2005 Environmental Sustainability Index

Benchmarking National Environmental Stewardship

Yale Center for Environmental Law and Policy
Yale University

Center for International Earth Science Information Network
Columbia University

In collaboration with:

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The 2005 Environmental Sustainability Index Report is available online at www.yale.edu/esi

Acknowledgments

The 2005 Environmental Sustainability Index (ESI) was made possible by generous external support from the Coca-Cola Foundation, the Samuel Family Foundation, and George Kailis.

The final version of the 2005 ESI benefited from the expertise, advice, and comments of the participants in an Expert Workshop that took place on 9-10 December 2004, at Yale University. The ESI team (from Yale, CIESIN, the JRC, and the World Economic Forum) gratefully acknowledges the contributions of: Neric Acosta, Bob Chen, Young-Keun Chung, Tomas Hak, Kirk Hamilton, Alan Hecht, Anders Hoffman, Michael Ma, Jeff McNeely, Charles Ian McNeill, Rosemary Montgomery, Heekyong Noh, John O'Connor, Tom Parris, Laszlo Pinter, Louise Rickard, N. Phillip Ross, and Ulrich Wieland.

A number of other people provided advice, support, analysis, data, or technical expertise. In this regard, we thank: Kym Anderson, Liliana Andonova, Timothy Boucher, Lisa Bürgi, Olivier Cattaneo, Thomas Cottier, William Davey, Carmen Dominguez, Richard Elin, Jay Emerson, Dave Ervin, John Finn, Tom Graedel, Tim Gregoire, Ashok Gulati, Dale Hataway, Sebastian Herrors, Jonathan Hoekstra, Gary Horlick, Eszter Horvath, Gary Hufbauer, John Jackson, Lee Ann Jackson, Alejandro Jara, Michael Jenkins, Tim Josling, Andrzej Kwiecinski, Wilfred Legg, Patrick Low, Arvind, Panagariya, Craig Pratt, C. Ford Runge, Gary Sampson, Jeff Schott, Gus Speth, and Xiaoshi Xing.

Finally, the authors would like to thank the many officials in national statistical and environment ministries for their participation in the ESI country data review. Their help improved the ESI data matrix and helped to hone the ESI methodological approach.

Suggested Citation

Esty, Daniel C., Marc Levy, Tanja Srebotnjak, and Alexander de Sherbinin (2005). *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. New Haven, Conn.: Yale Center for Environmental Law & Policy.

Disclaimers

The word "country" is used loosely in this report to refer to both actual countries and other administrative or economic entities. Similarly, the maps presented are for illustrative purposes and do not imply any preference in cases where territory is under dispute.

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Executive Summary

The Environmental Sustainability Index (ESI) benchmarks the ability of nations to protect the environment over the next several decades. It does so by integrating 76 data sets – tracking natural resource endowments, past and present pollution levels, environmental management efforts, and the capacity of a society to improve its environmental performance – into 21 indicators of environmental sustainability. These indicators permit comparison across a range of issues that fall into the following five broad categories:

- Environmental Systems
- Reducing Environmental Stresses
- Reducing Human Vulnerability to Environmental Stresses
- Societal and Institutional Capacity to Respond to Environmental Challenges
- Global Stewardship

The indicators and variables on which they are constructed build on the well-established "Pressure-State-Response" environmental policy model. The issues incorporated and variables used were chosen through an extensive review of the environmental literature, assessment of available data, rigorous analysis, and broad-based consultation with policymakers, scientists, and indicator experts. While they do not provide a definitive vision of sustainability, the collection of indicators and variables that form the 2005 ESI provide: (1) a powerful tool for putting environmental decisionmaking on firmer analytical footing (2) an alternative to GDP and the Human Development Index for gauging country progress, and (3) a useful mechanism for benchmarking environmental performance.

The higher a country's ESI score, the better positioned it is to maintain favorable environmental conditions into the future. The five highest-ranking countries are Finland, Norway, Uruguay, Sweden, and Iceland – all countries that have substantial natural resource endowments and low population density. Each has managed the challenges of development with some success.

The lowest ranking countries are North Korea, Iraq, Taiwan, Turkmenistan, and Uzbekistan. These countries face numerous issues, both natural and manmade, and have not managed their policy choices well.

While absolute measures of sustainability remain elusive, many aspects of environmental sustainability can be measured at least in relative terms. National positions on various important elements of environmental stewardship can therefore be determined and are instructive.

The key results and conclusions that emerge from the 2005 ESI can be summarized as follows:

- The ESI has proven to be a useful gauge of national environmental stewardship. It provides a valuable summary measure of environmental performance and a counterpart to yardsticks of human development and economic wellbeing. Any measure of sustainability will have shortcomings given the significant gaps in critical data sets, divergent views about what comprises sustainability, and differing opinions about how best to address underlying uncertainties.

- Environmental sustainability is a fundamentally multi-dimensional concept. Some environmental challenges arise from development and industrialization – natural resource depletion (especially of non-renewable resources), pollution, and ecosystem destruction. Other challenges are a function of underdevelopment and poverty-induced short-term thinking – resource depletion (especially of potentially renewable resources such as forests and water) and lack of investment in capacity and infrastructure committed to pollution control and ecosystem protection.

- There are significant differences across countries in both current environmental results and probable longer-term trends. By assembling a broad array of data that make cross-country comparisons possible, the ESI provides a powerful tool for tracking environmental performance, identifying leaders and laggards on an issue-by-issue basis, and designing policy responses.

- Most countries do well on some issues and much less well on others. Virtually no nation scores very high or very low on all 21 indicators. Thus, every society has something to learn from benchmarking its environmental performance against relevant peer countries.

- Environmental sustainability entails issues that are local as well as national and global in scale, all of which should figure in international comparisons (as they do in the ESI).

- The ESI and its elements provide a foundation for more data-driven environmental analysis and decisionmaking. In doing so, it sheds light on a number of critical issues. The ESI demonstrates, for example, that income contributes to the potential for strong environmental stewardship, but does not guarantee it. Indeed, it is striking how many of the bottom rungs of ESI are occupied by countries that are relatively wealthy.

- The relationship between environmental sustainability and economic development is complex. At every level of income, countries face environmental challenges. Some countries manage their pollution control and natural resource management challenges relatively well while others do not. Development status is therefore not environmental destiny.

- The ESI suggests that a more quantitative and systematic approach to environmental policymaking – where: (a) problems are tracked through a carefully constructed set of metrics and indicators (b) policy progress is evaluated empirically, and (c) governments benchmark their results against a relevant peer group – can help to highlight superior environmental programs, technologies, strategies, and approaches.

- ESI-based analysis reveals some of the critical determinants of environmental performance: low population density, economic vitality, and quality of governance. Some of these variables have long been identified as theoretically important. The ESI provides empirical support for these theories.

- Serious and persistent data gaps plague the ESI and other efforts to shift pollution control and natural resource management onto more analytically rigorous underpinnings. Investment at the local, national, and global scales in a more complete set of key indicators should be seen as a fundamental policy priority. The ESI does not cover a number of important issues – e.g., quality of waste management, wetlands destruction, and exposure to heavy metals such as lead and mercury – because the requisite data are not collected or are not reported on a basis that permits cross-country comparisons.

- The need for improved data to undergird better environmental policymaking emerges especially strongly in the developing world in the context of worldwide efforts to achieve the large-scale environmental aims of the Millennium Development Goals.

Environmental Sustainability Index (ESI) 2005

Country ESI Scores by Quintile

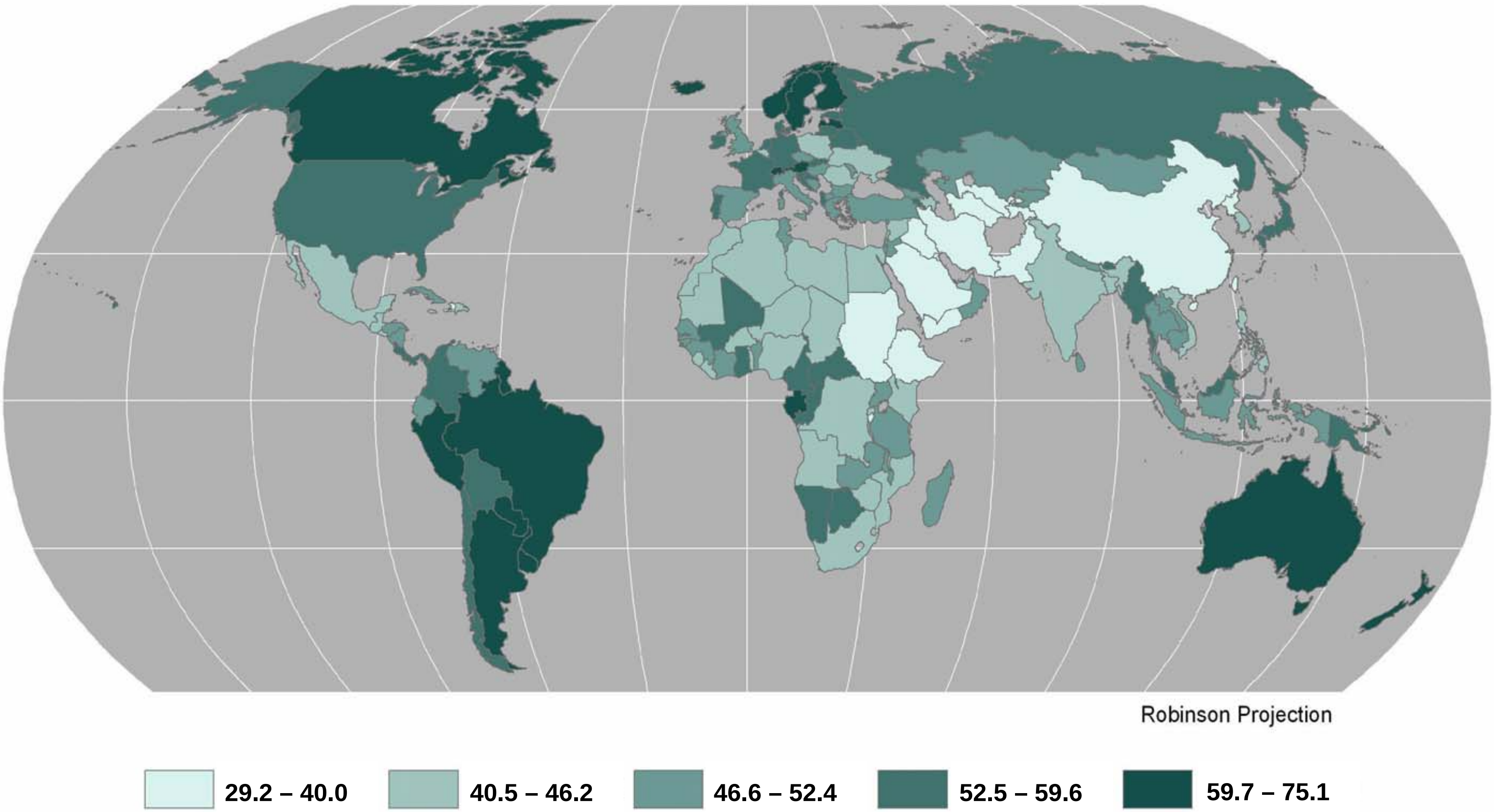

Table 1: 2005 Environmental Sustainability Index – Scores and Rankings

ESI Rank	Country Name	ESI Score	OECD Rank	Non-OECD Rank	Comp-onents
1	Finland	75.1	1		
2	Norway	73.4	2		
3	Uruguay	71.8		1	
4	Sweden	71.7	3		
5	Iceland	70.8	4		
6	Canada	64.4	5		
7	Switzerland	63.7	6		
8	Guyana	62.9		2	
9	Argentina	62.7		3	
10	Austria	62.7	7		
11	Brazil	62.2		4	
12	Gabon	61.7		5	
13	Australia	61.0	8		
14	New Zealand	60.9	9		
15	Latvia	60.4		6	
16	Peru	60.4		7	
17	Paraguay	59.7		8	
18	Costa Rica	59.6		9	
19	Croatia	59.5		10	
20	Bolivia	59.5		11	
21	Ireland	59.2	10		
22	Lithuania	58.9		12	
23	Colombia	58.9		13	
24	Albania	58.8		14	
25	Central Afr. Rep.	58.7		15	
26	Denmark	58.2	11		
27	Estonia	58.2		16	
28	Panama	57.7		17	
29	Slovenia	57.5		18	
30	Japan	57.3	12		
31	Germany	56.9	13		
32	Namibia	56.7		19	
33	Russia	56.1		20	
34	Botswana	55.9		21	
35	P. N. Guinea	55.2		22	
36	France	55.2	14		
37	Portugal	54.2	15		
38	Malaysia	54.0		23	
39	Congo	53.8		24	
40	Netherlands	53.7	16		
41	Mali	53.7		25	
42	Chile	53.6		26	
43	Bhutan	53.5		27	
44	Armenia	53.2		28	
45	United States	52.9	17		
46	Myanmar	52.8		29	
47	Belarus	52.8		30	
48	Slovakia	52.8	18		
49	Ghana	52.8		31	
50	Cameroon	52.5		32	
51	Ecuador	52.4		33	
52	Laos	52.4		34	
53	Cuba	52.3		35	
54	Hungary	52.0	19		
55	Tunisia	51.8		36	
56	Georgia	51.5		37	
57	Uganda	51.3		38	
58	Moldova	51.2		39	
59	Senegal	51.1		40	
60	Zambia	51.1		41	
61	Bosnia & Herze.	51.0		42	
62	Israel	50.9		43	
63	Tanzania	50.3		44	
64	Madagascar	50.2		45	
65	United Kingdom	50.2	20		
66	Nicaragua	50.2		46	
67	Greece	50.1	21		
68	Cambodia	50.1		47	
69	Italy	50.1	22		
70	Bulgaria	50.0		48	
71	Mongolia	50.0		49	
72	Gambia	50.0		50	
73	Thailand	49.7		51	
74	Malawi	49.3		52	

The column labeled "components" contains bar charts for the five ESI core components – Systems, Stresses, Vulnerability, Capacity, and Global Stewardship – that shows the relative strengths and weaknesses for each country. Higher bars correspond to higher levels of sustainability. The relative heights are comparable across components and across countries.

