not only the economic welfare of these people but also the environment in these areas.

In general the poor in developing countries suffer from 3 major processes of environmental entitlement loss:

1. The poor are displaced from their traditional entitlement to common resources by development activities or by appropriation of their resources by rich claimants.
2. Their remaining resource entitlements are reduced by sharing with children or by sale so as to cope with other economic losses.
3. Their existing resource entitlements are degraded through excessive use.

There may be a positive correlation between poverty and environment but there does not exist only a simple cause and effect relationship between both. The poor people's perception and behavior towards their natural resource base may be influenced by several factors like;

a) Economic distortions arising from policy and market failures
b) labour and capital endowment constraints
c) access to alternative income earning activities
d) Other institutional and legal factors such as land tenure or property rights etc.

The corollary to a positive correlation between poverty and environment is the fact that poor people have little or no capital endowments and hence would not think of degrading their 'natural capital' endowment on which their livelihood mostly depends. However they only tend to degrade their environment under certain circumstances when the changing economic and social conditions have altered the incentive structures of the poor, including perhaps their control over or access to essential resources.

A holistic approach to the linkages of poverty and environment begins with better understanding of poverty. Poverty might be a pronounced form of deprivation but this may arise due to lack of various types of capital –social, man made human and natural. This deficiency would make the people deprived leading to their vulnerability. Millennium Ecosystems Assessment (2003) and the World Bank clearly bring various types of capital into picture and attribute as the source of powerlessness and vulnerability of the poor (Table2).

Table2: Dimensions of Poverty

Lack of assets	Powerlessness	Vulnerability
Assets include: • Natural Capital • Human Capital • Financial Capital • Physical Capital • Social Capital	Powerlessness caused by: • Social Differences (including Gender) • Inequitable access to resources • Unresponsive public administrations • Corruption • Inequitable legal systems	Multiple risks resulting from: • Economic Crises • Natural Disasters • Social Crises

(Source: The World Bank 2001)

Vulnerability of people makes their time horizon of action and behaviour short sighted. That also makes their future highly discounted leading to commit to short-term goals and environment and conservation issues are relegated to the background. It is very important that management regime for natural resources, soil, water, forest and biodiversity recognizes the influence of poverty in their scheme of action and policies. Response policies for natural resources and environment might have lesser chance of success if a thematic dimensional aspect of poverty is not recgnised and incorporated into the conservation policies. At the same time, any policies addressing the incidence of poverty must acknowledge and embrace the contribution of ecosystems and environment (MA, 2003, 2005). Poverty reduction strategy

Can easily be seen in the context of opportunity created, empowerment enforced and security generated for the poor leading to an effective conservation policies (please see the Table3 below on opportunity, empowerment and security created by the PRST for the poor.

Table3: Some Dimensions of Poverty Reduction

Opportunities and growth	Empowerment	Security
• Expanding Assets of Poor • Encouraging Private Investments • Expanding International Markets • Pro-poor Market Reform • Restructuring Aid • Debt Relief	• Addressing Social Inequalities • Enhanced Public Participation in Decision-Making • Pro-Poor Decentralization • Public Administration Reforms • Legal Reforms • Providing forums for Debate	• Risk Management • Safety nets • Coping with Natural Disasters

(Source: World Bank, 2001)

For a decision makers the ingredients of a successful policy to remove poverty and conserve environmental condition lie in the effective intervention at the appropriate point. This means targeting the symptom of poverty effectively. This will also address the environmental concerns adequately. Identification of entry point of intervention is most critical element in poverty- environmental linkages. Following table 4 summarises the types and degree of intervention in poverty – environment space.

Table4: Entry Points of Implementations

Dimension of Poverty	**Entry Points**	**Local/site level Interventions**	**Policy/Political (national/international) interventions**
Problem: Lack of Assets and opportunities **Solutions:** Provide opportunities, build/restore assets	• Employment • Access to capital, technology and markets • Trade policy • Competition policy • Resource tenure	• Forest restoration • Watershed protection • NTFP marketing • Improved access to resources and tenure • Micro credit programmes • Biodiversity-friendly enterprises	• Tenure reform • Transfer mechanism to compensate loss and reward stewardship • Environment and poverty concerns built into international trade • Access and benefit-sharing related to genetic resources • Research to improve farm productivity
Problem: Lack of Power **Solution:** Empowerment and access	• Participation • Democratic decision-making • Rule of law (equality before the law) • Access to information • Accountability and transparency	• User groups supported • Gender and equality aspects of projects • Citizen report cards • Power relations that limit access are addressed	• Tenure reform • User network supported • Public administrative reform • Devolved power to the grass roots • Strengthened recognition of cultural identity/ indigenous knowledge • Enhanced connectivity of rural areas

Problem: Vulnerability **Solution:** Security	• Diversification • Insurance • Prevention • Early Warning/ prediction	• Infrastructure and neighborhood improvement • Diverse livelihood option and low-cost local initiatives to help communities deal with risk of natural disasters • Food banks and agricultural cooperatives	• Plan for better disaster management with communities • Provide access rights to diverse resources in protected areas
Problem: Lack of Capacity Solution: Enhance capability	• Literacy • Health • Provision of basic services • Access to information	• Environmental sanitation projects • Skill development • Build capacity of/revive local institutions	• Research on diseases that affect the poor • Formal and non-formal education programmes • Enhanced connectivity of rural areas

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