



Indicators from the Environmental Sustainability Index Related to Land Degradation

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What is the ESI?

- The ESI measures the *relative* progress of 146 countries towards sustainability
 - “The ESI score quantifies the likelihood that a country will be able to preserve valuable environmental resources effectively over the period of several decades.” (2005 ESI report, p.23)
- It is constructed from 76 variables aggregated to 21 indicators and 5 components
- It is developed on the premise the effective indicators **describe** problems, **diagnose** causes, **design** solutions, and **drive** action

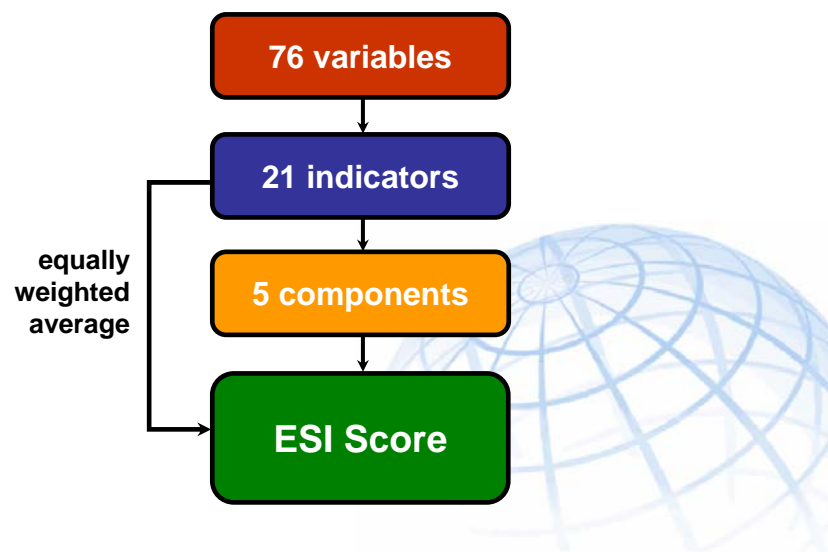
2005 Environmental Sustainability Index Partners



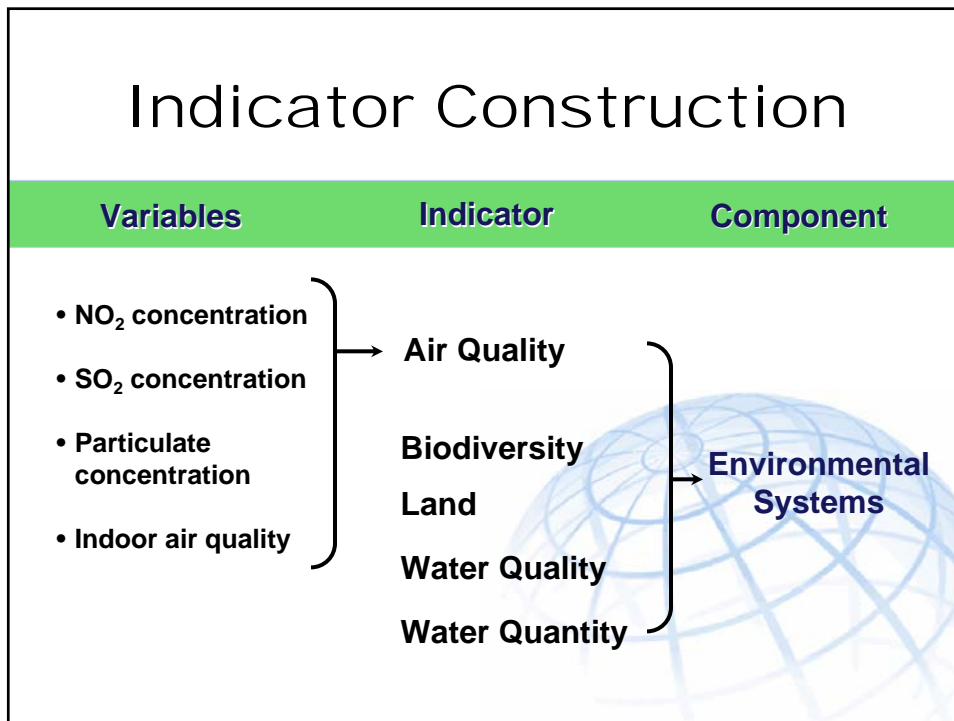
EUROPEAN COMMISSION
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Constructing the ESI



