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# Making 'dirty' nations look clean? The nation state and the problem of selecting and weighting indices as tools for measuring progress towards sustainability

Stephen Morse [a], Evan D.G. Fraser [b,*]

[a] *Department of Geography, School of Human and Environmental Sciences, University of Reading, Reading RG6 6AH, UK*
[b] *Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK*

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**Abstract**

Pressing global environmental problems highlight the need to develop tools to measure progress towards "sustainability." However, some argue that any such attempt inevitably reflects the views of those creating such tools and only produce highly contested notions of "reality." To explore this tension, we critically assesses the Environmental Sustainability Index (ESI), a well-publicized product of the World Economic Forum that is designed to measure 'sustainability' by ranking nations on league tables based on extensive databases of environmental indicators. By recreating this index, and then using statistical tools (principal components analysis) to test relations between various components of the index, we challenge ways in which countries are ranked in the ESI. Based on this analysis, we suggest (1) that the approach taken to aggregate, interpret and present the ESI creates a misleading impression that Western countries are more sustainable than the developing world; (2) that unaccounted methodological biases allowed the authors of the ESI to over-generalize the relative 'sustainability' of different countries; and, (3) that this has resulted in simplistic conclusions on the relation between economic growth and environmental sustainability. This criticism should not be interpreted as a call for the abandonment of efforts to create standardized comparable data. Instead, this paper proposes that indicator selection and data collection should draw on a range of voices, including local stakeholders as well as international experts. We also propose that aggregating data into final league ranking tables is too prone to error and creates the illusion of absolute and categorical interpretations.
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## 1. Introduction

When surveying the state of the planet today, most scholars of the environment cannot help but feel a growing sense of alarm. Notwithstanding the views of sceptical environmentalists (Lomborg, 2001), evidence of a global decline in nearly all of the earth's major ecosystems presents a nightmarish scenario, and quite clearly, a solution to these problems eludes us. In some cases, such as climate change, it seems that the power of scientific modelling does not provide us with the precise guidance we need to understand the costs of different policies relative to the costs of inaction. In other cases, such as the potential impact of genetically modified crops on human and ecosystem health, it seems that the scientific processes of collecting and interpreting data for good environmental governance are highly contentious to say the least. In still other cases, decades of development work led by Western Institutions seems to have disenfranchised local communities, deepened poverty and

* Corresponding author.
*E-mail address:* evan@env.leeds.ac.uk (E.D.G. Fraser).

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exacerbated environmental problems. There is clearly the need for strong, rigorous and analytic tools to help fill these gaps and provide guidance for intervention. However, it is unclear at what scale we should apply our efforts. For example, Chasek (2001) analyses scores of multi-lateral environmental treaties, and suggests that many of these have failed because environmental problems are not constrained to the specific geographic regions that impose policy. The declining power of the nation state may also play a role (Jones and Jones, 2004). Some suggest that environmental governance, based on the Westphalian nation state, is doomed to failure: after all, meetings of heads-of-state do little to affect a poor farmer's decision to clear land for crops (Fraser and Mabee, 2002) and it is well known that environmental problems do not respect political boundaries but follow ecological pathways through landscapes (Fraser et al., 2003). This sort of logic leads Meadowcroft to question whether existing governance institutions have the potential to "*... restrict social and economic behaviour within the frontiers of ecological sustainability*" (Meadowcroft, 2002, p. 169).

Sustainable development, with its emphasis on local participation (United Nations, 1992) was supposed to help address this by allowing organizations that cut across political and geographic boundaries an opportunity to influence and help set agendas (Meadowcroft, 2002). This reflects what Matthews describes as a power shift away from national governments to other players such as business and civil society (Matthews, 1997). However, despite trends since the fall of the Soviet Union that suggest a decline in the power of national governments, the global environmental agenda is still very much driven from the capital cities of G-8 countries. As a result, Boehmer-Christiansen expresses the concern that sustainable development has become an elaborate justification by rich nations to protect prevailing hegemonic interests (Boehmer-Christiansen, 2002). In our opinion, global environmental governance is caught in a bind. Taking the extreme polar views, on the one hand are post-modernists who critique the notion of sustainable development since, "*those who give original discourse direction ... shape ideological hegemony by producing leading concepts*" (from Kohler-Koch, p. 351 quoted in Boehmer-Christiansen, 2002), while on the other hand are those who address problems by proposing the tools with which we are to find solutions. The post-modernists express concern that the second group is inherently insensitive to local contextual issues, while the second group (perhaps regarding themselves as more pragmatic) largely ignore the post-modernists in their dogged efforts to solve the problems of today with apparently endless deconstruction. Nowhere is this bind more apparent than when it comes to trying to choose indicators that are supposed to help measure progress towards, or indeed away from, 'sustainability' (Bell and Morse, 1999, 2003).

One point on the frontline between post-modernist critique of environmental governance and the position of the 'more pragmatics' can be represented by national-level indices designed to measure our impact on the earth. Pragmatists may argue that such indices are useful as they allow a sort of 'name and shame' policy as an incentive for action, while critics will argue that such indices are at best worthless due to methodological problems and may even hide problems and prevent solutions if powerful parties use them as a method to mask problems they themselves cause. This gives rise to a series of very post-modern sounding questions such as: who defines and measures sustainability, and who benefits from these definitions? For example, Escobar (1996) attacks the view, which he says is common in the sustainable development literature, that environmental problems can be solved through technical interventions, arguing instead that nature is "socially constructed" and therefore reflects intellectual and technical biases.

An excellent example of the issues at play is provided by the recently (late 1990s) created Environmental Sustainability Index (ESI) backed by the World Economic Forum (WEF) (Global Leaders of Tomorrow Environment Task Force, 2002). Referring to themselves as the 'Global Leaders of Tomorrow' (or simply the 'Global Leaders'), this group has developed a composite index that aggregates a total of 68 datasets covering 142 countries into a single numerical value for each of the countries. Countries are then ranked in terms of their ESI in much the same way as the United Nations Development Programme ranks countries in terms of their Human Development Index (HDI). High ranks equate to better environmental sustainability.

However, despite this attempt at impartiality and objectivity, there is obviously much subjective judgement at play, including:

- decisions over what data to include and the source(s) of that data,
- how data collected at 'points' in space/time are scaled up to the country level,
- how data are manipulated in the process of calculating the ESI (e.g. whether the data are transformed or not),
- how data sets are aggregated and what weighting is applied (see: Sands and Podmore, 2000; Niemeijer, 2002; Parris and Kates, 2003; Jesinghaus, 2000 for a discussion on the problems with aggregation and weighting).

The last two points are especially problematic for the ESI, and although the authors of the ESI argue that all 68 data sets should have equal weighting in the final index ("*... in our judgment there was no firm basis for*

*applying differential weights given the current state of scientific understanding . . .*" (Global Leaders of Tomorrow Environment Task Force, 2002, p. 47)), this may still create a bias as selecting specific data seems sets make some countries—specifically richer ones—look unrealistically 'good' (or 'clean') in terms of environmental sustainability. Critics point out that this ignores a well-documented literature highlighting the many environmental problems in poor countries caused by rich nations exporting both pollution and polluting industries (for example, see Nowak, 2002).