ESI Rank	Country Name	ESI Score	OECD Rank	Non-OECD Rank	Components
75	Indonesia	48.8		53	
76	Spain	48.8	23		
77	Guinea-Bissau	48.6		54	
78	Kazakhstan	48.6		55	
79	Sri Lanka	48.5		56	
80	Kyrgyzstan	48.4		57	
81	Guinea	48.1		58	
82	Venezuela	48.1		59	
83	Oman	47.9		60	
84	Jordan	47.8		61	
85	Nepal	47.7		62	
86	Benin	47.5		63	
87	Honduras	47.4		64	
88	Côte d'Ivoire	47.3		65	
89	Serbia & Monteneg.	47.3		66	
90	Macedonia	47.2		67	
91	Turkey	46.6	24		
92	Czech Rep.	46.6	25		
93	South Africa	46.2		68	
94	Romania	46.2		69	
95	Mexico	46.2	26		
96	Algeria	46.0		70	
97	Burkina Faso	45.7		71	
98	Nigeria	45.4		72	
99	Azerbaijan	45.4		73	
100	Kenya	45.3		74	
101	India	45.2		75	
102	Poland	45.0	27		
103	Niger	45.0		76	
104	Chad	45.0		77	
105	Morocco	44.8		78	
106	Rwanda	44.8		79	
107	Mozambique	44.8		80	
108	Ukraine	44.7		81	
109	Jamaica	44.7		82	
110	United Arab Em.	44.6		83	
111	Togo	44.5		84	
112	Belgium	44.4	28		
113	Dem. Rep. Congo	44.1		85	
114	Bangladesh	44.1		86	
115	Egypt	44.0		87	
116	Guatemala	44.0		88	
117	Syria	43.8		89	
118	El Salvador	43.8		90	
119	Dominican Rep.	43.7		91	
120	Sierra Leone	43.4		92	
121	Liberia	43.4		93	
122	South Korea	43.0	29		
123	Angola	42.9		94	
124	Mauritania	42.6		95	
125	Philippines	42.3		96	
126	Libya	42.3		97	
127	Viet Nam	42.3		98	
128	Zimbabwe	41.2		99	
129	Lebanon	40.5		100	
130	Burundi	40.0		101	
131	Pakistan	39.9		102	
132	Iran	39.8		103	
133	China	38.6		104	
134	Tajikistan	38.6		105	
135	Ethiopia	37.9		106	
136	Saudi Arabia	37.8		107	
137	Yemen	37.3		108	
138	Kuwait	36.6		109	
139	Trinidad & Tobago	36.3		110	
140	Sudan	35.9		111	
141	Haiti	34.8		112	
142	Uzbekistan	34.4		113	
143	Iraq	33.6		114	
144	Turkmenistan	33.1		115	
145	Taiwan	32.7		116	
146	North Korea	29.2		117	

Note: The 2005 ESI scores are not directly comparable to the 2002 ESI scores. See Appendix A for details on the methodology

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Chapter 1 – The Need for an Environmental Sustainability Index

We live in an era of numbers. In many realms, decisionmaking has become increasingly data-driven. But the environmental domain has curiously lagged in this regard. Plagued by widespread information gaps and uncertainties, environmental policymaking has often been based on generalized observations, best guesses, and "expert opinion" – or, worse yet, rhetoric and emotion (Esty 2002).

This report presents the 2005 Environmental Sustainability Index (ESI), which provides a composite profile of national environmental stewardship based on a compilation of 21 indicators that derive from 76 underlying data sets. The ESI offers a tool for shifting pollution control and natural resource management onto firmer analytic underpinnings. In this regard, the heart of the ESI is not the rankings but rather the underlying indicators and variables. By facilitating comparative analysis across national jurisdictions, these metrics provide a mechanism for making environmental management more quantitative, empirically grounded, and systematic.

This report demonstrates how a commitment to environmental indicators and greater emphasis on statistical analysis might strengthen environmental problem solving at the national policy level. The ESI, though still under development and impaired by persistent data gaps in both basic environmental monitoring data and more advanced metrics, illustrates the potential of such a policy tool. The same approach could enhance decisionmaking at the global scale, the local level, in corporations, and even within households. The lack of information on many critical issues, limited data coverage, and the non-comparability of data across countries all render the design of indices more difficult and implicitly influence what gets measured.

The selection of the 21 indicators and their underlying variables is the result of careful screening of available data sources combined with innovative approaches to designing alternative measures and "proxies" for important issues where routine monitoring does not exist and metrics are not available. Although imperfect, the ESI helps to fill a long-existing gap in environmental performance evaluation. It offers a small step toward a more vigorous and quantitative approach to environmental decisionmaking.

Just as companies have long benchmarked their performance against industry peers, national governments are finding it useful to compare their performance against others who are similarly situated, and the ESI makes such "peer group" comparisons relatively easy to do. The overall rankings must be taken for what they are – a relative and approximate indication of how close a country is to being on a sustainable environmental trajectory based on a "snapshot" view of a range of widely recognized issues including pollution control, natural resource management, and societal problem solving capacities. The real value of the ESI therefore emerges from looking at the relative position of each country on the 21 underlying indicators. In fact, given the "noise" in the analysis, we cannot really be sure that Finland outranks Norway overall. But we can say with some confidence that both of these countries are outperforming the United States and France in important aspects of environmental policy.

The most important function of the Environmental Sustainability Index is as a policy tool for identifying issues that deserve greater attention within national environmental protection programs and across societies more generally. The Environmental Sustainability Index also provides a way of identifying those governments that are at the leading edge with regard to any particular issue. This information is useful in identifying "best practices" and may help to guide thinking on what it will take to make policy progress.

The analysis of best practices and successful environmental policy does not imply that only one way towards sustainability exists. Countries face an array of issues and policy questions when trying to improve their environmental performance. The answers that make sense will depend on the nation's specific environmental, economic, and social circumstances, internal factors such as the priority given to environmental issues as well as a multitude of external factors including the environmental policies of neighboring countries. Each policy choice must be formulated and evaluated within this context. The ESI can assist in this analytical process by identifying (a) the most significant issues a country faces (b) similar countries that have successfully addressed those issues, and (c) the trade-offs that can be expected as a result of suboptimal environmental choices.

The ESI provides a useful national policymaker's guide to pollution control and natural resource management challenges, highlighting where each particular country might find that marginal investments of funding and political attention could best be deployed. Objective measures of policy performance are an important mechanism for budget rationalization and priority setting.

The ESI takes seriously the need to track a full range of pollution and natural resource management issues that are critical to a human-centered measure of environmental wellbeing. It incorporates issues that are local in scope as well as those that are global in scale. While countries at different levels of development and with diverse national priorities may choose to focus on different elements of environmental sustainability, all of the issues included in the ESI are of relevance to all countries. The broad scope of the ESI with its strong emphasis on fundamental issues – such as air pollution, water quality, and human alterations of terrestrial ecosystems – has won praise in the developing world because it features basic environmental needs and not just those of concern to developed countries.

The overall ESI scores and rankings also help to ensure that countries are graded not only on their economic results (e.g., GDP growth or competitiveness rankings) but also on other policy goals including environmental performance. In this regard, it is striking how many of the bottom rungs on the ESI are occupied by countries that are relatively wealthy.

The ESI also provides a tool for achieving global-scale policy goals. The Millennium Declaration and the related Millennium Development Goals (MDGs) explicitly commit the world community to making progress in achieving environmental sustainability within the context of a broader global agenda aimed at reducing poverty, malnutrition, and expanding education and health care (UN 2000). Moreover, donor countries supporting the MDG process increasingly insist upon accountability and transparency in how their money is spent – and the evaluation of which investments are paying off and which are not.

Some MDGs have well-established metrics that allow progress on these goals to be tracked. Goal 7 of the MDGs aims at "Ensuring Environmental Sustainability" but lacks the breadth of indicators needed to adequately gauge progress toward this ambitious goal because no such set of appropriate metrics is readily available. The ESI offers a starting point for developing such a set of metrics.

In all these regards, context matters. The ESI, with its emphasis on relative rankings, provides a mechanism for establishing context and for understanding what is possible in terms of policy progress. Indeed, it turns out the comparisons to relevant peer countries are particularly important in goal setting, identifying best practices in both policymaking and technology adoption, and spurring competitive pressure for improved performance.

Decisionmakers are eager for tools that will help them to identify problems, track trends, set priorities, understand policy tradeoffs and synergies, target environmental investments, evaluate programs, and focus limited political attention. The ESI is such a tool.

Countries want to be seen as doing well in comparison to those similarly situated. Establishing the right peer groups is thus a critical element of any benchmarking exercise. In support of this quest, we offer a series of potentially relevant groupings in Tables 2 through 8.

Table 2: High Population Density Countries – Countries and territories in which more than half the land area has a population density above 100 persons per square kilometer

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Japan	57.3	8	Poland	45.0	15	Philippines	42.3
2	Germany	56.9	9	Rwanda	44.8	16	Lebanon	40.5
3	Netherlands	53.7	10	Jamaica	44.7	17	Burundi	40.0
4	Italy	50.1	11	Belgium	44.4	18	Trinidad & Tobago	36.3
5	Sri Lanka	48.5	12	Bangladesh	44.1	19	Haiti	34.8
6	Nepal	47.7	13	El Salvador	43.8	20	Taiwan	32.7
7	India	45.2	14	South Korea	43.0	21	North Korea	29.2

Note: Countries identified using CIESIN's PLACE data set (CIESIN 2003)

Table 3: Desert Countries – Countries that are more than 50% desert (WWF Biome Classification)

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Namibia	56.7	8	Niger	45.0	15	Iran	39.8
2	Israel	50.9	9	Morocco	44.8	16	Saudi Arabia	37.8
3	Kazakhstan	48.6	10	United Arab Em.	44.6	17	Yemen	37.3
4	Oman	47.9	11	Egypt	44.0	18	Kuwait	36.6
5	Jordan	47.8	12	Mauritania	42.6	19	Uzbekistan	34.4
6	Algeria	46.0	13	Libya	42.3	20	Iraq	33.6
7	Azerbaijan	45.4	14	Pakistan	39.9	21	Turkmenistan	33.1

Note: Countries identified using CIESIN's PLACE data set (CIESIN 2003)

Table 4: OAS Member Countries – Organization of American States member countries

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Uruguay	71.8	9	Bolivia	59.5	17	Honduras	47.4
2	Canada	64.4	10	Colombia	58.9	18	Mexico	46.2
3	Guyana	62.9	11	Panama	57.7	19	Jamaica	44.7
4	Argentina	62.7	12	Chile	53.6	20	Guatemala	44.0
5	Brazil	62.2	13	United States	52.9	21	El Salvador	43.8
6	Peru	60.4	14	Cuba	52.3	22	Dominican Rep.	43.7
7	Paraguay	59.7	15	Nicaragua	50.2	23	Trinidad & Tobago	36.3
8	Costa Rica	59.6	16	Venezuela	48.1	24	Haiti	34.8

Table 5: ASEAN Member Countries – Association of Southeast Asian Nations member countries

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Malaysia	54.0	4	Cambodia	50.1	7	Philippines	42.3
2	Myanmar	52.8	5	Thailand	49.7	8	Viet Nam	42.3
3	Laos	52.4	6	Indonesia	48.8			

Table 6: NEPAD Member Countries – New Partnership for Africa's Development member countries

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Gabon	61.7	15	Malawi	49.3	29	Togo	44.5
2	Central Afr. Rep.	58.7	16	Guinea-Bissau	48.6	30	Dem. Rep. Congo	44.1
3	Namibia	56.7	17	Guinea	48.1	31	Egypt	44.0
4	Botswana	55.9	18	Benin	47.5	32	Sierra Leone	43.4
5	Mali	53.7	19	Côte d'Ivoire	47.3	33	Liberia	43.4
6	Ghana	52.8	20	South Africa	46.2	34	Angola	42.9
7	Cameroon	52.5	21	Algeria	46.0	35	Mauritania	42.6
8	Tunisia	51.8	22	Burkina Faso	45.7	36	Libya	42.3
9	Uganda	51.3	23	Nigeria	45.4	37	Zimbabwe	41.2
10	Senegal	51.1	24	Kenya	45.3	38	Burundi	40.0
11	Zambia	51.1	25	Niger	45.0	39	Ethiopia	37.9
12	Tanzania	50.3	26	Chad	45.0	40	Sudan	35.9
13	Madagascar	50.2	27	Rwanda	44.8			
14	Gambia	50.0	28	Mozambique	44.8			

Table 7: EU Member Countries – European Union member countries

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Finland	75.1	9	Slovenia	57.5	17	Greece	50.1
2	Sweden	71.7	10	Germany	56.9	18	Italy	50.1
3	Austria	62.7	11	France	55.2	19	Spain	48.8
4	Latvia	60.4	12	Portugal	54.2	20	Czech Rep.	46.6
5	Ireland	59.2	13	Netherlands	53.7	21	Poland	45.0
6	Lithuania	58.9	14	Slovakia	52.8	22	Belgium	44.4
7	Denmark	58.2	15	Hungary	52.0			
8	Estonia	58.2	16	United Kingdom	50.2			

Table 8: NIS Countries – Russia and newly independent states that were former republics of the Soviet Union

RANK	Country	ESI	RANK	Country	ESI	RANK	Country	ESI
1	Latvia	60.4	6	Belarus	52.8	11	Azerbaijan	45.4
2	Lithuania	58.9	7	Georgia	51.5	12	Ukraine	44.7
3	Estonia	58.2	8	Moldova	51.2	13	Tajikistan	38.6
4	Russia	56.1	9	Kazakhstan	48.6	14	Uzbekistan	34.4
5	Armenia	53.2	10	Kyrgyzstan	48.4	15	Turkmenistan	33.1

Chapter 2 – Our Approach

Measuring Sustainability

Sustainability is a characteristic of dynamic systems that maintain themselves over time; it is not a fixed endpoint that can be defined. Environmental sustainability refers to the long-term maintenance of valued environmental resources in an evolving human context.

The best way to define and measure sustainability is contested. Economists often emphasize an accounting approach that focuses on the maintenance of capital stocks. Some in the environmental realm focus on natural resource depletion and whether the current rates of resource use can be sustained into the distant future.

Our emphasis is broader, more policy-oriented, and shorter term. The Environmental Sustainability Index (ESI) provides a gauge of a society's natural resource endowments and environmental history, pollution stocks and flows, and resource extraction rates as well as institutional mechanisms and abilities to change future pollution and resource use trajectories.

The ESI Framework

In seeking to provide a policy-relevant gauge of national environmental conditions and their likely trajectory over the next several decades, the ESI centers on the state of environmental systems, both natural and managed. It also measures stresses on those systems, including natural resource depletion and pollution rates, because the magnitude of such stresses serve as a useful indicator of the pressure on the underlying systems. The ESI further measures impacts and responses and human vulnerability to environmental change. In addition, the ESI tracks a society's capacity to cope with environmental stresses and each country's contribution to global stewardship.

These five core components and the logic for their inclusion in the ESI are laid out in Table 9.

This basic model builds on a broad base of theory in the ecological sciences and environmental policy. The core components of the ESI have a great deal of overlap with the widely used Pressure-State-Response (PSR) indicator model, and especially its more recent

Table 9: 2005 Environmental Sustainability Index Building Blocks – Components

Component	Logic
Environmental Systems	A country is more likely to be environmentally sustainable to the extent that its vital environmental systems are maintained at healthy levels, and to the extent to which levels are improving rather than deteriorating.
Reducing Environmental Stresses	A country is more likely to be environmentally sustainable if the levels of anthropogenic stress are low enough to engender no demonstrable harm to its environmental systems.
Reducing Human Vulnerability	A country is more likely to be environmentally sustainable to the extent that people and social systems are not vulnerable to environmental disturbances that affect basic human wellbeing; becoming less vulnerable is a sign that a society is on a track to greater sustainability.
Social and Institutional Capacity	A country is more likely to be environmentally sustainable to the extent that it has in place institutions and underlying social patterns of skills, attitudes, and networks that foster effective responses to environmental challenges.
Global Stewardship	A country is more likely to be environmentally sustainable if it cooperates with other countries to manage common environmental problems, and if it reduces negative transboundary environmental impacts on other countries to levels that cause no serious harm.