76 Variables		21 Indicators	5 Components	
•Nitrogen dioxide concentration •Sulfur dioxide concentration •Ecoregions at risk •Threatened birds •Threatened mammals	•Particulate concentration •Indoor air quality •Threatened amphibians •National Biodiversity Index	Air Quality Biodiversity	Environmental Systems	
•Wilderness area •Dissolved oxygen •Electrical conductivity •Surface water availability	•Developed area •Suspended solids •Phosphorus concentration •Groundwater availability	Land Water Quality Water Quantity		
•Coal consumption •Nitrogen oxide emissions •Sulfur dioxide emissions •Forest cover change	•VOC emissions •Vehicles in use •Acidification	Reducing Air Pollution Reducing Ecosystem Stress		Reducing Stresses
•Population growth •Ecological Footprint •Waste recycling rates •Industrial organic effluents •Fertilizer consumption •Overfishing •Sustainably managed forests •Market distortions	•Total fertility rate •Hazardous waste generation •Pesticide consumption •Area under water stress •Salinization due to irrigation •Agricultural subsidies	Reducing Population Pressure Reducing Waste & Consumption Pressures Reducing Water Stress Natural Resources Management		
•Deaths from intestinal infect. diseases •Child mortality rate •Malnutrition	•Child mortality due to respiratory infections •Safe drinking water supply	Environmental Health Basic Human Sustenance		
•Casualties due to environmental disasters	•Environmental Hazard Exposure Index	Exposure to Natural Disasters		
•Gasoline price •Corruption •Government effectiveness •Protected land area •Environmental governance •Strength of rule of law	•Civil and political liberties •Sustainable development data gaps •International environmental engagement •Environmental knowledge creation •Democratic institutions •Local Agenda 21 initiatives	Environmental Governance	Social and Institutional Capacity	
•Energy efficiency •Corporate sustainability (Dow Jones) •Corporate sustainability (Innovest) •ISO 14001 certified companies	•Renewable energy production •Private sector environmental innovation •Participation in Responsible Care Program	Energy Efficiency Private Sector Responsiveness		
•Innovation capacity •Digital Access Index •Female primary education	•University enrollment •Research scientists	Science and Technology		
•Intergovernmental environmental activities •Role in intl. environmental aid •Greenhouse gas emissions / GDP	•Participation in intl. environmental agreements •Greenhouse gas emissions / capita	Participation in International Collaborative Efforts Greenhouse Gas Emissions		Global Stewardship
•Transboundary sulfur dioxide spillovers	•Polluting-goods imports	Reducing Transboundary Environmental Pressures		