Similarly, some environmental problems that have impacts far beyond national borders do not receive adequate weight in the ESI, while local problems that are insignificant in a global context play a large role in determining a country's rank in the ESI. [1] It is almost as if the ESI treats each country as a discrete unit, the environmental policies and performance of which have no relevance outside the national border. This criticism, which seems to support the post-modernist claim that sustainable development is a Western tool that reinforces the status quo, is especially important, as one of the main purposes of aggregate indicators is to facilitate comparisons between regions and plot progress over time. Indeed, different variables and weightings can generate very different ranks, and in one example, *The Ecologist* magazine and the Friends of the Earth organization, using the same datasets as used by 'Global Leaders' for their ESI, produced widely different rankings simply by changing the methods used to aggregate data (The Ecologist, 2001). From this analysis, The Ecologist (2001, p. 47) concludes:

> "if we are going to label nations 'good' or 'bad' in environmental terms, we must get our measurements right. Studies like the ESI, based on misleading data, which fail to take into account the true environmental costs that rich countries impose on the world, are designed to make dirty nations look clean."

But does the Ecologist's re-working of the ESI suffer from the same criticism as the original form created by the 'Global Leaders'? After all, if we decide that we need precise definitions of environmental sustainability and tools to measure this concept—which not everyone agrees with—biases, context, and human error will always occur where people decide what variables to use and how to measure and weigh them. Especially considering that the data used may not be collected in a rigorous or consistent fashion, can we trust the results of this sort of index that purports to provide an environmental ranking of so many nations? Or should we dismiss indices such as the ESI as inherently and unavoidably methodologically flawed and avoid attempts at reducing huge amounts of data, which span social, economic and environmental concerns, into simple diagnostics? If we do this, and adopt a more comprehensive and descriptive approach, how can we compare regions or even communicate key trends to the public?

These questions illustrate the bind that those who try to manage the environment find themselves in, and will form the basis for this paper. Although we may contest the definition of sustainable development, and pick apart the arithmetic and subjectivity of an aggregated league table of nations, few deny the immediacy of today's ecological crisis or the need to develop tools to help provide clear and concrete guidance. To find a balance and generate tools that go beyond those that simply reinforce prevailing orthodoxy, it may be appropriate to only aggregate complex data if the methodology is fully explained, assumptions are made clear, and raw data are provided so anyone can re-create versions of the index just like *The Ecologist* and Friends of the Earth did (JRC, 2003). But is this enough? Should such transparency give us the confidence that results based on aggregating data across a range of areas (social, intuitional, cultural, economic, atmospheric, terrestrial . . .) and scales (global, regional, local . . .) are accurate?

The aim of this paper is to explore whether methodological transparency is an adequate solution to the problems posed by highly aggregated indices. In addition, the paper will explore the nation-state focus at the heart of such indices and ask whether this is relevant in the globalized world in which we live. To do this we will use the ESI as a case study, and attempt to disaggregate the data and develop our own conclusions based on the same inputs that the Global Leaders used. In doing so, we will expose the assumptions that may have influenced the Global Leaders and highlight the possible range of interpretations that an aggregated index like the ESI can provide once a spectrum of differential weighting is applied to its components. We will first review the origins of the ESI and the theory behind its use as promoted by the Global Leaders. This will be followed by a brief summary of the methodology employed in its calculations [2] and an exploration of the range of values for the ESI that can be created by changing some of its components. We will conclude with a more discursive discussion on the implications this exercise has for the use of aggregate indicators more generally. The raw data for the variables as presented in the ESI reports have been employed throughout.

[1] Brazil, which is home to the globally significant and highly degraded Amazon Rain Forest, is in the top 20 'most sustainable' countries, whilst countries such as Rwanda, Trinidad and Tobago and Haiti, where environmental problems only have a local effect, do very poorly in the ESI league tables.

[2] Full details regarding the ESI methodology as applied by the Global Leaders can be found at http://www.ciesin.org/indicators/ESI/.

## 2. Origins of the environment sustainability index

The ESI is a product of the World Economic Forum, a group of top business leaders, academics, and politicians who meet annually in Davos, Switzerland. Established in 1970 as an informal gathering of Europe's chief executives, the forum has expanded both its participant list and agenda. It now proclaims itself to be "*... the foremost global community of business, political, intellectual and other leaders of society committed to improving the state of the world.*" (World Economic Forum, 2004, on-line edition). Its mission is to bring together "*... global leaders, from all walks of life, to pursue economic and social activity that will improve the state of the world.*" (World Economic Forum, 2003–2004, on line edition). With members who represent 1000 of the world's wealthiest companies, and 200 smaller companies, the WEF strives to apply 30 years of experience in bringing business leaders together, and solve major global problems by proving a platform to encourage public-private partnerships. This is predicated on the understanding that "*... to succeed, business leaders must do more than manage their financial bottom line ...*" (World Economic Forum, 2003–2004, on line edition). The World Economic Forum has been severely criticized by opponents of economic globalisation as only providing an opportunity for the already wealthy and powerful to further influence political agendas (O'Brien, 2000), and has been described as "*... the archetype of the most exclusive and powerful transnational elite club*" (Graz, 2003, p. 335). In recent years, however, the organizers have taken steps to broaden participation, and now explicitly include high profile critics of economic globalisation in their panel of speakers (for example, Vandana Shiva, one of the worlds most outspoken critics of the global agri-food industry, spoke to the forum in 2000). Furthermore, Graz (2003) suggests that although the Forum provides an opportunity for members of the most wealthy and elite business and political communities to network, it has only a limited ability to affect real world change because it lacks formal institutional ties with national governments.

One of the main outputs of the World Economic Forum has been its 'Global Competitiveness Report' published annually since 1979. The Competitiveness Report purports to be the "*... most up-to-date, comprehensive data source available on the comparative strengths and weaknesses of leading economies of the world.*" (World Economic Forum, 2003–2004, on-line edition). The ESI was proposed as an environmental counterweight to the 'Competitiveness Report', and is said by them to demonstrate the Forum's commitment to issues that go beyond narrowly defined economic concerns. The ESI is designed to benchmark environmental progress and allow for a greater understanding of tradeoffs in environmental policy. Its goal is to provide comparability across a wide range of countries, focus on environmental problems, express results in a single number while allowing more sophisticated dis-aggregation, and encourage debate. An initial pilot study was completed in 2000 by a group of academics housed at the Yale Centre for Environmental Law and Policy and Columbia University Centre for International Earth Science Information Network. Included in this group of academics were a former US Environmental Protection Agency Chief of Staff and a political scientist who has had a high-profile career working on such projects as the Millennium Ecosystem Assessment and the State Failure Task Force. The pilot study was based on data from 60 countries and led to a full study in 2001 that covered 122 countries (Environmental Sustainability Index, 2001). In 2002, the World Leaders expanded this work to include 142 countries based on 68 data sets (Environmental Sustainability Index, 2002). In 2002, the World Leaders also developed the Environmental Progress Index (EPI). According to the World Leaders, both indices address the gap between governmental desires to respond to environmental problems and our ability to measure and assess these problems. They differ in that the original index, the ESI, is aimed at decision makers who "*wish to compare nations' long-term environmental trajectories*," while the EPI is used to generate national comparisons on efforts to manage a narrower set of environmental issues such as air and water quality, climate change, and ecosystem preservation (Global Leaders of Tomorrow Environment Task Force and the World Economic Forum, 2002, p. 2).

## 3. Summary of methods used to generate the ESI

Details of the ESI methodology can be found in the ESI reports and will not be covered in depth here. Instead, we wish to point out the key steps of the process with a view to highlighting the subjectivity of the decisions being made. While the exact form of the ESI has changed since its inception in 1999, by 2002 it comprised 68 data sets (referred to as 'variables') grouped into a total of 20 indicators and five components. The number of variables within each indicator varies as do the number of indicators in each component. The result is a somewhat complex hierarchy of data and indicators (Table 1).