Box 1: "Sustainability" in the Broader Sense

The ESI does not track sustainability in the overarching "triple bottom line" (economic-environmental-social) sense that is now often used. Sustainability in this broader sense is the dynamic condition of society that depends on more than the protection and management of environmental resources and stresses as measured with the ESI. It is also necessary to have economic sustainability, with wealth distributed so that extreme poverty is eliminated, capital accounts are in balance, and investments in wealth-generating assets are at least equivalent to their depreciation. In addition, no society can be considered sustainable without attention to the social dimension, including effective governance, social justice, and respect for diverse cultural, ethical, and spiritual needs. The ultimate sustainability of human society also depends on education, through which knowledge, science, culture, values and the accumulated experience that we call civilization are transmitted from one generation to the next. For a complete measure of sustainability, the ESI needs to be coupled with equivalent economic and social sustainability indices to give an integrated set of measures of the efforts of countries to move towards full sustainability. With such measures, it will be easier to explore and understand the interactions between the economic, social, and environmental dimensions of the human system.

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DPSIR variant that additionally breaks out Driving Forces and Impacts[1]. The cumulative picture created by these five components does not in any authoritative way define sustainability, but instead represents a comprehensive gauge of a country's present environmental quality and capacity to maintain or enhance conditions in the years ahead.

Indicators and Variables

While we separate the ESI into five components for analytic purposes, each of these components, in turn, encompasses between three and six "indicators" of environmental sustainability. We consider the 21 indicators to be the fundamental building blocks of environmental sustainability – and it is these 21 indicators that are aggregated to create the ESI.

Each indicator builds on a logic developed by a careful review of the science and the literature in the environmental field, as well as thorough consultation with many experts from across the environmental sciences, government, business, non-governmental groups, research centers, and the academic sector. Ideally, these indicators would include all relevant aspects of functioning environmental systems, be distinct in their cause-effect relationships, permit aggregation, reflect the diversity of circumstances across political jurisdictions (including disaggregated data for large countries), be easily quantifiable, and be scale-neutral.

Due to significant data gaps and conceptual limitations (such as how to measure and attribute the vitality of the oceans on a national basis), the actual indicator set falls short of the ideal. For example, a number of important issues including wetlands protection, the quality of solid and hazardous waste management, exposure to heavy metals and toxics, and ecosystem functionality were omitted because we lack adequate data to measure them across a significant number of countries. Other issues such as biodiversity loss, private sector contributions to sustainability, and progress towards more sustainable fisheries, forestry, and agricultural management practices are covered only to the extent available data permit. We discuss these data limitations and our vision of the "ideal" indicator set in Appendix G.

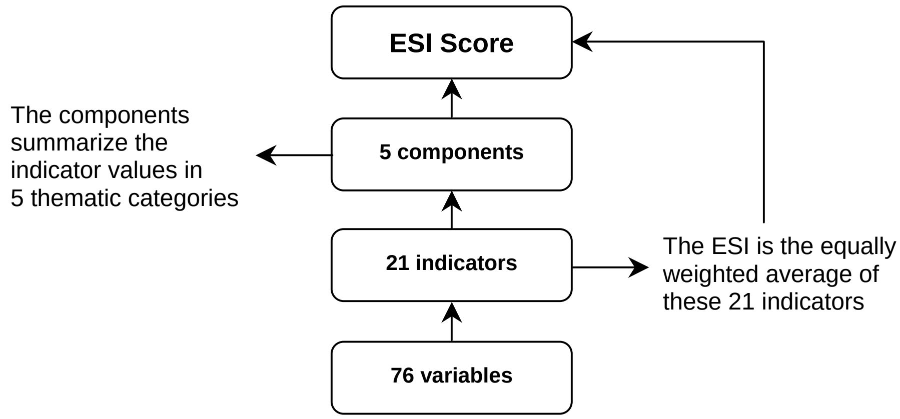

Figure 1: Constructing the ESI Score

The ESI score represents an equally weighted average of the 21 indicator scores. Each indicator builds on between 2 and 12 data sets for a total of 76 underlying variables. Air quality, for example, is a composite indicator that includes variables tracking the concentration of nitrogen oxides, sulfur dioxide, and particulates. 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.

We settled on uniform weighting of the 21 indicators because simple aggregation is transparent and easy to understand. Moreover, when we asked leading experts from the governmental, business, and non-governmental sectors to rank the indicators, none stood out as being of substantially higher or lower importance than the others. Similarly, when we tried to use statistical methods (including principal component analysis) to identify appropriate weights, nearly equal values were suggested across all 21 indicators. Thus, although on an individual country basis, different prioritizations are likely to exist, on average these differences in weighting are less pronounced. The details of this effort are discussed in Appendix A.

The sensitivity analysis in Chapter 4 furthermore shows that the choice of aggregation strategies (and the implicit weighting that results) does not matter for most countries. Aggregating at the level of the five components (which we do *not* do for the reason stated above) substantially changes the ranks for only a few countries – particularly those with high levels of pollution and high capacity as well as low environmental vulnerability. Belgium and South Korea, in particular, move up dramatically as their institutional strengths are given much more weight under component-based aggregation.

To improve the policy utility of the ESI and to respect the diversity of judgments about how to weight the indicators, we plan to introduce an interactive version of the ESI which will allow the user to adjust the indicator (or component) weights however he or she wishes, and then to calculate a new score.

By giving each variable within an indicator the same weight and weighting each of the 21 indicators equally, we provide an imperfect but clear starting point for analysis. Table 10 shows in summary the nesting of variables within indicators and indicators within components.

Table 10: 2005 Environmental Sustainability Index Building Blocks – Indicators and Variables

Component	Indicator Number	Indicator	Variable Number	Variable Code	Variable
Environmental Systems	1	Air Quality	1	NO2	Urban population weighted NO_2 concentration
			2	SO2	Urban population weighted SO_2 concentration
			3	TSP	Urban population weighted TSP concentration
			4	INDOOR	Indoor air pollution from solid fuel use
	2	Biodiversity	5	ECORISK	Percentage of country's territory in threatened ecoregions
			6	PRTBRD	Threatened bird species as percentage of known breeding bird species in each country
			7	PRTMAM	Threatened mammal species as percentage of known mammal species in each country
			8	PRTAMPH	Threatened amphibian species as percentage of known amphibian species in each country
			9	NBI	National Biodiversity Index
	3	Land	10	ANTH10	Percentage of total land area (including inland waters) having very low anthropogenic impact
			11	ANTH40	Percentage of total land area (including inland waters) having very high anthropogenic impact
	4	Water Quality	12	WQ_DO	Dissolved oxygen concentration
			13	WQ_EC	Electrical conductivity
			14	WQ_PH	Phosphorus concentration
			15	WQ_SS	Suspended solids
	5	Water Quantity	16	WATAVL	Freshwater availability per capita
			17	GRDAVL	Internal groundwater availability per capita
Reducing Environmental Stresses	6	Reducing Air Pollution	18	COALKM	Coal consumption per populated land area
			19	NOXKM	Anthropogenic NO_x emissions per populated land area
			20	SO2KM	Anthropogenic SO_2 emissions per populated land area
			21	VOCKM	Anthropogenic VOC emissions per populated land area
			22	CARSKM	Vehicles in use per populated land area
	7	Reducing Ecosystem Stress	23	FOREST	Annual average forest cover change rate from 1990 to 2000
			24	ACEXC	Acidification exceedance from anthropogenic sulfur deposition
	8	Reducing Population Pressure	25	GR2050	Percentage change in projected population 2004-2050
			26	TFR	Total Fertility Rate
	9	Reducing Waste & Consumption Pressures	27	EFPC	Ecological Footprint per capita
			28	RECYCLE	Waste recycling rates
			29	HAZWST	Generation of hazardous waste
	10	Reducing Water Stress	30	BODWAT	Industrial organic water pollutant (BOD) emissions per available freshwater
			31	FERTHA	Fertilizer consumption per hectare of arable land
			32	PESTHA	Pesticide consumption per hectare of arable land
			33	WATSTR	Percentage of country under severe water stress
	11	Natural Resource Management	34	OVRFSH	Productivity overfishing
			35	FORCERT	Percentage of total forest area that is certified for sustainable management
			36	WEFSUB	World Economic Forum Survey on subsidies
			37	IRRSAL	Salinized area due to irrigation as percentage of total arable land
			38	AGSUB	Agricultural subsidies

Component	Indicator Number	Indicator	Variable Number	Variable Code	Variable
Reducing Human Vulnerability	12	Environmental Health	39	DISINT	Death rate from intestinal infectious diseases
			40	DISRES	Child death rate from respiratory diseases
			41	U5MORT	Children under five mortality rate per 1,000 live births
	13	Basic Human Sustenance	42	UND_NO	Percentage of undernourished in total population
			43	WATSUP	Percentage of population with access to improved drinking water source
	14	Reducing Environment-Related Natural Disaster Vulnerability	44	DISCAS	Average number of deaths per million inhabitants from floods, tropical cyclones, and droughts
			45	DISEXP	Environmental Hazard Exposure Index
Social and Institutional Capacity	15	Environmental Governance	46	GASPR	Ratio of gasoline price to world average
			47	GRAFT	Corruption measure
			48	GOVEFF	Government effectiveness
			49	PRAREA	Percentage of total land area under protected status
			50	WEFGOV	World Economic Forum Survey on environmental governance
			51	LAW	Rule of law
			52	AGENDA21	Local Agenda 21 initiatives per million people
			53	CIVLIB	Civil and Political Liberties
			54	CSDMIS	Percentage of variables missing from the CGSDI "Rio to Joburg Dashboard"
			55	IUCN	IUCN member organizations per million population
			56	KNWLDG	Knowledge creation in environmental science, technology, and policy
			57	POLITY	Democracy measure
	16	Eco-Efficiency	58	ENEFF	Energy efficiency
			59	RENPC	Hydropower and renewable energy production as a percentage of total energy consumption
	17	Private Sector Responsiveness	60	DJSGI	Dow Jones Sustainability Group Index (DJSGI)
			61	ECOVAL	Average Innovest EcoValue rating of firms headquartered in a country
			62	ISO14	Number of ISO 14001 certified companies per billion dollars GDP (PPP)
			63	WEFPRI	World Economic Forum Survey on private sector environmental innovation
			64	RESCARE	Participation in the Responsible Care Program of the Chemical Manufacturer's Association
	18	Science and Technology	65	INNOV	Innovation Index
			66	DAI	Digital Access Index
			67	PECR	Female primary education completion rate
			68	ENROL	Gross tertiary enrollment rate
			69	RESEARCH	Number of researchers per million inhabitants
Global Stewardship	19	Participation in International Collaborative Efforts	70	EIONUM	Number of memberships in environmental intergovernmental organizations
			71	FUNDING	Contribution to international and bilateral funding of environmental projects and development aid
			72	PARTICIP	Participation in international environmental agreements
	20	Greenhouse Gas Emissions	73	CO2GDP	Carbon emissions per million US dollars GDP
			74	CO2PC	Carbon emissions per capita
	21	Reducing Transboundary Environmental Pressures	75	SO2EXP	SO_2 Exports
			76	POLEXP	Import of polluting goods and raw materials as percentage of total imports of goods and services

Data Coverage

We sought to include as many countries as we could in the 2005 ESI. For a detailed discussion of the inclusion criteria for countries, see Appendix A. Where countries were missing data points, we attempted to fill the gaps in a variety of ways. We sent out an initial data matrix to the Environment Ministry and the Statistical Office of every country that was close to meeting our data coverage threshold of 60% of the total variables, asking them to check our numbers and to fill gaps or update the data where possible. We accepted the data provided when they could be verified. A full discussion of this "country data review" is provided in Appendix A.

Ultimately, any country with fewer than 45 reported variables out of 76 was excluded from the analysis. We also excluded countries that did not meet baseline thresholds for land area and population because these small countries cannot be compared to others in the ESI. We discuss the complexity of including small countries and report the data for these countries in Appendix E.

A total of 146 countries met the criteria for inclusion in the 2005 ESI. For these countries, we then used Markov Chain Monte Carlo simulation to impute values for the missing variables where a logic for imputation existed.

Not only do data gaps mean that some important issues cannot be incorporated into the ESI, but many of the data sets that we do use are patchy, incomplete, haphazardly constructed, or otherwise deficient in some respect. In order to highlight where improved data is needed, we have undertaken to "grade" the 76 variables that are in the 2005 ESI on eight parameters. The results of this grading exercise are reported in Appendix A.

Data Transformation

To calculate the ESI scores for each country and to facilitate the aggregation of variables into indicators, the raw data were transformed in a variety of ways. A number of variables require appropriate "denominators" to permit comparisons across countries of different scales, including transformations to improve the imputation model and the symmetry of the data. To avoid having extreme data points skew the results, we "trim the tails" of each data set distribution and construct a "z-score" for each variable that preserves the relative position of each country for each variable while providing a neutral way to aggregate the variable into indicators. The details of this methodology are provided in Appendix A.

Comparing the ESI to Other Indicator Efforts

Despite the urgent need for indicators that allow tracking of environmental performance on a national basis, data on pollution control and natural resource management remain spotty at best. A number of UN agencies and other international bodies collect data, but much of the information is lacking harmonized methodologies, timeliness, and rigorous quality assurance and quality control protocols. Further investments in environmental data and the production of indicators must be made a point of focus for both national and global decisionmakers. Getting the appropriate analytic and empirical underpinnings for good decisionmaking is essential to successful policymaking.

In recent years, important indicator development work has been done on the local and regional scales by groups such as the International Institute for Sustainable Development, which produced the IISD Compendium of Global Indicator Initiatives (IISD 2004). Others have worked at the global scale, including the OECD, those working on the "Dashboard of Sustainability" (ESL 2004), and Robert Prescott Allen's work on the Well-being of Nations (Prescott-Allen 2001). However there are relatively few comprehensive environmental indicator sets that permit cross-national comparisons in support ofsound policymaking.

For a variety of reasons, intergovernmental organizations have been unable or unwilling to produce such indicators, leaving an important void in the international policy realm. The closest the international community came in recent years was when the UN Commission on Sustainable Development adopted a work program on indicators that produced standard methodologies for extensive sets of indicators (UN CSD 1996; UN CSD 2001). The program aimed to help governments measure their own sustainability at the national level with sets of indicators they could adapt to their own requirements rather than a universal set of global indicators. But even here the CSD chose neither to endorse any single set of indicators nor to produce comparable cross-national indicators.