ESI Rankings

Top Ten

1	Finland
2	Norway
3	Uruguay
4	Iceland
5	Sweden
6	Canada
7	Switzerland
8	Guyana
9	Argentina
10	Austria

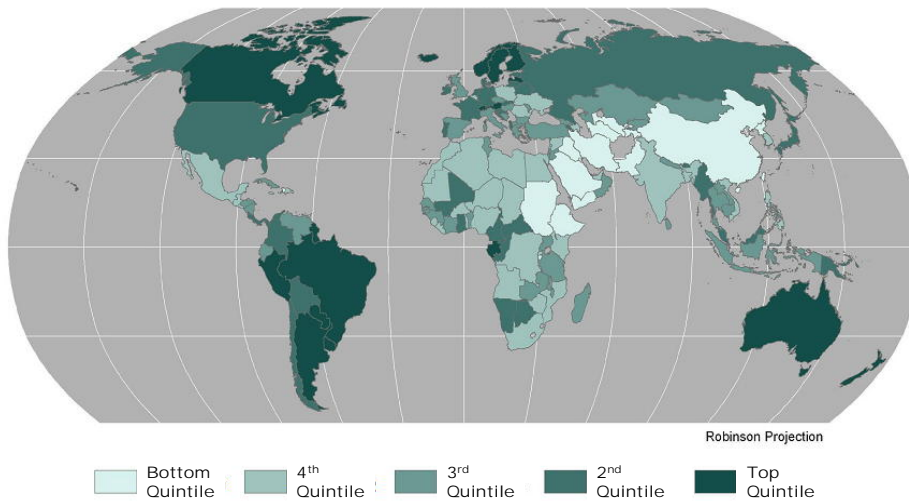
Other Countries

11	Brazil
31	Germany
33	Russia
36	France
45	U.S.A.
65	U.K.
93	South Africa
95	Mexico
101	India
133	China

Bottom Ten

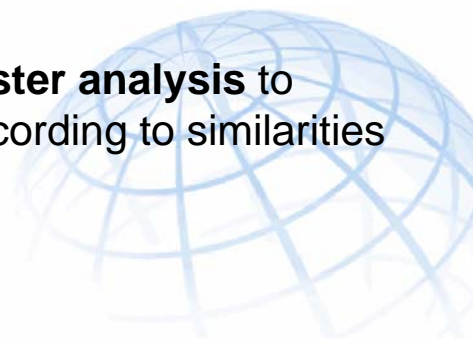
137	Yemen
138	Kuwait
139	Trinidad & Tob.
140	Sudan
141	Haiti
142	Uzbekistan
143	Iraq
144	Turkmenistan
145	Taiwan
146	North Korea

ESI Country Scores by Quintile

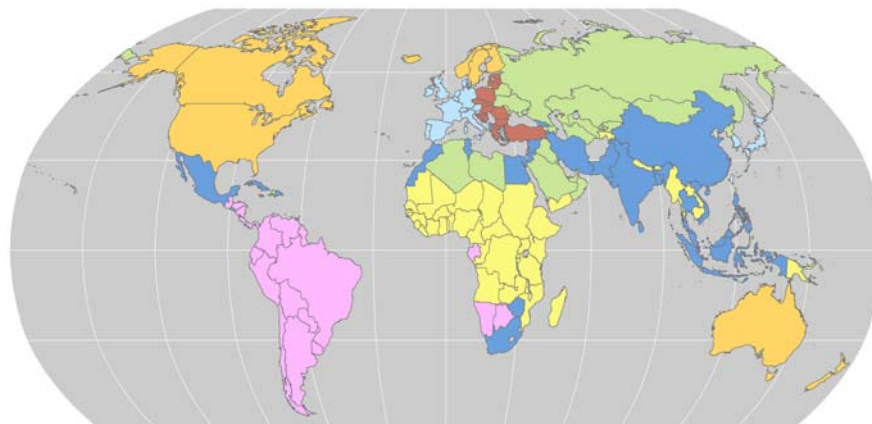


Peer-group Analysis

- Statistical analysis of similarities between countries allows to identify “**best practices**”, determine the **leaders** for any given issue
- 2005 ESI uses **cluster analysis** to group countries according to similarities in the 21 indicators



Cluster Analysis: ESI Characteristic-Based Country Groupings



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

Robinson Projection

Most influential factor for 2005 ESI: Governance

Most Highly Correlated variables with ESI

Variable	Correlation
Civil liberties	0.59
WEF environmental governance survey	0.54
Government effectiveness	0.51
Democratic institutions	0.50
Rule of Law	0.50
Participation in intl. Environmental agreements	0.49

Assessing Land Degradation Using ESI Variables

- **Agricultural Land:**
 - Fertilizer consumption per hectare (100 gr./ha)
 - Pesticide consumption per hectare (100 gr./ha)
 - Salinized lands as % of irrigated land area
 - Agricultural subsidies (scale from 1 to 8, with 8 highest)
- **Forests**
 - Forest certification (% forests under FSC and PEFC)
 - Deforestation (% annual change 1990-2000)
- **Water:**
 - Water quality indicator (combined DO, PH, SS, and EC)
 - Water availability (1,000 cubic meters per person)
 - Water stress (% territory in which consumption >40% avail.)

Sample Results

- 115 ESI countries in Africa, Asia, Latin America, and Eastern Europe & former Soviet Union
- Results are only indicative



Fertilizer Use per Hectare Arable Land (100 gr/ha)