At the very heart of the ESI are the variables, and these are diverse in nature, covering not only the sort of biophysical measures (such as air and water pollution) that would be obvious with such an index but also socio-economic factors such as corruption and participation in international agreements to protect the environment. As already mentioned, it is this subjective

Table 1
Components of the 2002 version of the Environmental Sustainability Index (ESI)

| | Component of the ESI | Number of indicators | Number of variables |
|---|---|---|---|
| The Environmental Sustainability Index (ESI) | Environmental systems (SYSTEM) | 5 | 13 |
| | Reducing environmental stresses (STRESS) | 5 | 15 |
| | Reducing human vulnerability (VULNER) | 2 | 5 |
| | Social and institutional capacity (CAP) | 5 | 22 |
| | Global stewardship (GLOBAL) | 3 | 13 |
| | Total | 20 | 68 |

decision over what variables to include that perhaps provides the most significant critique of the ESI. A summary of all 68 variables and their aggregation to the five components of the ESI is provided as Table 2.

This hierarchical aggregation from variables to indicators and the ESI was generated on the basis of "*... a careful review of the environmental literature, expert advice, statistical analysis, as well as peer review assessments and critical assessments of the 2001 ESI.*" (Global Leaders of Tomorrow Environment Task Force, 2002, p. 6) Putting aside fundamental considerations of variable selection, data collection and scaling-up to the country level for the moment, once a value for each country has been arrived at there are a number of manipulations that take place in arriving at the ESI. If the data within each variable have a highly skewed distribution then the original data are transformed by taking logarithms. [3] Global Leaders suggest that any variable with a 'skewness' above four should be transformed before inclusion in the index. One additional complication here is that Global Leaders tested for skewness with a larger data set than the 142 countries listed in the reports. Hence, while the skewness of some of the variables listed in the reports is greater than four, no transformation took place.

Following transformation, each variable is capped (using the 97.5% and 2.5% percentile values) to remove extremes and then standardized into $z$-values. The latter was done in one of two ways depending upon the relationship between the 'polarity' of the variable and sustainability. If the variable was deemed 'good' (e.g. high water availability per capita is better than low water availability), the $z$-value was generated by subtracting the mean from the country value and dividing by the standard deviation. The result is that $z$-value will increase with the country value and a country value less than the mean will yield a negative $z$-value. However, if high values are deemed to be 'bad' for sustainability (e.g. high levels of a pollutant) then the $z$ value is derived by subtracting the country value from the mean and then dividing by the standard deviation. In this case, a high value for a country (i.e. one greater than the mean) will result in a negative $z$-value. The aim is to standardize the distribution so that the average of all the country $z$-values for a variable will be zero and the standard deviation will be one. The value of each indicator for a country is simply provided by the average of the variable $z$-values that comprise that indicator, and in turn the indicator $z$ -values are averaged to generate a $z$-value for each of the five ESI components.

In order to generate values that are more intuitive, the $z$-values for each of the five components are transformed using the 'standardized normal percentile'. The result is a set of numbers for each of the components with a theoretical minimum of 0 and a theoretical maximum of 100. In essence, the $z$-values are converted to numbers that look like percentages, with high values suggesting 'better' sustainability. The standardized normal percentile values of the components for each country are averaged to provide the ESI. It should be noted that the final averaging is done by weighting the contribution of the components based upon the number of indicators they comprise and not by the number of variables. In other words:

$$\mathrm{ESI} = (5 * \mathrm{SYSTEM}) + (5 * \mathrm{STRESS}) + (2 * \mathrm{VULNER}) + (5 * \mathrm{CAP}) + (3 * \mathrm{GLOBAL})/20$$

Not

$$\mathrm{ESI} = (13 * \mathrm{SYSTEM}) + (15 * \mathrm{STRESS}) + (5 * \mathrm{VULNER}) + (22 * \mathrm{CAP}) + (13 * \mathrm{GLOBAL})/68$$ [4]

The higher the ESI then the better the environmental sustainability of the country, and the results are presented in a league table format.

[3] *Statistical note*: many statistical tests require data to be arranged along a 'normal' bell shape curve, with the majority of data points falling at the middle of the data range, and a small number falling at extreme values. In this case, some data ranges did not conform to this and fell along a long gentle slope. Following generally agreed statistical rules, data that exhibited this were transformed by taking the log (base 10) of each value.

[4] For example, the 'percentage' values of SYSTEM, STRESS, VULNER, CAP and GLOBAL for Albania are 62.2, 62.8, 59.8, 47.2 and 59.0 respectively. Weighting on the basis of number of indicators yields the published ESI value of 57.9. Weighting on the basis of variables yields a value of 56.7. This might seem like a small difference but could shift that country up or down the league table by a couple of places.

Table 2
Variables used in the 2002 version of the Environmental Sustainability Index (ESI)

| Component | Indicator | Variable | |
|---|---|---|---|
| SYSTEM | Air quality (SYSAIR) | $NO_2$ | Urban $SO_2$ concentration |
| | | $SO_2$ | Urban $NO_2$ concentration |
| | | TSP | Urban Total Suspended Particulate concentration |
| | Water quantity (SYSWQN) | WATCAP | Internal renewable water per capita |
| | | WATINC | Per capita water inflow from other countries |
| | Water quality (SYSWQL) | GMS_DO | Dissolved oxygen concentration |
| | | GMS_PH | Phosphorus concentration |
| | | GMS_SS | Suspended solids |
| | | GMS_EC | Electrical conductivity |
| | Biodiversity (SYSBIO) | PRT_MAM | Percentage of mammals threatened |
| | | PRT_BRD | Percentage of breeding birds threatened |
| | Land (SYSLAN) | ANTH10 | Percent of land area having very low anthropogenic impact |
| | | ANTH40 | Percent of land area having high anthropogenic impact |
| STRESS | Reducing air pollution (STRAIR) | NOXKM | $NO_x$ emissions per populated land area |
| | | SO2KM | $SO_2$ emissions per populated land area |
| | | VOCKM | VOCs emissions per populated land area |
| | | COALKM | Coal consumption per populated land area |
| | | CARSKM | Vehicles per populated land area |
| | Reducing water stress (STRWAT) | FERTHA | Fertilizer consumption per hectare of arable land |
| | | PESTHA | Pesticide use per hectare of crop land |
| | | BODWAT | Industrial organic pollutants per available fresh water |
| | | WATSTR | Percentage of country's territory under severe water stress |
| | Reducing ecosystem stress (STRECO) | FOREST | Percentage change in forest cover 1990–1995 |
| | | AC_EXE | Percentage of country with acidification exceedence |
| | Reducing waste and consumption pressures (STRWAS) | EFPC | Ecological footprint per capita |
| | | NUKE | Radioactive waste |
| | Reducing population growth (STRPOP) | TFR | Total fertility rate |
| | | GR2050 | Percentage change in projected population between 2000 and 2050 |
| VULNER | Basic human sustenance (VULSUS) | UND_NO | Proportion of undernourished in total population |
| | | WATSUP | Percent of population with access to improved drinking water supply |
| | Environmental health (VULHEA) | DISRES | Child death rate from respiratory disease |
| | | DISINT | Death rate from intestinal infectious disease |
| | | U5MORT | Under-5 mortality rate |
| CAP | Science/technology (CAPST) | INNOV | Innovation Index |
| | | TAI | Technology Achievement Index |
| | | SCHOOL | Mean years of schooling (age 15 and above) |
| | Capacity for debate (CAPDEB) | IUCN | IUCN member organizations per million population |
| | | CIVLIB | Civil and political liberties |
| | | POLITY | Democratic institutions |
| | | ESIMIS | Percentage of ESI variables in publicly available data sets |
| | Environmental governance (CAPGOV) | WEFGOV | WAF survey questions of environmental governance |