Although UN agencies and other international bodies routinely produce global indicators permitting cross-national comparisons on economics, health, security issues, human rights, and other high priority issues of global concern, efforts focused on the environment remain underfunded and understaffed. Instead, international agencies produce volumes of more broadly dispersed data on the environment. The information collected is often not methodologically consistent from country to country. This non-comparability hinders usefulness from a policy perspective.

In the absence of effective environmental sustainability indicators, it is impossible for environmental decisionmaking to undergo the virtuous circle of diagnosis, target-setting, implementation, and evaluation that is possible in other realms. Instead, environmental decisionmaking suffers from drift, with no clear expression of priorities, no coherent policy targets, and no ability to evaluate performance against objective criteria (Levy and Meier 2004).

Apart from the Ecological Footprint, when the ESI was first produced in 2000, there were no other cross-national environmental performance indices or rankings available. Since that time, a number of global-scale aggregate indicator efforts have emerged. We highlight below some of these other efforts and compare them to the ESI. A more technically complete discussion, including statistical comparisons, can be found in Appendix F.

Robert Prescott-Allen's *Wellbeing of Nations* (IUCN 2001) has much in common with the ESI. It combines measures of environmental and human wellbeing, using a series of thematic indicators, which are aggregated in an overall indicator of environmental wellbeing and human wellbeing, which in turn can be averaged to produce an overall indicator. It quantifies levels of sustainability in a broad range of environmental areas, including water, air, biodiversity, and landscape. The Wellbeing Index combines environmental outcomes with human outcomes and relies on relative rankings to generate aggregated quantitative indicators (although performance on individual indicators is measured against absolute benchmarks). Unlike the ESI, the *Wellbeing of Nations* does not include measures of social capacity and it is not updated. The Wellbeing Index has also been criticized for its lack of transparency in the determination of the underlying weighting scheme. While the ESI is also based on a weighted aggregation, its choice and justification of the weights is straightforward and transparent.

The Consultative Group on Sustainable Development Indicators (CGSDI) has produced a set of indicators spanning economic, environmental, and social development objectives, in a framework designed to be consistent with the UN Commission on Sustainable Development Indicator Initiative. The CGSDI collection covers a wider range of outcomes than the ESI, because its focus is sustainable development broadly defined, as opposed to environmental sustainability. It does not explicitly publish an aggregated overall index of sustainable development, although such an index is straightforward to calculate with the data produced. The CGSDI indicators, in spite of their explicit connection to the UN process, is weakly institutionalized, with no clear ongoing mechanism for data collection, evaluation, aggregation, analysis and dissemination.

The Ecological Footprint, developed by Mathis Wackernagel and his colleagues, meas-

measures the degree to which a given country is living within its ecological means. It aggregates the consumption of natural resources within a country in terms of the land area that is estimated to require the support of such consumption. This land area is then divided by the actual land area of the country – countries whose footprints are larger than their actual area are said to be consuming beyond a sustainable level. The Ecological Footprint has an intuitive appeal insofar as natural resource depletion is a central element of sustainability. It differs from the ESI in that it focuses on a single dynamic rather than a broader measure of environmental conditions. The ESI includes resource consumption and uses the Ecological Footprint as a variable because of its obvious relevance to sustainability. But the ESI also tracks many other aspects of environmental stewardship, particularly those associated with pollution and environmental public health.

Uncertainties and Conclusions

The validity, interpretability, and explanatory power of the Environmental Sustainability Index depend on the quality and completeness of the input data. Without sufficient data coverage at the national or sub-national scale, we would be unable to build the data matrix which underlies the Index, and we would have to rely more extensively on modeling techniques to fill the matrix gaps.

Data quality is also instrumental for the calculation of the indicators and Index. We are aware that there are many sources of uncertainty including measurement error, systematic and human error as well missing data. Despite our goal of minimizing these errors, the ESI must be understood as an emergent product, prone to some imprecision where these data difficulties persist.

We aimed for the highest possible quality of both the 2005 ESI data and the Index construction methodology by engaging in extensive peer- and country-reviews. The many responses received to our country "data review" requests are a testimony to the recognition of many environmental officials of the importance of accurate, current, and informative environmental data and indicators. Dozens of experts helped to update, refine, and critique the 2005 ESI. They contributed individually and collectively to ensuring that the 2005 ESI stands at the forefront of currently available environmental indices and indicator projects.

We recognize that several methodological issues, including issue/indicator selection and the equal weighting of our 21 indicators, are open to dispute. We have continuously reviewed and improved the ESI methodology – and we expect to continue to do so as more data become available and statistical techniques are refined. As noted above, our vision of what an ideal ESI ought to include – if the data were available – can be found in Appendix G.

Although the ESI as it stands is partial and constrained by data limitations, we see enormous value in having a comparative tool that helps to identify the leaders and laggards with regard to a broad range of environmental issues. It is in the spirit of providing a starting point for data-driven and empirically grounded policymaking that the Environmental Sustainability Index is put forward.

Box 2: Can Environmental Sustainability Be Measured?

Although we acknowledge that “measuring” environmental sustainability is challenging, there are some common misconceptions about how difficult it is. We address these misunderstandings below:

Argument: the concept is too abstract. It is true that environmental sustainability is an abstract concept, however it does not follow that it cannot be measured with concrete indicators. “Health” is an equally abstract concept, yet the World Health Organization has made great progress constructing useful cross-national indicators of aggregated health outcomes. “Poverty” is very abstract as well, but a number of useful indicators have been produced to permit target setting and evaluation. Many other examples can be cited in which abstractness is not an obstacle to measurement, for example, in the cases of corruption, democracy, or human rights. There is no reason to suspect that the environment is any different from other abstract concepts.

Argument: the concept is too multi-faceted. Some argue the measures proposed as constituents of environmental sustainability are causally connected in multiple ways, diminishing their ability to serve as indicators. It is true that the many indicators proposed in the ESI are connected through complicated pathways of causality. Levels of environmental pollution, for example, can diminish the state of environmental systems, and also affect people and organisms adversely, while social and institutional capacity can intervene either in directly altering any of these phenomena or in changing the nature of the causal connections among them. We agree that this reality makes indicator creation challenging. However, complex causal structures are not a reason for inaction; in fact, we argue that indicators can help make it possible to resolve disputes on causality by strengthening the empirical nature of policy debates.

Argument: the term “environment” covers too wide a range of issues. Environmental sustainability encompasses a wide range of issues from pollution to natural resource management challenges and institutional capacity. It requires attention to the past, the present, and the future. Underlying natural resource endowments and past pollution as well as resource consumption define the environmental starting point for any society. Current pollution flows and resource use clearly are important determinants of sustainability. And the ability to change trajectories – including the societal and institutional capacity to fix problems and improve results over time – is also a key driver of sustainability. In response, the issues reflected in the ESI *do* range widely. But this fact does not invalidate the ESI. To the contrary, the diversity of issues embedded in the concept of environmental sustainability makes the need for a broad-gauge ESI more clear.

Argument: there is no common unit of measurement. We agree that the availability of a common unit of measurement, in terms of monetary value, land area, population, or risk, would greatly facilitate the definition of environmental sustainability. However, the multi-dimensional framework of the ESI cannot readily be reduced to a common scale. Transforming the ESI’s 21 indicators and underlying 76 variables to a common measurement metric would imply large-scale assumptions and generalizations that would bias the results and mask much of the analytic fraction of the index. Instead, making variables comparable on a cross-national level using GDP, people, or populated land area as denominators allows the aggregation of information that originally had different units of measurement and is the best option with the variety of the data included in the ESI.

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Chapter 3 – Main Findings

ESI Scores and Ranks

The ESI ranking provides a relative gauge of environmental stewardship in 146 countries. The Nordic countries, Uruguay, and Canada occupy the top ranks and have consistently done so in previous ESI rankings (ESI 2001; ESI 2002). Other than Uruguay, these nations are highly developed countries endowed with natural resources, strong economies, and low population densities. As industrialized countries, they have substantial pollution stresses, but generally manage their environmental challenges well. Uruguay stands in the top tier for a slightly different reason. It is not very industrialized and thus faces relatively low environmental stresses. It does, however have some economic strengths and reasonably good political and social institutions and capacity. So while it does not score very high on any aspect of the ESI, it has no real weaknesses and thus lands in the top quintile across all the components.

At the bottom of the table, North Korea, Taiwan, Turkmenistan, Iraq, Uzbekistan, and Haiti are all countries with serious environmental stresses, poor policy responses, and (with the exception of Taiwan) limited institutional capacity. Among the next lowest five countries are both Kuwait and Saudi Arabia. Their presence at the bottom of the rankings, along with relatively rich Taiwan, suggests that a country's level of economic development does not exclusively determine its environmental performance. Most of the countries near the bottom of the rankings, however, suffer from the challenges of poverty and weak governance. It appears that poor environmental planning and limited investment in environmental protection and infrastructure as compared to the leading countries translate into markedly lower results (Esty, Levy et al. 2003).

While it is clearly possible to identify leaders and laggards and to pose hypotheses on the reasons for their positions at the high and low ends of the rankings, it is more difficult to analyze the middle ranks. In part, the volatility of the mid-ranking countries is a normal statistical result. Since the majority of countries have ESI scores located closely around the center of the ESI distribution, small movements result in larger changes in ranks compared to countries in the top and bottom positions.

Countries at various stages of economic development, human development status, and geographical size and location have ESI values in the mid-range of 40 to 60. This fact seems to indicate that environmental sustainability challenges come in multiple forms and combinations. The diversity of underlying institutions – including economic systems, legal regimes, and regulatory systems – adds to the complexity of the picture.

While definitive statements are hard to make using the existing data, it does not appear that any country has yet achieved sustainability. Nevertheless, the ESI can be useful in the search for role models and best practices. Lagging countries might look to the leaders, as shown in the relevant peer group charts, and adopt the policy instruments, technologies, and approaches of these leading-edge nations. Because the ESI is an aggregate index, the search for policy models is best conducted at the indicator or variable level rather than at the level of components or total ESI score. For example, if the United States wanted to improve its environmental performance (and its ESI score), it should focus on its lagging indicators, such as its high levels of waste and greenhouse gas emissions.

Table 11: 2005 Environmental Sustainability Index – Scores and Rankings (alphabetical order)

ESI Rank	Country Name	ESI Score	OECD Rank	Non-OECD Rank	ESI Rank	Country Name	ESI Score	OECD Rank	Non-OECD Rank	ESI Rank	Country Name	ESI Score	OECD Rank	Non-OECD Rank
24	Albania	58.8		14	67	Greece	50.1	21		2	Norway	73.4	2	
96	Algeria	46.0		70	116	Guatemala	44.0		88	83	Oman	47.9		60
123	Angola	42.9		94	81	Guinea	48.1		58	35	P. N. Guinea	55.2		22
9	Argentina	62.7		3	77	Guinea-Bissau	48.6		54	131	Pakistan	39.9		102
44	Armenia	53.2		28	8	Guyana	62.9		2	28	Panama	57.7		17
13	Australia	61.0	8		141	Haiti	34.8		112	17	Paraguay	59.7		8
10	Austria	62.7	7		87	Honduras	47.4		64	16	Peru	60.4		7
99	Azerbaijan	45.4		73	54	Hungary	52.0	19		125	Philippines	42.3		97
114	Bangladesh	44.1		86	5	Iceland	70.8	4		102	Poland	45.0	27	
47	Belarus	52.8		30	101	India	45.2		75	37	Portugal	54.2	15	
112	Belgium	44.4	28		75	Indonesia	48.8		53	94	Romania	46.2		69
86	Benin	47.5		63	132	Iran	39.8		103	33	Russia	56.1		20
43	Bhutan	53.5		27	143	Iraq	33.6		114	106	Rwanda	44.8		79
20	Bolivia	59.5		11	21	Ireland	59.2	10		136	Saudi Arabia	37.8		107
61	Bosnia & Herze.	51.0		42	62	Israel	50.9		43	59	Senegal	51.1		40
34	Botswana	55.9		21	69	Italy	50.1	22		89	Serbia & Mont.	47.3		66
11	Brazil	62.2		4	109	Jamaica	44.7		82	120	Sierra Leone	43.4		92
70	Bulgaria	50.0		48	30	Japan	57.3	12		48	Slovakia	52.8	18	
97	Burkina Faso	45.7		71	84	Jordan	47.8		61	29	Slovenia	57.5		18
130	Burundi	40.0		101	78	Kazakhstan	48.6		55	93	South Africa	46.2		68
68	Cambodia	50.1		47	100	Kenya	45.3		74	122	South Korea	43.0	29	
50	Cameroon	52.5		32	138	Kuwait	36.6		109	76	Spain	48.8	23	
6	Canada	64.4	5		80	Kyrgyzstan	48.4		57	79	Sri Lanka	48.5		56
25	Central Afr. Rep.	58.7		15	52	Laos	52.4		34	140	Sudan	35.9		111
104	Chad	45.0		77	15	Latvia	60.4		6	4	Sweden	71.7	3	
42	Chile	53.6		26	129	Lebanon	40.5		100	7	Switzerland	63.7	6	
133	China	38.6		104	121	Liberia	43.4		93	117	Syria	43.8		89
23	Colombia	58.9		13	126	Libya	42.3		96	145	Taiwan	32.7		116
39	Congo	53.8		24	22	Lithuania	58.9		12	134	Tajikistan	38.6		105
18	Costa Rica	59.6		9	90	Macedonia	47.2		67	63	Tanzania	50.3		44
88	Côte d'Ivoire	47.3		65	64	Madagascar	50.2		45	73	Thailand	49.7		51
19	Croatia	59.5		10	74	Malawi	49.3		52	111	Togo	44.5		84
53	Cuba	52.3		35	38	Malaysia	54.0		23	139	Trinidad & Tob.	36.3		110
92	Czech Rep.	46.6	25		41	Mali	53.7		25	55	Tunisia	51.8		36
113	Dem. Rep. Congo	44.1		85	124	Mauritania	42.6		95	91	Turkey	46.6	24	
26	Denmark	58.2	11		95	Mexico	46.2	26		144	Turkmenistan	33.1		115
119	Dominican Rep.	43.7		91	58	Moldova	51.2		39	57	Uganda	51.3		38
51	Ecuador	52.4		33	71	Mongolia	50.0		49	108	Ukraine	44.7		81
115	Egypt	44.0		87	105	Morocco	44.8		78	110	United Arab Em.	44.6		83
118	El Salvador	43.8		90	107	Mozambique	44.8		80	65	United Kingdom	50.2	20	
27	Estonia	58.2		16	46	Myanmar	52.8		29	45	United States	52.9	17	
135	Ethiopia	37.9		106	32	Namibia	56.7		19	3	Uruguay	71.8		1
1	Finland	75.1	1		85	Nepal	47.7		62	142	Uzbekistan	34.4		113
36	France	55.2	14		40	Netherlands	53.7	16		82	Venezuela	48.1		59
12	Gabon	61.7		5	14	New Zealand	60.9	9		127	Viet Nam	42.3		98
72	Gambia	50.0		50	66	Nicaragua	50.2		46	137	Yemen	37.3		108
56	Georgia	51.5		37	103	Niger	45.0		76	60	Zambia	51.1		41
31	Germany	56.9	13		98	Nigeria	45.4		72	128	Zimbabwe	41.2		99
49	Ghana	52.8		31	146	North Korea	29.2		117					

Note: The 2005 ESI scores are not directly comparable to the 2002 ESI Scores. See Appendix A for details on the methodology.