Countries with greatest application

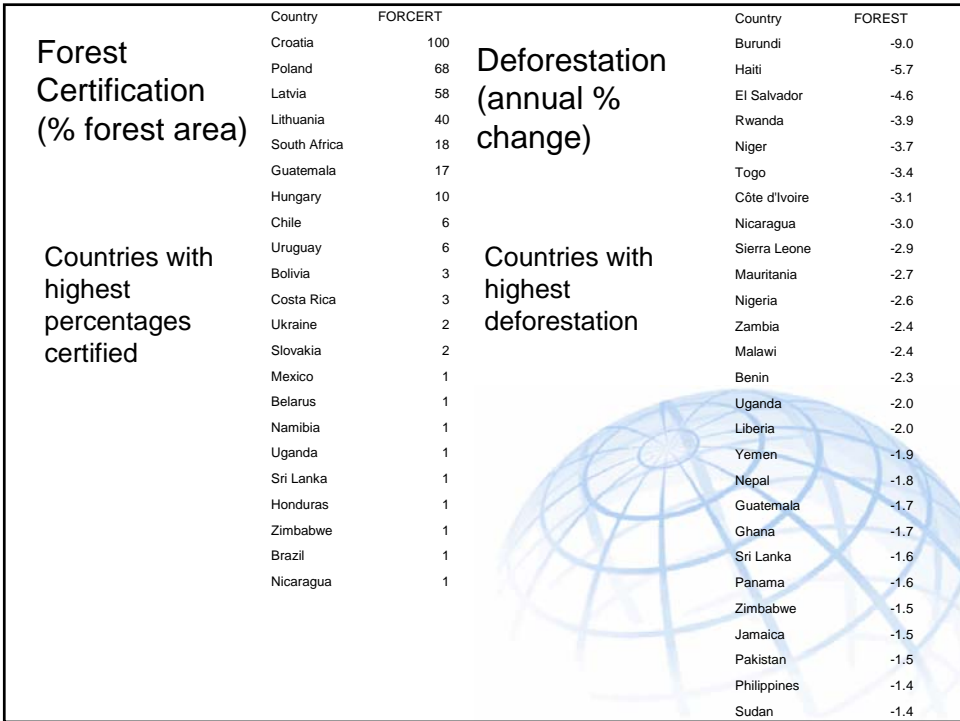
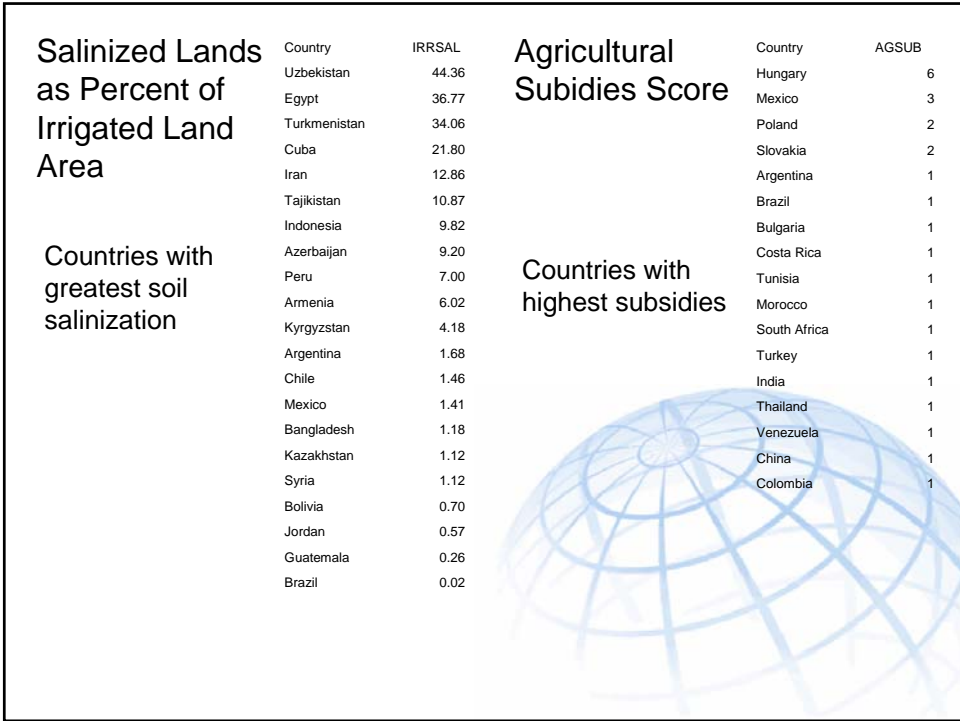
Country	FERTHA	
Malaysia	6,281.76	= 628 kg/ha
Costa Rica	5,686.67	
Egypt	4,574.16	
Lebanon	3,210.77	
Viet Nam	3,075.69	
Sri Lanka	2,616.54	
Colombia	2,545.31	
China	2,463.03	
Chile	2,426.84	
Bangladesh	1,675.70	
Oman	1,576.58	
Uzbekistan	1,545.82	
Croatia	1,474.98	
Ecuador	1,423.46	
Honduras	1,418.54	
Philippines	1,382.95	
Pakistan	1,360.44	
Guatemala	1,345.18	
Belarus	1,272.22	
Indonesia	1,231.02	
Venezuela	1,154.73	
Brazil	1,150.60	
North Korea	1,148.00	
Thailand	1,144.67	
Poland	1,114.21	
El Salvador	1,108.70	
India	1,073.24	