Table 2 (*continued*)

| Component | Indicator | Variable | |
|---|---|---|---|
| | | PRAREA | Percentage of land area under protected status |
| | | EIA | Number of sectoral EIA guidelines |
| | | FSC | FSC accredited forest area as a percent of total forest area |
| | | GRAFT | Reducing corruption |
| | | GASPR | Ratio of gasoline price to international average |
| | | WEFSUB | WEF subsidies survey question |
| | | SUBFSH | WWF subsidy measures |
| | Private sector responsiveness (CAPPRI) | ISO14 | Number of ISO14001 certified companies per million $ GDP |
| | | DJSGI | Dow Jones sustainability group index |
| | | ECOVAL | Average Innovest EcoValue rating of firms |
| | | WBCSD | World Business Council for Sustainable Development members |
| | | WEFPRI | WEF survey questions on private sector environmental innovation |
| | Eco-efficiency (CAPEFF) | ENEFF | Energy efficiency (total energy consumption per unit GDP) |
| | | RENPC | Renewable energy production as a percent of total energy consumption |
| GLOBAL | Participation in international collaborative efforts (GLOPAR) | EIONUM | Number of memberships in environmental intergovernmental organizations |
| | | CITES | Percentage of CITES reporting requirements met |
| | | VIENNA | Levels of participation in the Vienna Convention/Montreal Protocol |
| | | FCCC | Levels of participation in the Climate Change Convention |
| | | MONFUN | Montreal Protocol multilateral fund participation |
| | | GEF | Global Environmental Facility participation |
| | | WAFAGR | Compliance with international agreements |
| | Reducing greenhouse gas emissions (GLOCLI) | CO2PC | Carbon lifestyle efficiency ($CO_2$ emissions per capita) |
| | | CO2GDP | Carbon economic efficiency ($CO_2$ emissions per $ GDP) |
| | Reducing trans-boundary environmental pressures (GLOTRA) | CFC | CFC consumption (total times per person) |
| | | SO2EXP | $SO_2$ exports |
| | | FSHCAT | Total marine fish catch |
| | | FSHCON | Seafood consumption per capita |

*Source*: ESI Report 2002.

Having provided this overview, the following are but a few of the issues that arise.

## 4. Critique 1: Data and the ESI

At the heart of the ESI calculation is the need for a reliable data set with a good coverage across countries. However, given the need for data covering 68 variables and 142 countries it is to be expected that there will be substantial gaps. These are filled by a process of 'imputation' based upon regression analysis with another associated variable. For example for the 'Air Quality' indicator under the 'Environmental systems' component, there are three variables; urban $SO_2$, $NO_2$ and TSP (total suspended particle) concentration. The proportions of each of these made up from observed and imputed values are shown in Table 3.

Table 3
Imputed and observed values for different air quality variables used in the Environmental Sustainability Index

| Variable | Observed values | Imputed values | Total |
|---|---|---|---|
| Urban $SO_2$ concentration | 51 | 91 | 142 |
| Urban $NO_2$ concentration | 50 | 92 | 142 |
| Urban total suspended particles (TSP) concentration | 49 | 93 | 142 |
| Total | 150 | 276 | 426 |

This indicator has the majority (65%) of its data values imputed rather than being based on direct measurement, a figure that is high even when it is assumed that the remaining 35% observed values are of good quality. We also need to note that in the 'Air Quality' indicator both the $SO_2$ and $NO_2$ variables are based on city averages over the period 1990–1996, which were then

'normalized' for the city population in 1995 and scaled-up to give a value for each country. However, there is much variation hidden within the single country values. For example, what about seasonal variation within a year and spatial variation within the country?

The problem associated with imputing data is not restricted to air quality variables. Twenty-four of the 68 variables used to generate the ESI have varying degrees of imputed data. The need for imputed data is a concern, especially as the imputed values are derived from a regression analysis of variables that are assumed to be associated. Ideally, each of these should include an error term thereby providing a range rather than a single value for each of the imputed data, but that would perhaps complicate the methodology so much as to make it unusable. Nevertheless, it should be noted that the dominant desire for a single-number end product to be derived for each country influences the means by which it is achieved.

## 5. Critique 2: The ESI and GDP

A significant finding of the ESI is that wealth (measured through GDP) is significantly and positively correlated with ESI ($R^2$ of 0.39: see page 14 in Global Leaders of Tomorrow Environment Task Force (2002) and there was a similar relationship between the ESI and the Global Competitive Index ($R^2 = 0.34$)). From this, the Global Leaders concluded that "*... environmental sustainability does not appear to impose a constraint on economic growth*" (Esty and Levy, 2000 on-line edition). Although in some places the Global Leaders have mollified this conclusion, and suggest in the final report that "*... within income groups, a considerable range* [in ESI values] *exists*." (Global Leaders of Tomorrow Environment Task Force, 2002, p. 15). This conclusion has opened up the ESI up to a host of criticism. For example, *The Ecologist* suggests that the rich countries appear better than they should because the variables that rich countries excel in count more than indicators that poorer nations score well in (The Ecologist, 2001).

While *The Ecologist* critique has substance, a closer inspection of the basic relationship between wealth and ESI (Fig. 1) reveals a much more complex picture than has yet been suggested by either the Global Leaders or *The Ecologist*. [5] Working with all of the ESI data and the 'Global Leaders' assumption of equal weighting there is evidence for both linear and quadratic relationships (having $R^2 = 0.82$ and $R^2 = 0.86$, respectively) suggesting that although the relation between GDP and ESI is strong for low income countries, it may plateau and perhaps even decline at high income levels. Dividing counties into different geographical, economic and political regions reinforces this observation. Fig. 2 illustrates that GDP and ESI have the highest correlation for African countries ($R^2 = 0.67$, $p < 0.01$), while the relationship is weaker for OECD countries ($R^2 = 0.47$, $p < 0.01$) and there is no statistically significant relationship between GDP and ESI for countries with more than 1.5 times the average GDP/capita (Fig. 2). All this suggests that the relation between GDP and ESI changes at different levels of income, and that it can be misleading to draw any global inferences from the data presented.

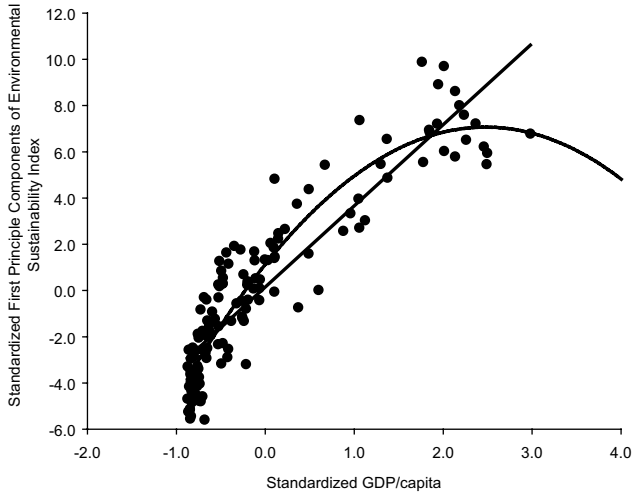


Fig. 1. Environmental Sustainability Index (standardized $z$-scores so that the mean ESI = 0) versus GDP/Capita (standardized $z$-scores so that the mean GDP = 0) for all countries in 2002 with a linear regression ($R^2 = 0.82$) and a quadratic regression line ($R^2 = 0.86$). The quadratic regression has been projected forward illustrating possible declines in Environmental Sustainability at higher income levels.