Box 3: How to Interpret an ESI Score

The ESI score quantifies the likelihood that a country will be able to preserve valuable environmental resources effectively over the period of several decades. Put another way, it evaluates a country's potential to avoid major environmental deterioration. The top-ranked country, Finland, has high scores across all the ESI's five components. Because it is doing relatively well across such a broad range of environmental sustainability dynamics, we expect it to be more likely to provide its citizens with high levels of environmental quality and services into the foreseeable future. The bottom-ranked country, North Korea, scores low in many dimensions, but not in all. It is the weak performance in a large number of indicators that generates the low overall score, which supports a conclusion that North Korea's medium-term environmental prospects are not good.

Because the different dimensions of environmental sustainability do not always correlate with one another, the ESI score taken by itself does not identify the relative contribution of the different indicators to the overall assessment of a country's medium-term prospects, nor what particular types of challenges are most likely to pose acute problems. Although North Korea has the lowest ESI score, for example, its Environmental Stress score is closer to the world median. The United States, by contrast, has a far higher ESI score (45th) than North Korea, but has a worse Environmental Stress score. Therefore, although we would conclude that the United States is more likely to be able to preserve its valuable environmental resources effectively than North Korea, it is probably more likely to encounter problems that stem from high levels of pollution or high rates of conversion of natural land. In some areas the U.S. has extremely poor scores (greenhouse gas emissions are a notable example). However, these are balanced by above average scores in many others areas, especially preservation of wilderness and investment in capacity.

Gabon is the highest-ranked country in Africa, which means that our analysis concludes that it is the African country least likely to experience major environmental deterioration in the short and medium-term future. It does not mean that Gabon is without problems. Contributing significantly to its high ESI score are its very high ranks on a number of natural resource measures, which account for it having the third highest overall score for environmental systems. As a developing country it has below-average scores on capacity, and this fact is likely to pose significant challenges to the country as it faces the future. Its ability to move forward effectively, though, is enhanced by its relatively good scores on human vulnerability and global stewardship.

Several countries in Latin America are in the top 20, including Uruguay which is ranked 3rd overall. This outcome reflects a few facets of these countries' development paths. Although some South American countries have acquired negative reputations for abuses of natural resources, such as the rapid Amazonian deforestation in the 1980s, for the most part the region remains rich in wilderness and managed natural resources. In some cases, policy innovation has contributed to dramatic improvements in controlling resource losses, such as the programs to combat illegal logging in Brazil. In addition, many of these countries have a large share of their economies devoted to agriculture, as opposed to heavy industry, which shifts the pollution to non-point sources for which data sources are not readily available. Their prominence in the top-20 list of ESI scores is also a function of the fact that they are more wealthy than most of Africa, and therefore can invest in significant capacity and vulnerability reduction; that they are less industrialized than North America, Europe, and much of Asia; and that they have retained greater wilderness than most world regions. While these facts do not guarantee that these countries will avoid environmental problems, they do suggest that their overall likelihood of major problems is lower than elsewhere.

Developed v. Developing Country Environmental Sustainability

While environmental sustainability is complex and hard to define, the ESI suggests that sustainability has multiple dimensions – and distinct challenges for developed versus developing countries. Developed countries must find ways to manage the environmental stresses of industrialization and consumption of natural resources, particularly those that are non-renewable. Developing countries face the risk of depleting renewable resources such as water and forests as well as the challenges of funding investments in environmental protection and creating functioning institutions that permit economic growth and support appropriate regulation.

While the core environmental challenges vary across countries, the ESI facilitates the process of finding relevant peer groups and benchmarking performance. Because of the range and complexity of issues that fall under the environmental rubric, policymaking needs to be made more data-driven and empirical. The ESI supports this goal.

As in previous ESI rankings, no country (except Uruguay) scored in the top quintile in all five components. This fact suggests that countries tend to experience sustainability as a multidimensional challenge where each country has strengths and weaknesses and a unique profile (see Appendix B for the complete set of country profiles). Every country thus has something to learn from its peers and multiple areas for environmental improvement.

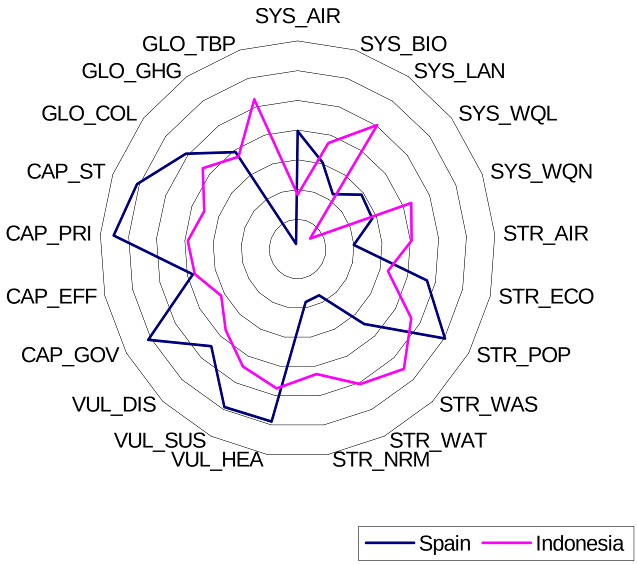
Relationship to Economic Development

Economic conditions affect environmental outcomes, but a country's level of development is by no means the only driver of its performance and ESI score. Richer countries tend to score high in human vulnerability and social and institutional capacity, and poorer countries tend to score higher in reducing environmental stresses and environmental systems. The global stewardship component has no clear relationship to income.

An individual country's performance is, therefore, best understood by looking not only at its overall ESI score or ranking but by examining its results with respect to the 21 key indicators of environmental sustainability. Because the 21 indicators span many distinct dimensions of environmental sustainability, it is possible for countries to have similar ESI scores but very different environmental profiles. The component-based bar chart in Table 1 highlights in summary form these differences. The "cluster analysis" discussed below further illuminates the range of sustainability challenges. Take, for example, the difference between Spain and Indonesia in Figure 2.

The analysis of the relative performance of countries with similar ESI scores but different indicators profiles helps to illuminate the range that exists across the most pressing environmental challenges countries face. The analysis of the differences and similarities among countries within the same peer group offers insights into the relative efficacy of their environmental policies – such as air pollution controls, biodiversity initiatives, and innovation in science and technology.

Spain, with an ESI score of 48.8 must deal with burdened ecological systems and quite high levels of environmental stress, as the "spider" graph on the next page suggests. Like other developed countries, Spain has reasonably strong capacity to handle the harms it faces. Indonesia, on the other hand, has a similar ESI score of 48.8, but faces a very different set of challenges. It has stronger underlying systems and less present stress in several regards, but much less developed institutional capacity to manage the challenges it must address, including severe water quality issues.



SYS_AIR:	Air Quality
SYS_BIO:	Biodiversity
SYS_LAN:	Land
SYS_WQL:	Water Quality
SYS_WQN:	Water Quantity
STR AIR:	Reducing Air Pollution
STR_ECO:	Reducing Ecosystem Stress
STR_POP:	Reducing Population Pressure
STR_WAS:	Reducing Waste & Consumption Pressures
STR_WAT:	Reducing Water Stress
STR_NRM:	Natural Resource Management
VUL_HEA:	Environmental Health
VUL_SUS:	Basic Human Sustenance
VUL_DIS:	Reducing Environment-Related Natural Disaster Vulnerability
CAP_GOV:	Environmental Governance
CAP_EFF:	Eco-Efficiency
CAP_PRI:	Private Sector Responsiveness
CAP_ST:	Science and Technology
GLO_COL:	Participation in International Collaborative Efforts
GLO_GHG:	Greenhouse Gas Emissions
GLO_TBP:	Reducing Transboundary Environmental Pressures

Figure 2: Comparison of Indicator Scores for Spain and Indonesia
Note: the greater the distance from the center, the better the indicator result

At every level of development, there exists a large range of ESI scores. This fact suggests that countries in similar circumstances have available a variety of environmental management strategies, some of which are much more effective than others. Whatever a country's development status, the ESI offers a useful tool for isolating appropriate policy interventions and environmental approaches.

Relationship between Environmental & Economic Performance

Traditional economic theory posits a tradeoff between economic progress and environmental quality. More recently, it has been suggested that increased wealth is a prerequisite for environmental improvements (Grossman and Krueger 1995) Several empirical studies have likewise shown that wealth is an important factor in explaining environmental policy results, but not alone determinative of environmental policy (Esty and Porter 2005). The low rankings of Kuwait, Saudi Arabia, and the United Arab Emirates suggest that there is no necessary connection between income and environmental success. Similarly, some developing countries, such as Costa Rica, place significant emphasis on the protection of their environmental assets. They have, as a result, environmental outcomes that are far better than would be predicted by their level of development.

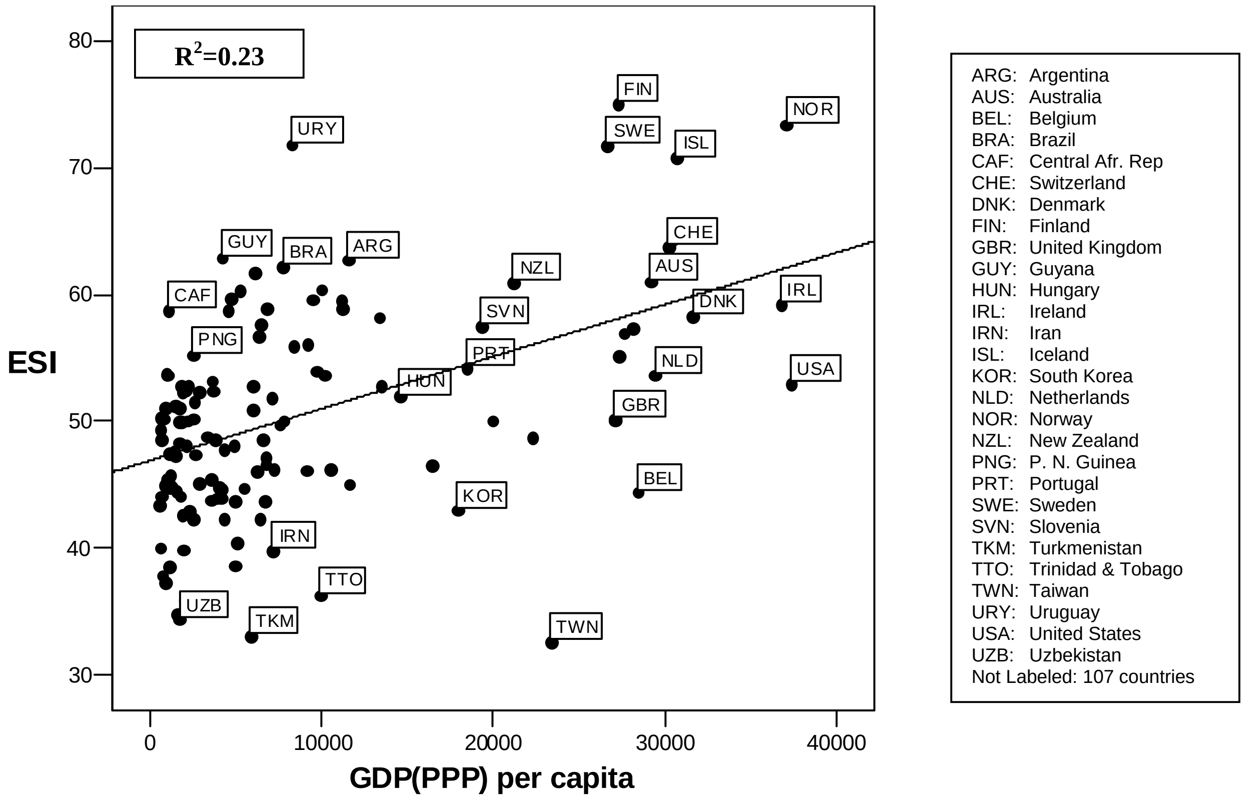


Figure 3: Regression of 2005 ESI on GDP (PPP) Per Capita

ESI versus Per Capita Gross Domestic Product (GDP)

In statistical terms, about 23% of the variance in the ESI is accounted for by per capita GDP. This result suggests that richer countries can – and do – invest in pollution control and other environmental amenities. Examining Figure 3 above, which provides the regression results of the ESI on GDP per capita, helps to illuminate the relationship between wealth and environmental results.

As indicated by their position above the regression line, the Nordic countries have high GDP per capita but even higher ESI scores than their wealth might forecast. The United Kingdom, Belgium, and the United States fall well below the regression line – indicating sub-par performance given their level of wealth.

Likewise, Trinidad and Tobago falls below Argentina and Brazil among medium-income level countries. And Tajikistan and Uzbekistan lag behind Guyana among low-income countries.

If we examine the ESI's components, we can get a more precise picture of the relationship to per capita income. The highest positive correlations are between GDP per capita and the ESI's Human Vulnerability and Social and Institutional Capacity Components. The correlation is negative for environmental stresses, meaning that high-income countries put significantly more stress on their environments than low-income ones.