Countries with least application

Country	FERTHA
Angola	0.00
Liberia	0.00
Bhutan	0.00
Cambodia	0.00
Rwanda	3.00
Central Afr. Rep.	3.11
Namibia	3.68
Sierra Leone	6.00
Gabon	9.23
Niger	11.10
Uganda	11.37
Madagascar	22.97
Kazakhstan	23.40
Mongolia	26.69
Ghana	27.57
Moldova	28.02
Gambia	32.00
Guinea	35.96
Burundi	38.89
Mauritania	40.98
Bolivia	41.79
Chad	48.61
Sudan	48.67
Kyrgyzstan	50.00
Tanzania	56.25
Mozambique	62.25
Zambia	69.20

6.25 kg/ha =






Water Quality Score (z-score)		Country	SYS_WQL	Country	SYS_WQL
Countries with highest scores		Russia	1.11	Morocco	-1.93
		Guyana	1.06	Indonesia	-1.71
		Nicaragua	1.04	Pakistan	-1.48
		Gabon	0.78	Turkey	-1.12
		Oman	0.74	Iraq	-1.04
		Bolivia	0.70	India	-0.96
		Macedonia	0.69	Algeria	-0.89
		Congo	0.68	Burundi	-0.86
		Panama	0.63	Romania	-0.85
		Costa Rica	0.62	Haiti	-0.83
		Cuba	0.62	Nigeria	-0.81
		Cameroon	0.55	Tanzania	-0.79
		Mali	0.52	Uzbekistan	-0.78
		Uruguay	0.51	Mexico	-0.74
		Latvia	0.50	Moldova	-0.74
		Argentina	0.46	Ethiopia	-0.73
		Ecuador	0.39	Serbia & M.	-0.71
		Mongolia	0.39	Lebanon	-0.70
		Botswana	0.38	Iran	-0.69
		Croatia	0.37	China	-0.66
	Slovakia	0.36	Syria	-0.65	
	Central Af	0.35	Togo	-0.62	
	Cambodia	0.33	Ghana	-0.61	
	Bosnia and H.	0.31	Azerbaijan	-0.56	
	Jamaica	0.30	Honduras	-0.53	
	Namibia	0.28	Ukraine	-0.53	
	Malaysia	0.27	Benin	-0.48	

Countries with lowest scores

Note: this indicator utilized imputed data



Water Stress (% of land area with consumption >40% of supply)		Country	WATSTR
Countries with highest stress		Syria	100
		Nepal	97
		Azerbaijan	96
		Tajikistan	95
		Turkmenistan	94
		Kyrgyzstan	94
		Tunisia	92
		Egypt	89
		Iran	87
		Armenia	87
		Uzbekistan	87
		Iraq	86
		Lebanon	85
		Libya	84
		Morocco	82
		Jordan	81
		India	80
		Pakistan	76
		South Africa	68
		Algeria	68
	Turkey	64	
	Yemen	64	
	Kazakhstan	57	
	Bulgaria	55	
	Chile	52	
	Georgia	51	
	Oman	50	



Water Availability (1,000 cubic meters per capita)		Countries with least water availability	
Country	WATAVL	Country	WATAVL
Congo	543.29	Jordan	0.37
Guyana	299.98	Tunisia	0.66
Uruguay	265.04	Morocco	0.68
Gabon	192.75	Algeria	0.76
P. N. Guinea	151.70	Lebanon	0.88
Angola	140.46	Burkina Faso	0.96
Paraguay	110.27	Pakistan	1.01
Colombia	90.58	Oman	1.35
Bolivia	80.90	Libya	1.43
Liberia	75.03	Armenia	1.45
Laos	74.99	South Africa	1.48
Peru	65.42	Iran	1.49
Venezuela	60.50	Haiti	1.55
Central Afr. Rep.	57.73	Poland	1.75
Namibia	54.75	Sri Lanka	1.86
Brazil	53.07	China	1.88
Cambodia	45.74	Rwanda	1.88
Croatia	33.59	Ukraine	1.93
Nicaragua	32.07	India	1.94
Yemen	30.36	Egypt	2.18
Dem. Rep. Congo	30.36	Dominican Rep.	2.23
Ecuador	29.52	Cuba	2.28
Panama	28.89	Burundi	2.38
Mongolia	28.26	Syria	2.50
Sierra Leone	27.94	Ethiopia	2.51
Argentina	27.27	Uzbekistan	2.60
Russia	24.65	Kenya	2.65