[5] To assess the relation between wealth and ESI we used the original data used by both the Global Leaders and *The Ecologist* to generate our own equivalent to the ESI. Following the approach of the 'World Leaders' methodology, the raw data for the 142 countries were first checked for 'skewness' and any variable having a skewness greater than 4.0 were transformed using logarithms (base 10). No percentile cutoffs were applied and the data were standardized using the original approach to generate $z$-values for each variable. No further aggregation took place. The same approach was used with Real GDP/capita ($ PPP) data gleaned from the 2002 Human Development Report of the UNDP. We then conducted a principle component analysis (PCA) using MINITAB to determine the degree to which the variation of standardized $z$-scores in the components of the ESI can be explained by standardized GDP per capita for each country. This statistical method provides more precision and nuance than the standard normal percentile approach based on averaging $z$-scores. Very briefly, the PCA provides 'aggregation' of a different sort and works by driving vectors through the multi-dimensional space occupied by all of the ESI variables. For more information see http://kybele.psych.cornell.edu/%7eedelman/psych-465-spring-2003/pca-tutorial.pdf

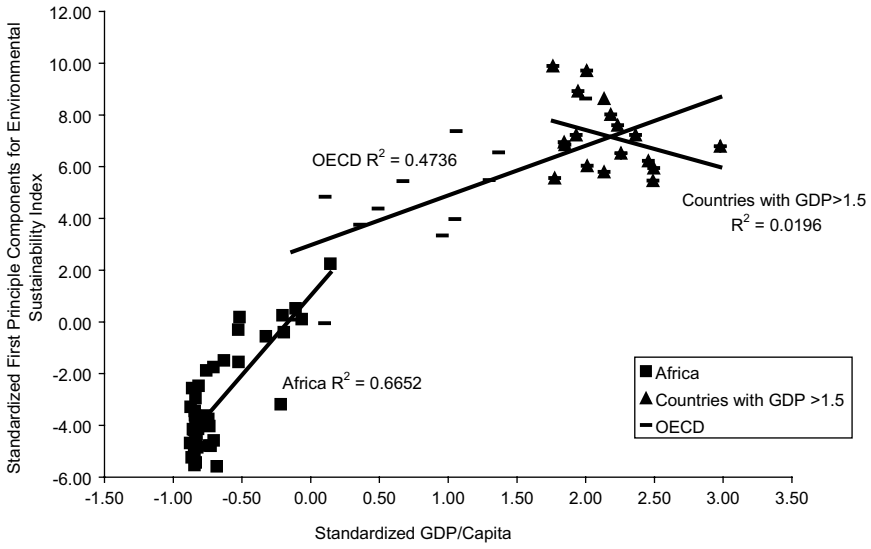


Fig. 2. Regional Breakdown of the Environmental Sustainability Index and GDP/Capita with Linear Trend line for African countries ($R^2$ = 67%, $p < 0.01$), OECD countries ($R^2$ = 47%, $p < 0.01$), and countries with 1.5 times average standardized income (not significant).

## 6. Critique 3: The components of ESI

Taking the five components of the ESI it is possible to generate many different versions of the index depending upon what is or is not included. Some of these will, like the original form of the ESI, be positively correlated with GDP/capita while others will be negatively correlated. Some idea as to the possible variation in outcome can be gleaned from Table 4 that comprises the correlation coefficients for the variable *z*-values with that for GDP/capita. Higher values of the correlation coefficient (e.g. for corruption; GRAFT) would suggest that sustainability is enhanced by income, while negative values (e.g. for ecological footprint per capita; EFPC) suggest that sustainability is compromised by income.

The variables can be aggregated with Principal Component Analysis in literally thousands of combinations and each of the aggregates would have a different relationship to GDP/capita. However, in order to simplify matters the correlation coefficients in Table 4 have been put together into the five components of the ESI in Fig. 3. In effect, the greater the area of each circle that is shaded then the more positive the linkage between sustainability and income. As can be seen from Fig. 3 the 'reducing stress' component of the ESI generally shows a negative relationship between sustainability and income, while the opposite is true for 'social and institutional capacity'. Re-introducing the between-country variation of these five ESI components and their relationships to GDP/capita generates the graphs in Fig. 4. Three of the components (Environmental Systems, Social and Institutional Capacity and Global Stewardship) clearly show a significant positive relationship with GDP/capita while the component Environmental Stress has a negative relationship and the component Environmental Vulnerability suggests a "U" shaped relation with GDP. One can show that sustainability is either positively or negatively related to economic performance depending upon what one deems to be important and how the variables are put together. If sustainability is viewed in terms of capacity and global stewardship then the richer countries do well relative to the poorer ones, while if sustainability is seen in terms of the stress placed on the environment, then the richer countries come out worst. The availability of raw data does allow the reader to put the pieces together any way they wish, and ironically, the criticism from *The Ecologist* was only possible because the 'Global Leaders' were transparent in their methods.

This raises a fundamental question however: which vision is 'right'? Indeed, is there a 'right' vision at all? Even with a limited data set of 64 variables, are we inevitably left with so many multiple perspectives that environmental sustainability evaporates? If so, then what is the point of the ESI and indeed any vision of sustainability beyond pleasant sounding and general definitions open to almost any interpretation possible?

## 7. Discussion on environmental sustainability indices: pro- or anti-development?

Since the ESI, along with the Human Development Index (HDI) and other such aggregated indicators, are essentially tools whose ultimate *raison d'être* is to promote 'good' development (be it economic, environmental, social or 'sustainable') this critique has to be seen within the context of broader debates in the development

Table 4
Correlation of ESI 2002 standardized variables with the standardized variable of real GDP/capita ($ PPP; 2002 data)