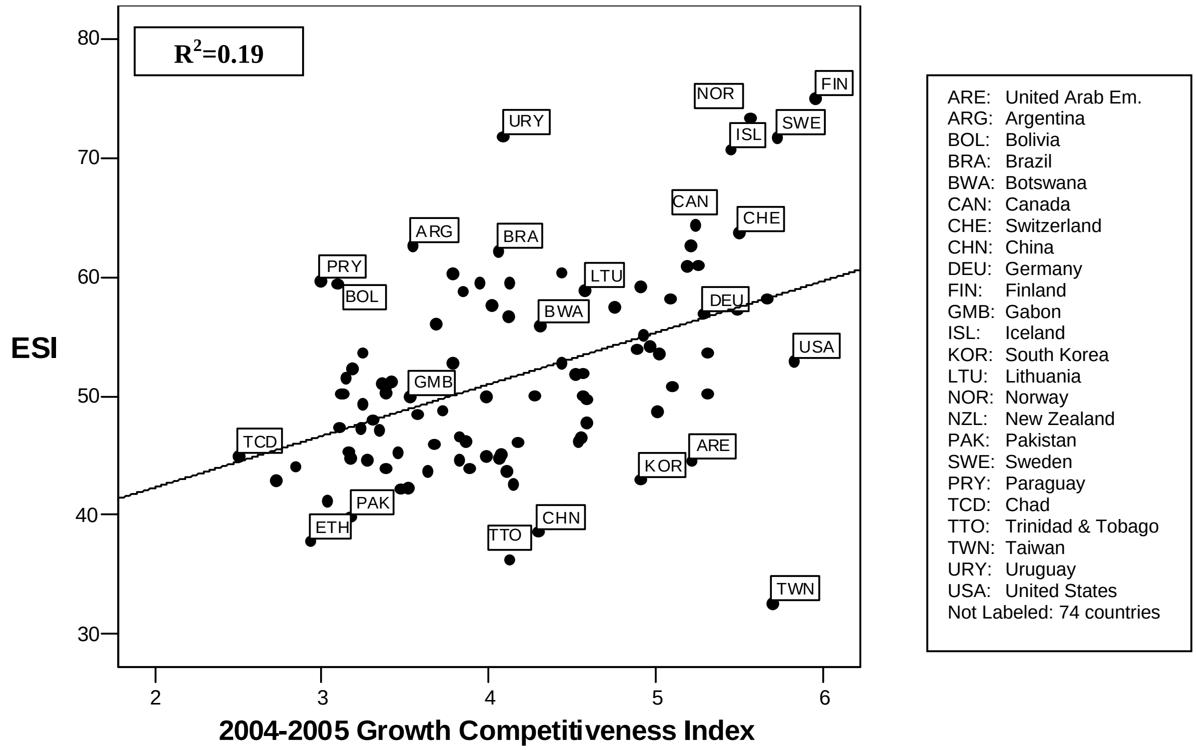


Figure 4: Regression of 2005 ESI on 2004-2005 Growth Competitiveness Index

ESI versus Growth Competitiveness Index

Classic economic theory suggests that a commitment to high levels of environmental performance might well negatively affect competitiveness. Michael Porter (Porter 1991) and others (Porter and C. van der Linde 1995) have suggested, however, that this presumption might be wrong under dynamic conditions. Regressing the ESI on the World Economic Forum's Growth Competitiveness Index scores provides a starting point for testing these competing hypotheses.

The Competitiveness Index explains approximately 19% of the variation in the ESI. As Figure 4 shows, competitiveness correlates positively with environmental sustainability. We cannot say whether this correlation implies any statistically significant causal relationship. The cautious conclusion is that a commitment to sustainability is compatible with national economic competitiveness.

As with wealth, countries with the same Growth Competitiveness Index (GCI) value often perform very differently in the environmental sphere. These results suggest that some countries handle environmental challenges without seeming to harm their competitiveness.

Finland and the United States have similar GCI scores, but Finland has a much higher ESI score. Similarly, Sweden, Iceland, and Norway are well above the regression line, while China, Trinidad and Tobago, and South Korea fall far below the line. To better understand these relationships, it may be useful to look at the correlations not just with the ESI as a whole but with the core components and underlying indicators. Table 12 below provides, in summary form, the most significant relationships. These results suggest that economic strength is a critical factor in addressing environmental challenges.

Table 12: ESI Components and Indicators with Statistically Significant Correlation to GDP and the Growth Competitiveness Index

		2004 GCI	Significance	GDP/cap	Significance
2005 Environmental Sustainability Index		0.45	***	0.48	***
Component					
SYSTEM	Environmental Systems	0.05		0.11	
STRESS	Reducing Environmental Stresses	-0.63	***	-0.60	***
VULNER	Reducing Human Vulnerability	0.69	***	0.54	***
CAP	Social and Institutional Capacity	0.85	***	0.82	***
GLOBAL	Global Stewardship	-0.04		0.14	
Indicator					
SYS_AIR	Air Quality	0.48	***	0.45	***
SYS_BIO	Biodiversity	-0.22	*	-0.16	
SYS_LAN	Land	-0.32	***	-0.35	***
SYS_WQL	Water Quality	0.42	***	0.52	***
SYS_WQN	Water Quantity	-0.08		0.01	
STR_AIR	Reducing Air Pollution	-0.73	***	-0.63	***
STR_ECO	Reducing Ecosystem Stresses	-0.07		-0.22	*
STR_POP	Reducing Population Growth	0.59	***	0.43	***
STR_WAS	Reducing Waste & Consumption Pressures	-0.47	***	-0.28	***
STR_WAT	Reducing Water Stress	-0.54	***	-0.39	***
STR_NRM	Natural Resource Management	-0.60	***	-0.57	***
VUL_HEA	Environmental Health	0.67	***	0.53	***
VUL_SUS	Basic Human Sustenance	0.73	***	0.55	***
VUL_DIS	Reducing Environment-Related Natural Disaster Vulnerability	0.26	***	0.20	
CAP_GOV	Environmental Governance	0.80	***	0.78	***
CAP_EFF	Eco-Efficiency	-0.23	*	-0.08	
CAP_PRI	Private Sector Responsiveness	0.83	***	0.76	***
CAP_ST	Science & Technology	0.87	***	0.83	***
GLO_COL	Participation in International Collaborative Efforts	0.87	***	0.83	***
GLO_GHG	Greenhouse Gas Emissions	0.43	***	0.49	***
GLO_TBP	Reducing Transboundary Environmental Pressures	-0.27	***	-0.03	

* statistically significant at 0.05 level ** statistically significant at 0.01 level *** statistically significant at <0.01 level

Central Role of Governance

In recent years, a growing emphasis has been placed on "governance" as a critical underpinning of policy success generally and environmental progress more specifically. The ESI provides some support for the focus on governance. In fact, if one looks at the correlations between the ESI and the 76 underlying variables, the top five bivariate correlations all include elements related to governance as Table 13 on the next page shows.

The highest bivariate correlation is with civil and political liberties, suggesting that countries where robust political debate takes place – facilitated by fair elections, free speech, engaged press, active NGOs, vibrant legislatures, etc. – are more likely to focus on environmental challenges. The second highest correlation is with survey data on environmental governance. This result suggests that countries that pay attention to environmental policy and regulate effectively are more likely to produce successful environmental outcomes. The third and fourth highest correlations are similar variables, including a World Bank gauge of governmental effectiveness and a University of Maryland measure of the democratic character of political institutions.

Table 13: Variables with Statistically Significant Correlation to the ESI

Variable Code	Variable with Statistically Significant Correlation with ESI	Correlation Coeficient	Significance
CIVLIB	Civil and Political Liberties	0.59	***
WEFGOV	World Economic Forum Survey on environmental governance	0.54	***
GOVEFF	Government effectiveness	0.51	***
POLITY	Democratic institutions	0.50	***
PARTICIP	Participation in international environmental agreements	0.49	***

*** statistically significant at <0.01 level

The variable tracking participation in international environmental agreements is the fifth most highly correlated with the ESI, suggesting a relationship between engagement in global governance and environmental policy success. While none of these correlations necessarily imply a causal connection, the coincidence of strong governance with high ESI scores is striking.

Finding Peer Countries – Cluster Analysis

As noted earlier, one of the most valuable uses of the ESI is as a mechanism for comparative policy analysis. In the quest for improved performance, it is very helpful to identify appropriate peer countries against whom one can benchmark environmental outcomes and policies. In addition, those at the leading edge of the peer group might also be looked to for best practices in the policy or technology domains.

Not only do peer countries provide a relevant context for judging one's own performance and perhaps a source of policy guidance, but the compilation of rankings within a peer group also spurs competition. One of the most powerful lessons of the earlier versions of the ESI is that national political leaders care a great deal about how their countries stack up against those who they consider to be similarly situated. When the Norwegian prime minister met with the ESI team, he was not satisfied with Norway's second place rank in the 2002 ESI. Instead, he wanted to discuss was what his country would need to do to overtake Finland for first place.

As noted in Chapter 1, one way to identify peer countries is through existing political institutions such as the European Union or ASEAN. But another way to identify relevant points of comparison is through statistical means. We therefore conducted a cluster analysis, which identifies statistically related groups of countries based on the similarity of indicator scores. While we can force the statistical tools to generate any number of clusters, we find that the seven groupings identified in Table 14 on the next page represent a particularly interesting set of peer groups. We see these clusters as having observable similarities and thus representing a useful point of departure for policy comparisons.

The fact that the clusters include many geographically connected countries, suggesting that they have similar underlying environmental characteristics, provides a logic for regional benchmarking.

Table 14: Cluster Analysis Results

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Low system & stress scores; low vulnerability & high capacity; moderate stewardship	Moderate system & stress scores; high vulnerability & low capacity; above average stewardship	Above average system score; low vulnerability; high capacity; moderate stress & stewardship	Moderate system, stress, & capacity scores; low vulnerability & stewardship	Above average system score, moderate stress, vulnerability, capacity, & stewardship	Moderate system, stress, & vulnerability scores; low capacity & stewardship	Low system score; moderate stress, vulnerability, capacity, & stewardship
Austria	Angola	Australia	Bosnia and Herze.	Argentina	Algeria	Albania
Belgium	Benin	Canada	Bulgaria	Bolivia	Armenia	Bangladesh
Denmark	Bhutan	Finland	Croatia	Botswana	Azerbaijan	China
France	Burkina Faso	Iceland	Czech Rep.	Brazil	Belarus	Cuba
Germany	Burundi	New Zealand	Estonia	Chile	Iraq	Dominican Rep.
Ireland	Cambodia	Norway	Greece	Colombia	Kazakhstan	Egypt
Israel	Cameroon	Sweden	Hungary	Costa Rica	Kuwait	El Salvador
Italy	Central Afr. Rep.	United States	Jamaica	Ecuador	Kyrgyzstan	Georgia
Japan	Chad		Latvia	Gabon	Libya	India
Netherlands	Congo		Lebanon	Guatemala	Moldova	Indonesia
Portugal	Côte d'Ivoire		Lithuania	Guyana	Mongolia	Iran
Slovenia	Dem. Rep. Congo		Macedonia	Honduras	North Korea	Jordan
South Korea	Ethiopia		Poland	Namibia	Oman	Malaysia
Spain	Gambia		Romania	Nicaragua	Russia	Mexico
Switzerland	Ghana		Serbia & Monteneg.	Panama	Saudi Arabia	Morocco
Taiwan	Guinea		Slovakia	Paraguay	Turkmenistan	Pakistan
United Kingdom	Guinea-Bissau		Trinidad & Tobago	Peru	Ukraine	Philippines
	Haiti		Turkey	Uruguay	United Arab Em.	South Africa
	Kenya			Venezuela	Uzbekistan	Sri Lanka
	Laos					Syria
	Liberia					Thailand
	Madagascar					Tunisia
	Malawi					Viet Nam
	Mali					Zimbabwe
	Mauritania					
	Mozambique					
	Myanmar					
	Nepal					
	Niger					
	Nigeria					
	P. N. Guinea					
	Rwanda					
	Senegal					
	Sierra Leone					
	Sudan					
	Tajikistan					
	Tanzania					
	Togo					
	Uganda					
	Yemen					
	Zambia					

Table 15: Characteristics of Clusters

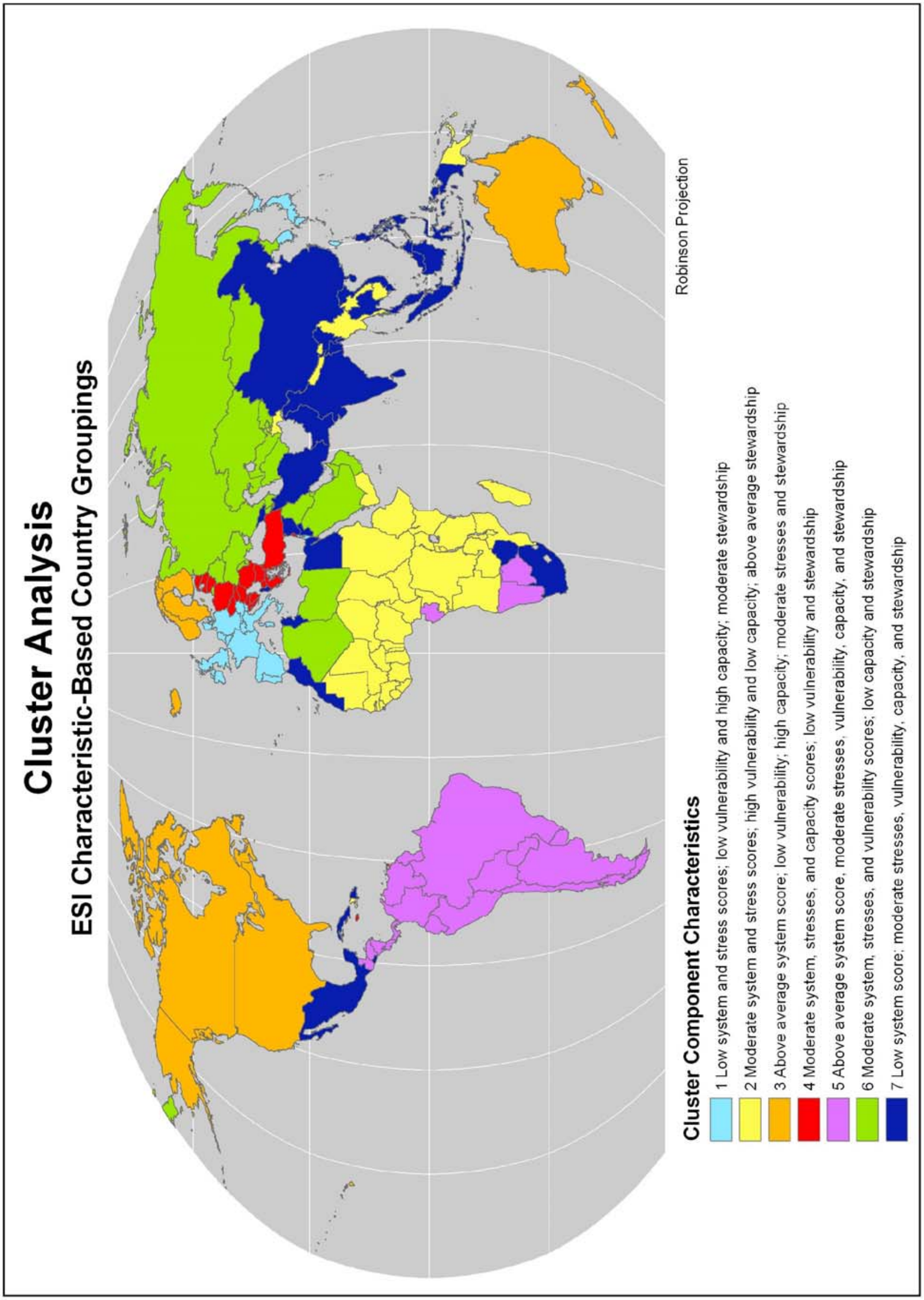
Cluster:		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
	Number of countries	17	41	8	18	19	19	24
	ESI	52.9	47.1	66.3	49.6	57.1	44.0	46.2
Average values of ESI Component Values	Environmental Systems	39.1	50.8	75.6	43.4	66.9	51.5	37.4
	Reducing Environmental Stresses	33.9	54.7	44.0	50.9	55.7	52.6	50.9
	Reducing Human Vulnerability	71.3	26.6	78.0	72.2	51.0	54.2	49.4
	Social and Institutional Capacity	77.7	36.1	83.5	52.3	52.1	29.6	44.4
	Global Stewardship	57.5	63.6	49.4	31.4	54.5	26.8	52.2
Average values of other characteris-tics	GDP/capita	$27,480	$420	$29,860	$4,390	$2,980	$3,810	$1,730
	Population (millions)	33.6	19.0	46.1	11.8	21.2	20.7	149
	Total Area (thousand square kilometers)	171	539	3,466	123	102	156	1,010
	Population Density (per square kilometer)	238	70.3	13.5	122	32.1	56.0	174
	Environmental Governance Indicator (z-score)*	1.0	-0.5	1.0	0.2	0.1	-0.6	-0.2

** Note: Higher z-scores correspond to more effective environmental governance.*

Cluster 1 represents relatively high population density industrialized countries with above average social and institutional capacity. Cluster 2 groups the least-developed countries, most of whom experience relatively low environmental stress, but have very weak institutional capacity and are particular vulnerable to natural disasters, undernourishment, and lack of sanitation and safe water supply.