| Component | Indicator | Variable | Correlation with GDP |
|---|---|---|---|
| SYSTEM | SYSAIR | $NO_2$ | 0.06 ns |
| | | SO2 | 0.56*** |
| | | TSP | 0.66*** |
| | SYSWQN | WATCAP | 0.13 ns |
| | | WATINC | −0.26** |
| | SYSWQL | GMS_DO | 0.61*** |
| | | GMS_PH | 0.25** |
| | | GMS_SS | 0.41*** |
| | | GMS_EC | 0.05 ns |
| | SYSBIO | PRT_MAM | −0.26** |
| | | PRT_BRD | −0.07 ns |
| | SYSLAN | ANTH10 | −0.02 ns |
| | | ANTH40 | −0.56*** |
| STRESS | STRAIR | NOXKM | −0.37*** |
| | | SO2KM | −0.32*** |
| | | VOCKM | −0.31*** |
| | | COALKM | −0.55*** |
| | | CARSKM | −0.7*** |
| | STRWAT | FERTHA | −0.52*** |
| | | PESTHA | −0.37*** |
| | | BODWAT | −0.15 ns |
| | | WATSTR | −0.01 ns |
| | STRECO | FOREST | 0.38*** |
| | | AC_EXE | −0.49*** |
| | STRWAS | EFPC | −0.84*** |
| | | NUKE | −0.17 ns |
| | STRPOP | TFR | 0.57*** |
| | | GR2050 | 0.46*** |
| VULNER | VULSUS | UND_NO | 0.61*** |
| | | WATSUP | 0.57*** |
| | VULHEA | DISRES | 0.64*** |
| | | DISINT | 0.64*** |
| | | U5MORT | 0.6*** |
| | CAPST | INNOV | 0.91*** |
| | | TAI | 0.92*** |
| | | SCHOOL | 0.79*** |
| | CAPDEB | IUCN | 0.44*** |
| | | CIVLIB | 0.62*** |
| | | POLITY | 0.48*** |
| | | ESIMIS | 0.61*** |
| | CAPGOV | WEFGOV | 0.9*** |
| | | PRAREA | 0.17* |
| | | EIA | 0.1 ns |
| | | FSC | 0.44*** |
| | | GRAFT | 0.87*** |
| | | GASPR | 0.35*** |
| | | WEFSUB | 0.67*** |
| | | SUBFSH | −0.43* |
| | CAPPRI | ISO14 | 0.71*** |
| | | DJSGI | 0.54*** |
| | | ECOVAL | 0.33 ns |
| | | WBCSD | 0.64*** |
| | | WEFPRI | 0.73*** |
| | CAPEFF | ENEFF | −0.15 ns |
| | | RENPC | −0.03 ns |
| GLOBAL | GLOPAR | EIONUM | 0.69*** |
| | | CITES | 0.31*** |
| | | VIENNA | 0.34*** |
| | | FCCC | 0.37*** |
| | | MONFUN | 0.4*** |
| | | GEF | −0.26** |
| | | WAFAGR | 0.83*** |
| | GLOCLI | CO2PC | −0.68*** |
| | | CO2GDP | −0.04 ns |
| | GLOTRA | CFC | 0.22* |
| | | SO2EXP | −0.1 ns |
| | | FSHCAT | −0.34*** |
| | | FSHCON | −0.56*** |

literature. After all, it has long been stressed that the nature of development, let alone sustainability, is contested, and much depends upon who has the power (often financial) to ensure that their vision dominates. The fact that the ESI seems to produce a ranking of nations that is skewed in favour of the already rich and powerful lends credence to this view.

The period immediately following the WWII saw the rise of what is now called the 'modernization' approach to development with an underlying and pervasive assumption that developing countries should follow the path of the West towards industrialization and mass consumption (Rostow, 1971). An alternative theory, "dependency theory," was proposed in the 1960s and in many ways was the mirror image of modernization with roots in theories of imperialism from earlier in the twentieth century (Lenin, 1939). Literature from dependency theory (and the closely aligned 'world systems' theory), argue that although the official channels whereby colonial powers exploited territories had been dismantled, they were replaced with 'neo' colonial structures so peripheral regions continued to be used as a source of cheap materials and labour for countries in the core of the economic world (Shannon, 1996; Wallerstein, 1975). This is pertinent to this discussion since the ESI is one of the pre-eminent tools that help policy makers measure (and therefore define) sustainability. Furthermore, its sponsoring organization, the World Economic Forum, has been criticized for creating an informal network of globally powerful and established individuals who come together to help set political agendas (Graz, 2003). The fact that the ESI concludes that the already wealthy are the most sustainable is somewhat suspicious, no matter how transparent and clear the methodology used to arrive at this conclusion.

The neo-Marxist ideas found within this debate have a long tradition of being applied to the environment. Just

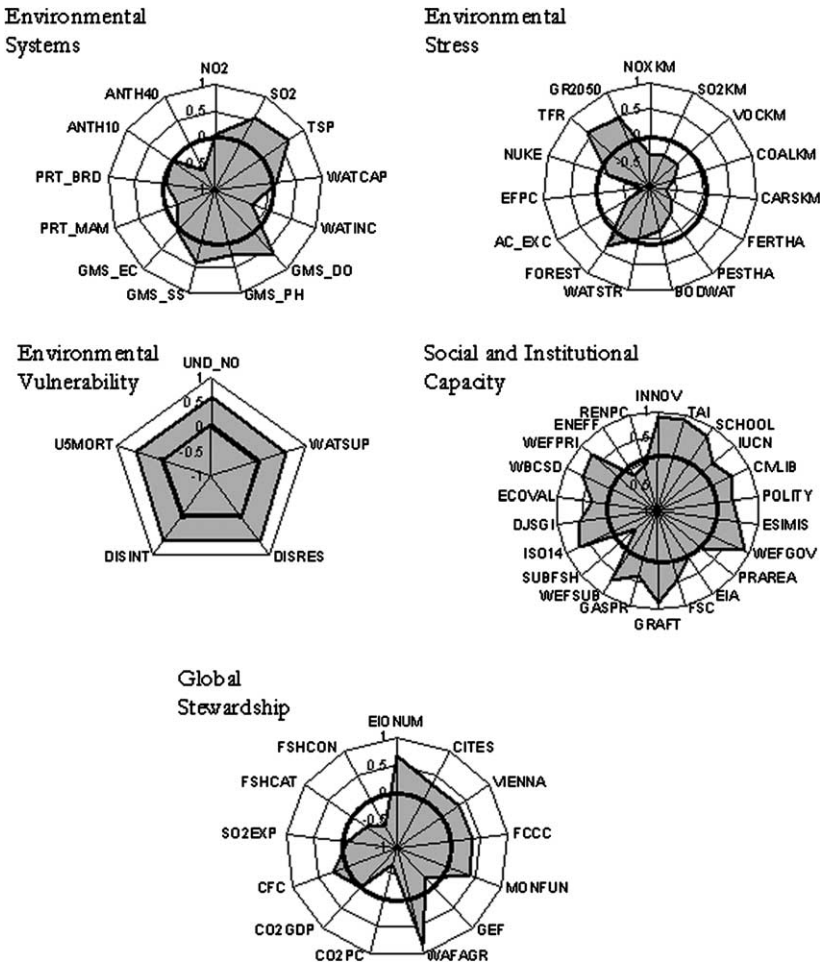


Fig. 3. Diagrammatic presentation of correlations coefficients between variable $z$-values and the $z$-value for GDP/capita ($ PPP) of each of the five major components of the ESI. The central highlighted circle denotes a correlation coefficient of 0, variables falling inside of this line are negatively correlated with GDP while variables falling outside of this line are positively correlated with GDP. Please see Table 2 for a full explanation of variable abbreviations.

as Marxism suggests the wealthy maintain their privileged position by exploiting labour, much of the modern environmental literature suggests that the powerful maintain their position by also exploiting the Earth. As a result, dependency and world systems theories are part of the intellectual tradition that led to constructs such as the ecological footprint (Rees and Wackernagel, 1995; Wackernagel and Rees, 1996; Wackernagel, 1994), which suggests that thanks to global trade, many of the environmental impacts caused by developed nations are manifest in remote locations. As a result, it is not surprising that Sutton (2003) observes the results of ecological footprints calculations do not "*correlate strongly* . . ." (p. 298) with the league tables generated by the ESI. Dauvergne (1997) extends this sort of discussion, and provides a detailed account of the ways that Japanese multi-national corporations drove deforestation in Indonesian during the 1990s, suggesting that Indonesian's forests represented Japan's 'shadow ecology' (MacNeill et al., 1991) by which he means:

> "the aggregate environmental impact on resources outside [a country's] territory of government practices, especially official development assistance (ODA); corporate conduct, investment and technology transfers; and trade, including consumption, export and consumer prices, and import tariffs" Dauvergne (1997, pp. 2–3).