Distinct from the first set of developed countries, Cluster 3 is formed by large land area, low population density countries with low levels of vulnerability and well-developed institutional capacity. Cluster 4 encompasses many of the countries of the former Eastern Bloc along with a handful of other nations (Jamaica, Lebanon, Trinidad & Tobago, and Turkey) who have similar patterns of moderate systems and environmental stresses and relatively low human vulnerability.

Cluster 5 brings together a large number of Central and South American countries, along with a few African countries, which all show relatively strong environmental systems, and middle-tier results with regard to their vulnerability and capacity. Cluster 6 includes Russia and the most ecologically burdened of the former republics of the Soviet Union along with a number of Middle Eastern countries (and a few other nations) who have average environmental systems, stresses, and human vulnerability but very low capacity and global stewardship. Cluster 7 covers largely high population density, middle-tier developing countries with strained ecological systems but middle-range scores across the rest of the components.


Cluster Analysis
ESI Characteristic-Based Country Groupings
Robinson Projection
Cluster Component Characteristics
1 Low system and stress scores; low vulnerability and high capacity; moderate stewardship
2 Moderate system and stress scores; high vulnerability and low capacity; above average stewardship
3 Above average system score; low vulnerability; high capacity; moderate stresses and stewardship
4 Moderate system, stresses, and capacity scores; low vulnerability and stewardship
5 Above average system score, moderate stresses, vulnerability, capacity, and stewardship
6 Moderate system, stresses, and vulnerability scores; low capacity and stewardship
7 Low system score; moderate stresses, vulnerability, capacity, and stewardship

ESI in Action

Because the ESI was the first effort to rank countries according to their environmental sustainability, it generated considerable attention. Approximately 100,000 downloads of the 2002 ESI report were recorded at Columbia University servers, and the report was made available through other websites as well. The ESI website has been widely read and linked from many locations. It is the second site listed in a Google search for the phrase "environmental sustainability." This attention itself illustrates the desire for information and quantitative metrics of environmental sustainability.

In the course of the five years since the release of the pilot ESI, many countries have used the ESI as a policy guide. Their experiences provide a powerful logic for further efforts to refine the ESI and other environmental indicator efforts. We highlight some of these experiences below.

Mexico's low ranking in the pilot 2000 ESI sparked a cabinet-level review within the country ordered by President Ernesto Zedillo who had read an account of the ESI in *The Economist.* An exchange of visits took place between the ESI team and Mexico's environment and natural resources ministry, SEMARNAT, in order to explain the ESI methodology and data sources and to demonstrate how the ESI's measures related to

Box 4: The Environmental Sustainability Index in the Philippines

The Environmental Sustainability Index as a basic conceptual and analytical framework has now been introduced to the discourse on environmental policymaking in the Philippines. As Member of the Committee on Appropriations and Vice-Chair of the Committee on Ecology, I learned of the ESI and argued for its inclusion as a framework for discussion in budget hearings for Department of Environment and Natural Resources (DENR) and its enforcement arm, the Environmental Managment Bureau (EMB). Noting the consistently dismal ranking (the lowest among the countries in Southeast Asia) of the Philippines, I insisted again on the government using the ESI as a policy tool in budget hearings in subsequent years.

In advancing the Philippines Clean Air Act, I proposed that the ESI and its measurement criteria be utilized as a benchmark for the assessment and evaluation of environmental policies and sustainability in our country. In a span of four years, two Secretaries of the DENR took careful heed of such proposals and instructed mid-level DENR directors to view and adopt the ESI – in whole or in parts – as a helpful, albeit tentative, gauge of the department's performance. While the DENR has stopped short of formally institutionalizing the ESI, the focus on quantitative measurement of performance has become integral to the decisionmaking and evaluation processes within the department.

As the new Chair of the Committee on Ecology in the House of Representatives, I have renewed the call for government to be more serious about measuring the efficacy of programs and policies on a range of environmental issues and sectors. With the dearth of data-driven environmental indices in the country, the ESI could well provide a reasonably sound basis for judging which technologies, approaches, strategies and regulatory mechanisms are effective or in need of improvement or overhaul. I am confident that the Philippine government will see fit to move towards more empirically based policy-formulation – notably in the environmental realm, with the ESI as an example.

Neric Acosta
Congressman, Philippine House of Representatives
Chair, Committee on Ecology (2004 - present)
Manila

environmental activities within Mexico. One of the most immediate consequences of this review was a high-level delegation from Mexico that visited the World Bank and the World Resources Institute to explore more effective ways to have their publications reflect recent Mexican data.

After Vicente Fox's election as President of Mexico in 2000, Mexican interest in the ESI intensified. Victor Lichtinger, Fox's first Environment Minister, put in place a set of policy reforms that prominently featured quantitative environmental sustainability metrics. In addition, reforms were adopted providing for enhanced transparency concerning environmental information.

Mexico has failed to fully implement Lichtinger's metrics-based sustainable development strategy. Nonetheless, the environmental policy agenda within Mexico has been permanently altered. Sustainability indicators now receive much more attention, and this sensitivity is seen within the private sector as well as the government. The Mexican Business Council on Sustainable Development released a set of state-level sustainability indicators in 2001.

South Korea embarked on a similar set of internal evaluations stemming from its 8th from bottom ranking in the 2002 ESI. The Ministry of Environment carried out a study examining the factors accounting for the low rank, and invited a representative from the ESI team to visit the country to meet with members of government, industry, civil society, and academia. The country sent two environmental policy experts from the Korea Environment Institute to spend a month with the ESI team learning the ESI methodology. The government adopted a strategic plan aimed at improving its rankings in a number of high-profile global indices, including the ESI. Special attention was paid to water policy and to patterns of international collaboration.

The United Arab Emirates, ranked second from the bottom in the 2002 ESI, launched a major internal review to explore the reasons for its low position and brought two members of the ESI team to the country for a series of high-level meetings. The most concrete response came from the Emirate of Abu Dhabi, which launched a regional initiative to dramatically improve the ability to monitor and communicate environmental conditions. This initiative, formally launched at the 2002 World Summit on Sustainable Development, is now being implemented.

Belgium ranked far below other European countries in the 2002 ESI, which triggered substantial media attention and political inquiry, including parliamentary hearings. The environmental authorities, particularly those in the Walloon region, undertook an issue-by-issue review of the ESI. This effort helped to identify a number of problems related to the gathering and reporting of environmental data, as well as raising a number of important theoretical questions about the construction of the ESI. The Walloon authorities recalculated the ESI based on updated data for Belgium but found that their nation still lagged other EU countries. This result spurred a focus on various policy shortcomings in Belgium, including the division of responsibilities among Belgian, Flemish, and Walloon authorities.

The Global Environmental Monitoring System Water Program (GEMS Water) has been an important source of data for the ESI because it is the primary source of comparable international information on surface water quality. The ESI reports were straightforward in their assessment that the suitability of the GEMS Water data for comparing water quality across nations was very low. In the past, very few countries provided data to the program and the data were difficult to obtain. When the 2003 World Water Development Report reprinted the 2002 ESI water quality indicator data, it drew attention to water quality data issues. Some governments were unhappy with the fact that the data table included only estimates of water quality where data was missing from GEMS Water. Others were dissatisfied with the fact that some countries reported data from a large number of water monitoring stations whereas others reported only a small number.

These complaints drew high-level attention to the serious deficiencies in the GEMS Water program, and played a significant role in a strategic effort to build the program into a more robust repository of relevant water quality data. A major drive was launched to bring new countries into the program. The approach shifted from passively receiving data from countries to actively requesting data updates on a regular basis. In addition, the data was made much more easily accessible. As a result of these changes, participation in GEMS Water has grown from less than 40 countries when the ESI first started using the data to over 100 countries today, although data coverage is still low. While the ESI cannot take credit for this shift, it did contribute to it by aggregating the GEMS Water data into national indicators and raising those indicators to high prominence.

Scholarly studies have made use of the ESI data to facilitate quantitative exploration of environmental phenomena. A partial list of known citations is provided in Appendix I. Globerman and Shapiro (2002), for example, modeled foreign direct investment flows as a function of governance structures and of environmental and development outcomes, and utilized the ESI effectively as a proxy for environmental outcomes. Several studies have sought to compare the ESI to alternative sustainability measures (Parris and Kates 2003), or as a benchmark by which to evaluate new indicators (Sutton 2003). Some studies have made use of components of the ESI in order to construct new indicators for other purposes (Birdsall and Clemens 2003). The ESI has also been used for pedagogical purposes allowing educators to create quantitively-based themes related to environmental stewardship.

Limitations

The results of the 2005 ESI should be seen as a relative gauge of environmental performance and a tool for highlighting policy issues that need to be addressed. The resulting rankings are subject to a number of uncertainties and qualifications. Our knowledge of environmental sustainability is incomplete, and our ability to draw precise conclusions is hampered by additional elements of uncertainty such as measurement error and missing data.

We do not have sufficient information to estimate the uncertainty due to knowledge gaps and measurement problems, but we can estimate the degree of error due to missing data. Although it underestimates the true uncertainty associated with the ESI scores, in Appendix A we report the variability in the ESI scores and ranks due to incomplete data as a measure of the level of confidence that can be placed on the ESI.

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Chapter 4 – Sensitivity Analysis

The robustness of the ESI cannot be fully assessed without evaluation of its sensitivity to the structure and aggregation methods utilized. To test this sensitivity, the ESI team launched a partnership with the Joint Research Centre (JRC) of the European Commission in Ispra, Italy. A short version of their findings is below. The more detailed version is included in Appendix A.

2005 ESI Sensitivity Analysis

Prepared by Michaela Saisana, Michela Nardo, and Andrea Saltelli (Applied Statistics Group), Joint Research Centre of the European Commission

Every composite index, including the ESI, involves subjective judgments such as: the selection of variables, the treatment of missing values, the choice of aggregation model, and the weights of the indicators. These subjective choices create the analytic framework and influence the message it communicates. Because such indices can send non-robust policy messages if they are poorly constructed or misinterpreted, it is important that their sensitivity be adequately tested.

Because the quality of a model depends on the soundness of its assumptions, good modeling practice requires evaluating confidence in the model and assessing the uncertainties associated with the modeling process. Sensitivity analysis lets one see the impact of the model frame by studying the relationship between information flowing in and out of the model (Saltelli, Chan et al. 2000).

Using sensitivity analysis, we can study how variations in ESI ranks derive from different sources of variation in the assumptions. Sensitivity analysis also demonstrates how each indicator depends upon the information that composes it. It is thus closely related to uncertainty analysis, which aims to quantify the overall uncertainty in a country's ranking as a result of the uncertainties in the model. A combination of uncertainty and sensitivity analyses can help to gauge the robustness of the ESI ranking, to increase the ESI's transparency, to identify the countries that improve or decline under certain assumptions, and to help frame the debate around the use of the Index.

The uncertainty and sensitivity analysis explores the effect of four main uncertainties/ assumptions in the ESI: (1) variability in the imputation of missing data (2) equal v. expert weighting of indicators (3) aggregation at the indicator v. the component level, and (4) linear v. non-compensatory aggregation schemes.

The main findings are summarized below. The detailed methodological approach and results are given in Appendix A.

Overall, the ESI shows only modest sensitivity to the choice of aggregation, indicator weighting, and the imputation procedure. For most countries, the possible scores and ranks are rarely at odds with their actual ESI score when tested against various combinations of assumptions in the sensitivity analysis. For 90 out of 146 countries, the difference between the ESI rank and the most likely (median) rank is less than 10 positions, given that all sources of uncertainty are simulated simultaneously. This outcome implies a reasonable degree of robustness of the ESI.

Which countries have the most volatile ranks and why? The top ten ranking countries in the ESI all have modest volatility (2 to 4 positions in the ranking) with the exceptions of Guyana (23 positions) and Argentina (9 positions). This small degree of sensitivity implies a very limited degree of uncertainty about the ESI scores for these countries. Guyana's high volatility can mainly be attributed to imputation uncertainties (28 variables out of 76 have been imputed) as well as the choice of the aggregation level. Argentina's volatility is entirely due to imputation, although only 5 variables have been imputed. The countries with the highest volatility (50 to 80 positions) are found between rank 39 (Congo) and rank 113 (Dem. Rep. Congo), which is partially due to the conversion of tightly bundled ESI scores to equidistant ranks.

Would the ESI be more stable and useful if no imputation had been carried out? Imputation allows us to include many countries in the ESI that would otherwise have to be dropped for lack of data – and it reduces the incentive for a country to fail to report data in categories where its performance is weak. Imputation, however, reduces to some degree our confidence in the accuracy of the scores and rankings. Imputation affects countries with larger amounts of missing data more than others. But this relationship is not entirely straightforward. Among the countries that are missing almost 33% of the observations, only Guinea-Bissau and Myanmar are highly susceptible to rank changes due to imputation. If no imputation had been applied, Syria, Algeria, Belgium and Dominican Republic would have improved by between 9 and 37 positions. Conversely, Mali, Guinea-Bissau, Myanmar and Zambia, would go down 27 to 44 positions. Overall, imputation creates an average uncertainty of 10 ranks.

What if a "non-compensatory" aggregation scheme had been used, instead of the linear aggregation scheme? Aggregation schemes matter mainly for the mid-performing countries. When the assumption of compensability among indicators is removed, countries having very poor performance in some indicators, such as Indonesia or Armenia, decline in rank, whereas countries with fewer extreme values, such as Azerbaijan or Spain, improve their position. Overall, the aggregation scheme methodology has an average impact of 8 ranks.

What if aggregation had been applied at the component level instead at the indicator level? Weighting the 5 components equally versus weighting the 21 indicators equally has only a small effect on most countries. But a few are significantly affected. For example, Belgium and South Korea improve their rank by almost 40 positions if aggregation is done at the component level. However, countries such as Congo or Nicaragua decline by 30 positions. This movement is can be traced to the fact that aggregation at the component level gives added weight to the components with fewer indicators (e.g., Reducing Human Vulnerability and Global Stewardship). Overall, the assumption on the aggregation level has an average impact of 8 ranks, similar to the impact of the aggregation scheme.