All this suggests that rich, powerful or developed nations maintain their privileged place in the world (and relatively pristine environments) partly by transferring many of the negative consequences of industrialization onto poorer regions. If this critique is true, then it has significant implications for the ESI and any other national ranking (such as that based on the HDI) that emerge out of the assumptions and presuppositions of well meaning Western elites. In short, the West looks good in the ESI by pushing our social and environmental problems onto poorer regions, and it is neither realistic, fair, nor accurate to compare rich and poor

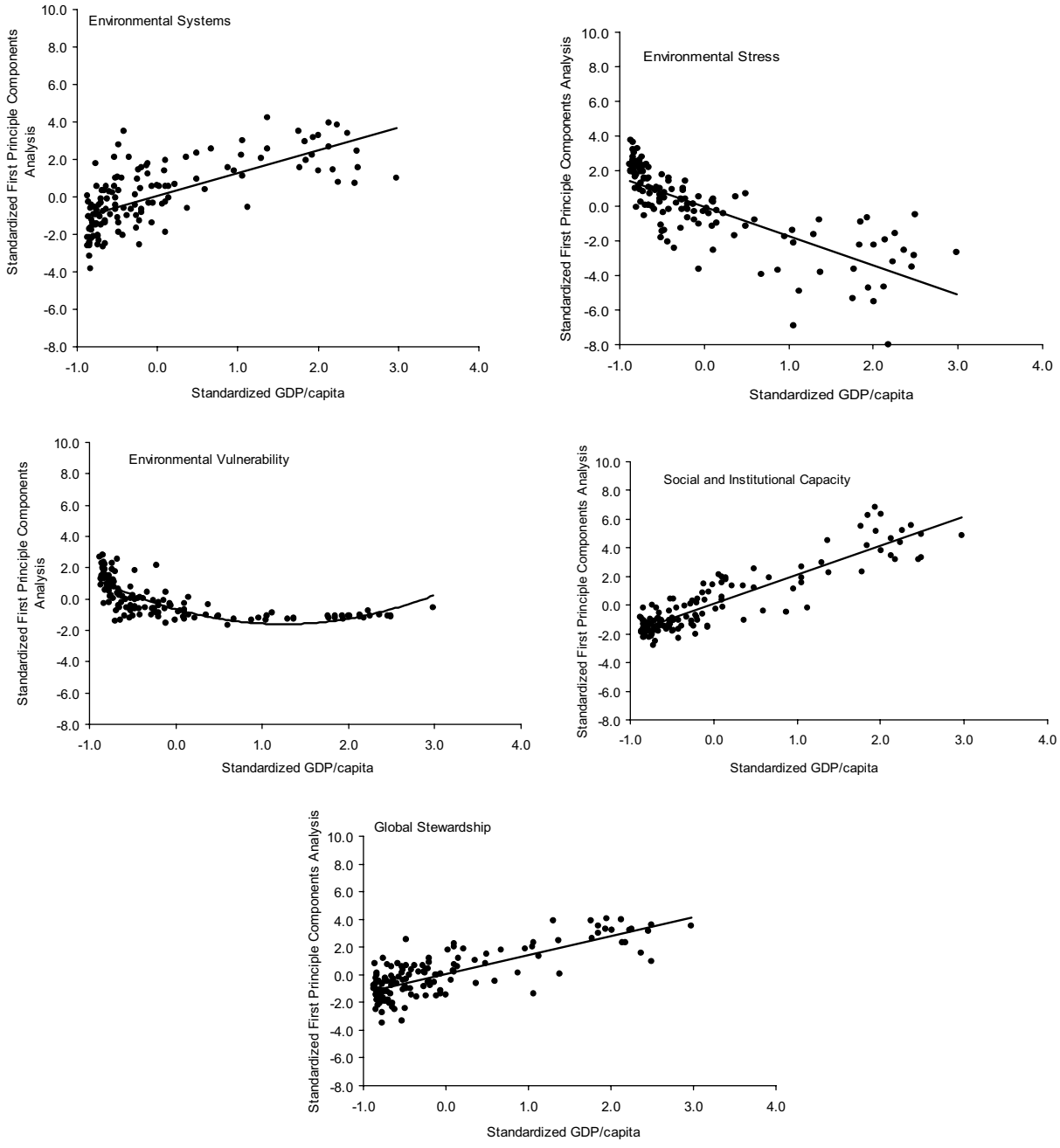


Fig. 4. Relationships between the standardized first principal component analysis and standardized values of GDP/capita for each of the five major components of the ESI.

countries. This logic also suggests that it is unjustifiable to make even tentative conclusions that wealth results in a better environment.

The top down and highly aggregated ranking of countries used by the Global Leaders contrasts sharply with other projects that try to develop benchmark indicators of sustainable development for the purpose of developing policy. For example, Prescott-Allen's Well-Being assessment also uses highly aggregated statistics to assess national well-being across socio-economic and environmental scales (Prescott-Allen, 2001). However, rather than simply ranking countries, giving the impression that some are 'good' whilst other are 'bad', the well-being assessment interprets each indicator and classifies results as good, fair, medium, poor and bad. This means that in the well-being assessment, all countries can perform equally badly without creating the illusion that some are doing well. There are, however, a host of problems with this approach in that it creates thresholds and artificial boundaries in data that may make some differences between good scores and fair scores seem larger than they really are.

The well-being assessment also attempts to address the problems that arise when external experts impose a method to aggregate data and attempts to answer the charge:

> "Is it the right of the author (development experts, academics, and development institutions) to represent the object of development, rather than for the latter to represent themselves, tell their own authentic stories, and let them be heard above and over the master narrative of the author?" Blaikie (2000, p. 1037).

In a version of the well-being assessment done to guide economic development in Western Canada the 'Coast Information Team' engaged in an extensive process of consultation where a wide range of stakeholders chose indicators, established targets, and defined the thresholds that distinguished between 'good', 'fair', 'medium', 'poor' and 'bad' (Coast Information Team, 2002). Similarly, work done in Botswana made use of extensive and broad ranged participation to define visions, choose indicators and establish goals (Reed and Dougill, 2002). These participatory approaches also try to provide data that are sensitive to sub-national variation, so although participatory approaches have methodological pitfalls, the vision of development they promote is rooted in a range of opinions each of which formally contributed to the collection and interpretation of the data.

These assessments are also more typical of recent trends in the development debate. Although the 1980s and 1990s were marked by the retreat of the state and an increasing dominance of free market philosophies (neo-liberalism) in the development agenda, this period also gave rise to 'micro-intervention' and 'people orientated' (neo-populist) approaches that imply localized deconstruction in the meaning of development rather than top-down imposition of a specific perspective. This philosophy is enshrined in the United Nation's Local Agenda 21 (United Nations, 1992) and stands opposed to the grand development theories of earlier in the twentieth century. Local Agenda 21 clearly states that all people have to play a role not just in the 'doing' of a development project but in setting the agenda as to what development means. This allowance for deconstruction of meaning at local levels is a radical departure from the structural approaches to development, and especially from the top-down and technocratic assumptions that rest behind modernization.

In the 1980s and 1990s terms such as post-structuralism, post-modernism and even post-development became widespread in the development literature. It is perhaps no coincidence that this period of deconstruction and questioning of apparent 'fundamentals' also saw the rise of sustainable development as an all-embracing paradigm requiring action at all levels (global, regional, national, urban/rural, household and individual) (see Pezzoli, 1997 for a comprehensive overview of the SD debate).

Against this backdrop, the ESI almost seems like a step back to a time when the role of the West to set agendas and define the world's goals was unquestioned and harkens to the now discredited classical paradigm of development (Blaikie, 2000). It is projects like the ESI, and the policies that flow from these theories, that have led many to question the power implicit in relationships between developing and developed nations. This line of enquiry has arrived at the conclusion that development can almost be seen as tyrannical since it imposes a view of the world that is at best misguided and distorted (see de Waal, 1997 for a discussion of food development projects in Africa). Based on this school of thought, resistance to development (i.e. anti-development) is necessary:

> "The defence of the local as a prerequisite to engaging with the global; the critique of the group's own situation, values and practices as a way of clarifying and strengthening identity; the opposition to modernising development; and the formulation of visions and concrete proposals in the context of existing constraints, these seem to be the principal elements for the collective construction of alternatives that these [Third World] *groups seem to be pursuing*" Escobar (1995, p. 226).

There is much in this quotation that resonates with sustainable development, particularly the need for local deconstruction of meaning as a prelude for action, but the ESI has all of the hallmarks of a top-down and tyrannical approach in the mode postulated by the anti-development school.

But is this a fair critique? Since we still live in a Westphalian and globalized world governed by nation states and open to increasingly transnational agendas (Matthews, 1997), do we run the risk of over-emphasizing the local? Since indices such as the ESI are open to so many contrasting interpretations, should we assume that local communities or even individual national governments are better placed to identify, collect and interpret data on environmental sustainability? In this paper, we have contested the Global Leaders interpretation as being top-down and non-participatory, but does this mean that countries (or even provinces, regions and communities) should be left to pursue their own interpretations? If so, countries may present themselves strategically, create serious distortions between rhetoric and reality, and render comparisons even less meaningful. In that sense, can one have a "*defense of the local as a prerequisite to engaging with the global*" if the local is also contested and has an impact on global sustainability? Indices such as the ESI do appear to go against the populist and local strands that underpin much of

sustainable development, but in fairness, its *raison d'être* is to bridge the local with the global even if it is imperfect. The question is whether such indices are the best way to help bridge that divide.

To move forward, we suggest that an open and transparent process is necessary. This much, the Global Leaders claim to have done. However, for all the merits of the ESI as a tool to help in the global stewardship of the environment, this sort of project must do more. It needs to formally recognize and include a plurality of voices in choosing and weighing indicators. A more participatory process, such as the one used in Canada to assess the 'wellbeing' of coastal communities or in Botswana to assess dryland degradation, would go part of the way to allaying concerns that the ESI is another tool of the post-colonial world that simply reinforces the power dominance of the West. This does not mean, however, that every locality is given the authority to simply represent reality to suit them. We still need somewhat objective standards that acknowledge pressing ecological imperatives. We readily accept that this creates a tension between top down and bottom up approaches, and we feel that negotiating these conflicting positions may be the most important role that environmental governance institutions play in the future.

We feel another improvement would be to change the nature of the way data are interpreted and aggregated. In this exercise, we followed the Global Leaders' methodology up to where they calculated standardized *z*-scores for data. At this point, the Global Leaders did three more steps. First, they created a de-facto ranking of data based on standard normal percentiles, and then used these standard normal percentiles to generate a single value to represent environmental sustainability. Finally, and perhaps most important of all, the Global Leaders displayed data in league tables giving the impression that some countries were absolutely and categorically more environmentally sustainable than others. In contrast, we diverged from the Global Leaders method at the variable *z*-scores, and used data collected at this level to explore some relations between components of sustainability and economic growth. No cut-offs were applied and no conversion with standard normal percentiles. Instead, we used one specific statistical methodology (principal components analysis) to investigate this relation and presented the results graphically. As a result, we feel we uncovered a wealth of complex, interesting and extremely policy-relevant outputs. Other tools could be used to investigate other relations, and we have simply scratched the surface.

Our criticism should not be interpreted as a call for the abandonment of such efforts to create standardized, comparable data to help guide development and policy. We agree whole-heartedly with the motivation and goals of the Global Leaders. We also agree with many of the methods they used. Criticizing this effort also does not mean that that we should simply allow every individual locale to create their own version of the ESI since this would result in confused and contradictory results that would be of no help in guiding policy at global levels. The ESI may be open to the critique that it focuses on the nation-state and implies a sort of 'sum of parts' approach to global stewardship, but over-localization could be far worse. For all its imperfections, the ESI does at least attempt to meld globally important indicators with the local level.

Instead, we propose that indicator selection and data collection should draw on a range of voices, including local stakeholders as well as international experts. This builds on the extensive literature on community participation in development projects (see: Smale et al., 2003; Cornwall, 2003; Eversole, 2003; Gladwin et al., 2002; Smith et al., 2000; Biggs and Smith, 1998; Pretty, 1995; Chambers, 1994a,b; Kapoor, 2001). We also propose that aggregating data into final league ranking tables is too prone to error and creates the illusion of absolute and categorical interpretations. In this case, we enthusiastically support collecting standardizing data to make them comparable. Stopping the analysis at this point allows data to be interpreted using various tools.

## 8. Conclusion

Although this paper is ostensibly a critical review of the ESI, this discussion goes beyond the evaluation of any specific tool. Using the ESI as a starting point, we have tried to contribute to the on-going debate in development and environmental studies between the 'pragmatists' and their critics. We agree that while such tools are far from perfect they do inspire debate, and we also acknowledge the viewpoint that there are many ways of interpreting reality. In criticizing the ESI, we have suggested that the approach the Global Leaders used to aggregate, interpret and present data reinforces the prevailing view that the West is better than the developing world. Unaccounted methodological biases have allowed them to over-generalize the relative 'sustainability' of different countries and make simplistic conclusions about basic relations such as how economic growth accounts for environmental sustainability. By using their data tables, and recreating much of their own methodology, we have uncovered a number of areas that contradict the Global Leaders basic conclusions. This is troubling.

To conclude, we would like to bring this discussion back to where this paper started: measuring environmental sustainability as an important dimension to sustainable development. In many ways sustainable development itself is trying to walk the knife edge between the modernist need to clearly define terms, mea-

sure progress and solve problems, and the post-modernists critique that tries to allow local contextual factors to rise out from under dominant meta-narratives. Sustainable development is an effort to simultaneously acknowledge that while local voices must play a role and we must struggle to balance asymmetrical power relations, there are also fundamental, real and non-negotiable problems that we also must try to solve. The ESI is one attempt at building a tool to help move us towards the goal promised by sustainable development. However, we feel that it has fallen into traps that the post-modernist literature has already clearly defined. This does not mean that we should not try to measure progress towards sustainable development or that indicator frameworks and indices are intrinsically flawed. Rather, it means that indicators and indices must avoid the charge of simply confirming dominant paradigms by including a stronger participatory element. They must also not over-generalize trends by presenting data in a less aggregated fashion.

Instead, we would argue that indices such as the ESI should be provided in full at the 'lower' layers of raw data, transformation and standardisation with $z$-values, in much the same way as the UNDP achieves with the HDI. The process of aggregation after that point with an index as complex as the ESI (the HDI only has three components) needs to be left open for other agencies, although 'World Leaders' could certainly generate variants of the index in graphical format based upon a number of accepted combinations of variables (assuming that no one variant will be universally tolerated by the groups involved). This much is straightforward, the problem is in generating these variants and this requires wide consultation. In this way, we believe the foundations established by 'World Leaders' in their pioneering work with the ESI could make a significant contribution to environmental sustainability and avoid the pitfall of being easily dismissed by critics as just another attempt to make "*dirty nations look clean*".

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