What if a set of expert-derived weights had been used for the 21 indicators instead of the equal weighting? An alternate weighting obtained by surveying the experts at the December 2004 ESI Review Meeting assigns slightly higher values to indicators within the System and Stress Components of ESI and less to the remaining indicators. Using these weights has a pronounced positive effect on the rank of a few countries such as Sri Lanka and Niger, but a negative effect on others such as the Chile, South Africa or Italy. Overall, the analysis shows only a small sensitivity to the weighting assumption with an average impact of 5 ranks.

Chapter 5 – Conclusions and Next Steps

The ESI is fundamentally a policy tool designed to make environmental decisionmaking more empirical and analytically rigorous. It provides a way to benchmark performance, highlight leaders and laggards on an issue-by-issue basis, and facilitate efforts to identify best practices. In these regards, the ESI represents an important step forward. But the data on which the ESI builds are crude and patchy, and the methodologies for combining data sets into a single index continue to be refined.

Measuring trends with respect to environmental sustainability is a conceptually difficult and ambitious undertaking. We recognize the many layers of uncertainty surrounding the measurement of environmental sustainability: the lack of a clear definition of the concept and benchmarks against which to verify current performance; the need to fold into a common metric the past, the present, and the future; the implicit assumptions and judgments made in the selection of the variables and indicators as well as their aggregation, and the uncertainty resulting from data gaps, including the possibility of failing to measure important aspects of environmental sustainability.

Yet, local, regional, and global environmental problems are increasing at a rate and scope that demands new approaches to facilitate action. As a "process," the ESI is designed and made available to the public in a transparent way. Its imperfections are openly acknowledged and discussed. Its use as a sustainability measure is largely constrained to serving as a tool for policymakers to signal trends in environmental pollution, natural resource use, environmental health, social and economic factors as well as international environmental law and policy. Although the ESI score provides a snapshot view of the relative position of countries, more informative analysis derives from the 21 indicators and underlying data sets. Simply put, no country will achieve sustainability by tracking the ESI score alone. Identifying the areas for improvement using the ESI's stepwise hierarchy offers a more fruitful approach to policy progress.

The problem of persistent data gaps, slow adoption of remote sensing and GIS technology for environmental monitoring, and incompatible methodologies constitute the most serious impediment to giving a full and unbiased picture of environmental sustainability trends. The quantitative basis is stronger in OECD countries than in many low-income nations especially in Africa and Asia. Consequently more data need to be imputed to calculate the indicator, component, and ESI values in these countries. The gaps and our imperfect means of filling them increase the uncertainty associated with the results.

Despite the data gaps, the statistical foundation of the 2005 ESI represents a significant refinement from earlier editions of the ESI. We made more extensive use of statistical modeling and analysis techniques to (i) impute missing data (ii) investigate similarities and differences among the countries with respect to their environmental performance and socio-economic driving forces (iii) understand better the relationships between the variables and indicators in the ESI, and (iv) rigorously test the sensitivity of the ESI to the implicit and explicit assumptions and methodological choices made. The results have facilitated several improvements to the ESI's construction as well as its interpretation.

The variables included in the ESI have also been updated with new data sets, more recent information, and extended geographical coverage by merging different data sources where possible and by developing new variables based either on new data initiatives or our own design. The country review of the ESI data has provided updated data and useful feedback, which have improved the ESI substantially.

Although we cannot determine with any satisfactory level of accuracy the precise position of a country on an overall basis, we can identify clearly the leaders and the laggards. Seen in this context, the ESI has proven to be a useful gauge of national environmental stewardship, providing a valuable counterpart and counterpoint to GDP growth as a metric of governmental policy "success."

We cannot say with confidence that any country is currently on a sustainable trajectory. Indeed, we do not have established benchmarks against which to measure long-term sustainability. But the variables and indicators in the ESI shed light on a range of unsustainable pollution and consumption paths. Every country faces serious pollution problems and is experiencing unsustainable levels of consumption of some natural resources. There are, however, significant differences in the progress toward sustainability within different societies. By assembling a broad array of data and metrics on a basis that makes cross-country comparisons possible, the ESI provides a powerful benchmarking tool and a valuable mechanism for identifying leading performers on each issue and isolating the best practices which they follow.

The ESI also helps to highlight some of the critical factors that shape environmental performance including: the quality of governance, the lack of corruption, and low population density. Some of these variables have long been identified as theoretically important. The ESI provides empirical support for these theories.

While environmental sustainability has become a buzzword, the concept of sustainability – with its combination of past, present, and future timeframes – inescapably presents some serious methodological complexities. The concept is dynamic and requires constant monitoring and re-adjustment. On the country level, sustainability is affected strongly by natural resource endowments, past development paths, current and future pressures, and capacities to deal with them. To provide policymakers with more immediate feedback on their current policy performance, a more focused index and set of indicators will be needed.

With this goal in mind, the ESI team plans to develop an environmental policy barometer that gauges more narrowly the impacts of current environmental policies, including pollution control, natural resource use and management, and environmental health regulations, on environmental outcomes such as air and water quality, land and habitat protection, exposure to environmental toxins, and the provision of global public goods. The project aims at supporting the Millennium Development Goals, specifically Goal 7 "Ensuring Environmental Sustainability." The new initiative will center on a system of target-oriented indices that track performance of countries towards the established policy goals.

Future Directions

While the ESI represents the state of the art in performance measures of environmental sustainability, it has limitations as a policy-making guide. We see a number of directions for future work, both technical and institutional.

All indices are handicapped by the poor quality and coverage of available data, with inconsistent methodologies, poor time series, and significant gaps, particularly for developing countries. There is no simple centralized solution to this problem. It requires a long-term effort by many partners. Each individual data set for a variable should be the responsibility of an appropriate organization that can ensure its quality control and regular updating. Governments need to recognize their primary responsibility for data collection. Public investments in data collection are more than repaid in improved decisionmaking. International assistance needs to be provided to countries without the capacity or resources to collect all the data necessary. Better coordination is needed among the providers of data sets.

This effort should be extended to build new data sets for key variables and indicators that should be in the ESI but had to be omitted for lack of adequate data. There is a particular gap in measures of sustainable resource management in productive activities, such as agriculture, forestry, and fisheries. New technologies such as remote sensing and automated monitoring stations are making it possible to produce new uniform global data series for various environmental parameters. In this regard, we believe that collaboration among the new Global Earth Observation System of Systems (GEOSS), the Integrated Global Observing Strategy (IGOS) Partnership and the various global observing projects to define and generate new data sets will better capture aspects of environmental sustainability, such as land use and vegetation changes, soil degradation, salinization, and air and water pollution.

Filling the gaps in the ESI will both help to move towards an ideal ESI, which would include all critical environmental parameters, and improve the balance and weighting of variables and indicators within the ESI. We are also committed to engaging with others who may be in a position to help eliminate data gaps.

Data availability has limited the ESI to "snapshot" measures at a single point in time, yet sustainability has much to do with dynamic changes and trends over time. We will work to develop the variables as time series data that can give the direction and speed of change, and thus the distance to sustainability targets. For some variables, this target will be reducing a damaging activity or pollutant to minimal levels; for others, sustainability will mean striking a balance between two undesirable extremes, and each variable should be scaled accordingly.

The ESI is not yet mature enough to begin comparing ESI values between editions. There are too many refinements in the methodology and improvements in variables for such comparisons at present. This flux will probably continue for some years. However, it is possible to back-calculate the ESI for previous years using the latest methodology and variables, in order to begin measuring not only the relative performance between countries but also how each country's performance is changing over time.

Finally, the production of the index itself needs to be put on a sustainable basis through better institutionalization. While it is quite appropriate that innovative measures like the ESI should be developed in an academic setting, an operational index for regular use by governments will be more credible if it becomes the responsibility of an appropriate international organization.

We hope to build the interest of governments in the ESI, and with their support discuss with intergovernmental bodies such as UNDP, UNEP, and the UN Statistics Division where an operational ESI might best be situated. Support for the ESI, and the development of various derivative products, could also be explored with other global and regional intergovernmental bodies and specialized agencies. Non-governmental organizations such as the World Resources Institute and Redefining Progress (with its Ecological Footprint) should also be involved, as should the private sector through organizations such as the World Economic Forum.

To build the case for the continued financing of the production of the ESI, and the generation of the necessary data series, some attention should be given to cost-benefit analyses of more data-driven decisionmaking. One of the goals of the ESI is to show the advantages of better science-based information. Some case studies of its impact on government decisionmaking processes and the resulting benefits would facilitate the transition of the ESI from an academic research program to an operational tool for decisionmaking.

The ESI is still a work in progress, but it has reached the point where it provides a credible measure of relative government performance on many of the short- and medium-term actions necessary to achieve environmental sustainability. With continued improvement, it will grow in validity and impact – perhaps someday becoming as important a measure as GDP in assessing national progress.

Box 5: Directions for Further Work: Data "Drill Down"

One of the remarkable stories behind the Information Age is how much environmentally relevant data and knowledge are being generated and shared without any plan, government mandate, or structured set of incentives to promote innovation. The ability to sift information is beginning to become as important as the capacity to gather it, beginning at the global level tackled by the ESI. This is particularly true for the quantitative performance measures that increasingly drive companies, communities, and even individuals to gauge their relative environmental performance against relevant peer groups. Even where government collects useful information, "hybrid" regulatory strategies may split responsibilities across two or more administrative levels, fragmenting data collection and leading to inconsistent data categories and collection methodologies. International collators of environmental data have, in particular, yet to "drill down" systematically to subnational sources where much of the most critical performance information is to be found.

In short, information sources change as decisionmaking becomes more market-oriented and decentralized, but by definition newcomers don't fit the organizing principles or "schema" previously designed to assist in the identification and classification of globally relevant information. Although designed for efficiency, these sorts of information-processing strategies often yield systematic and predictable errors which, when magnified on a global level, can severely distort both how nations approach environmental decisionmaking and how they analyze and discuss improvements to the global system of environmental indicators. The ESI counters this tendency by not only permitting but also encouraging change in technical details (both variables and how they are synthesized into indicators) on how to measure progress toward environmental sustainability.

This bottom-up, evolutionary approach to indicators takes more time and money than repetition of standard sources and methods. It also risks changing overall results so much that not only the ESI but the objectivity of indicators in general can be called into question. Fortunately, even changing a number of variables and adding several indicators produced relatively few major changes in country rankings between the 2005 ESI and the 2002 ESI. Nevertheless, one direction for further work centers on devising a more systematic approach to changing variables and justifying changes so the ESI can show where better environmental data needs to percolate up from decentralized and market-oriented decisionmaking processes.

Some environmental problems cannot be resolved by improving information flows among decisionmaking processes — or even by generation of more and better information. Improved data and information will not address questions of distributional equity. Nor will information fix human limitations with regard to risk perception. Nonetheless, the Information Age creates the possibility of reduced information gaps and restructuring institutional arrangements to form an environmental protection regime that is more refined, individualized, and efficient (Esty 2004). Realizing the possibility may require that national governments (and the international institutions they create) devise a decentralized and market-oriented information strategy that identifies gaps by origin (for example, technical and analytic barriers, market failures, and institutional shortcomings) and then decides who should fill them and who should pay. The ESI might become a catalyst for such a strategy, by going beyond the "wish list" of better indicators that has been given in reports to date. Such taxonomy would also help to connect indicators to actions, clarifying who should act and what might be done to effect progress on a particular variable or indicator.

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Endnotes

[1] What we term Systems correspond to the DPSIR's State category. Our Stresses are largely the same as the Pressure measures, though we include a handful of Driving Forces, such as population growth rates. Our Vulnerability component corresponds closely with the DPSIR Impact category. In many ways, our Capacity component has much in common with the Response category of the DPSIR framework, but there is an important difference. The Response category typically is used to monitor deliberate social responses to environmental change, such as governmental policy or human behavior. It is usually seen as causally subsequent to the other elements of the DPSIR framework. In our case, we seek primarily to measure aspects of social and institutional capacity that will influence the nature of ongoing environmental stewardship. Many of the relevant measures in this regard are not strictly responses to environmental change. Rather they include independent measures of social strength that in many ways will shape environmental outcomes. The Global Stewardship component has no simple counterpart in the DPSIR framework, but rather deploys some of its elements within the category of global responsibility.

List of Acronyms

ASEAN	Association of Southeast Asian Nations
BA	Budget Allocation
BOD	Biochemical Oxygen Demand
CGSDI	Consultative Group on Sustainable Development Indicators
CFC	Chlorofluorocarbons
CITES	Convention on International Trade of Endangered Species of Wild Fauna and Flora
DJSGI	Dow Jones Sustainability Group Index
DPSIR	Driving Force-Pressure-State-Impact-Response
EcoValue 21	Innovest corporate environmental responsibility rating of companies
EM	Expectation Maximization
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
ESL	European Statistical Laboratory
EU	European Union
EVI	Environmental Vulnerability Index
EWI	Ecosystem Wellbeing Index
FSC	Forest Stewardship Council
GCI	Growth Competitiveness Index
GEMS	Global Environmental Monitoring System
GEOSS	Global Earth Observation System of Systems
GDP	Gross Domestic Product
HDI	Human Development Index
IGOS	Integrated Global Observation Strategy
IIASA	International Institute for Applied Systems Analysis
IISD Inventory	International Institute for Sustainable Development Compendium of Sustainability Indicators Initiatives
IPCC	Intergovernmental Panel on Climate Change
ISO 14001	International Organization of Standardization’s Environmental Management Standards
IUCN	World Conservation Union
LA21	Local Agenda 21
MAR	Missing at Random
MCAR	Missing Completely at Random
MCMC	Markov Chain Monte Carlo
MDGs	Millennium Development Goals
NEPAD	New Partnership for Africa’s Development

NIS	Newly Independent States of the former Republics of the Soviet Union
NO_x	Nitrogen oxides
OAS	Organization of American States
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PEFC	Pan-European Forest Certification Council
PLACE	Population, Landscape and Climate Estimates (CIESIN 2003)
POPs	Persistent Organic Pollutants
PPP	Purchasing Power Parities
PSR	Pressure-State-Response environmental policy model
SA	Sensitivity Analysis
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Secretariat of Envronment and Natural Resources, Mexico)
SO_2	Sulfur dioxide
SO_x	Sulfur oxides
UA	Uncertainty Analysis
UN CSD	Commission for Sustainable Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VOC	Volatile Organic Compounds
WWF	World Wildlife Fund

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Appendix A – Methodology

Appendix B – Country Profiles

Appendix C – Variable Profiles

Appendix D – Component & Indicator Scores

Appendix E – ESI Values in Small States

Appendix F – Comparison of the ESI to Other Sustainability Indicators

Appendix G – An Ideal Set of ESI Indicators

Appendix H – Critiques and Responses

Appendix I – Published Citations to the ESI