Sub-Indices		Highest scoring countries			
Country	Ag Land Score	Country	Forest Score	Country	Water Score
Dem. Rep. Congo	0.49	Croatia	2.46	Congo	3.12
Cambodia	0.47	Poland	1.69	Guyana	2.00
Liberia	0.47	Latvia	1.47	Uruguay	1.63
Central Afr. Rep.	0.47	Uruguay	1.44	Gabon	1.35
Sierra Leone	0.46	Oman	1.37	P. N. Guinea	0.92
Gabon	0.46	Lithuania	0.98	Angola	0.77
Niger	0.46	Belarus	0.82	Paraguay	0.75
Madagascar	0.46	Egypt	0.82	Colombia	0.63
Angola	0.46	Kyrgyzstan	0.62	Bolivia	0.62
Rwanda	0.46	Kazakhstan	0.51	Nicaragua	0.61
Mongolia	0.46	South Africa	0.33	Russia	0.57
Namibia	0.46	Libya	0.29	Laos	0.55
Mauritania	0.46	Hungary	0.27	Central Afr. Rep.	0.52
Gambia	0.46	Algeria	0.26	Panama	0.46
Guinea	0.46	Armenia	0.26	Brazil	0.46
Chad	0.46	Bangladesh	0.26	Cambodia	0.45
Sudan	0.46	Azerbaijan	0.26	Costa Rica	0.43
Tanzania	0.46	Cuba	0.26	Cameroon	0.39
Mozambique	0.46	China	0.23	Croatia	0.38
Togo	0.45	Slovakia	0.20	Liberia	0.36
Guinea-Bissau	0.45	Gambia	0.18	Mongolia	0.35
Cameroon	0.45	Bulgaria	0.07	Macedonia	0.35
Mali	0.45	Tajikistan	0.04	Latvia	0.33
Ethiopia	0.45	Viet Nam	0.04	Namibia	0.31
Burkina Faso	0.45	Ukraine	0.04	Slovakia	0.30
Bhutan	0.45	Chile	0.03	Bhutan	0.29
Botswana	0.44	Romania	-0.03	Ecuador	0.29

Country	Overall Score						
Kazakhstan	0.14	Uganda	0.00	Malaysia	-0.16		
Congo	1.14	Slovakia	0.13	Ecuador	0.00	Côte d'Ivoire	-0.16
Uruguay	1.08	Mozambique	0.13	Albania	0.00	Nigeria	-0.18
Croatia	1.02	Guinea	0.12	Cuba	-0.02	Niger	-0.19
Guyana	0.75	Mali	0.12	Dominican Rep.	-0.02	Jordan	-0.19
Latvia	0.74	Bangladesh	0.11	Viet Nam	-0.02	Yemen	-0.20
Poland	0.62	Guinea-Bissau	0.11	Bulgaria	-0.03	Colombia	-0.20
Gabon	0.49	Chad	0.11	Georgia	-0.03	Azerbaijan	-0.21
Oman	0.49	Botswana	0.09	Zimbabwe	-0.03	Rwanda	-0.21
Lithuania	0.45	Guatemala	0.09	Libya	-0.03	Sri Lanka	-0.22
Belarus	0.41	Madagascar	0.09	Zambia	-0.04	Togo	-0.23
P. N. Guinea	0.37	Burkina Faso	0.09	Algeria	-0.05	Tunisia	-0.24
Angola	0.36	Myanmar	0.07	South Africa	-0.05	Tajikistan	-0.25
Bolivia	0.29	Romania	0.07	Sudan	-0.06	Turkey	-0.25
Central Af	0.28	Kenya	0.06	Armenia	-0.06	Indonesia	-0.25
Laos	0.26	Tanzania	0.06	Thailand	-0.06	Iraq	-0.26
Paraguay	0.25	Liberia	0.06	Honduras	-0.06	Syria	-0.28
Gambia	0.23	Moldova	0.05	Malawi	-0.06	India	-0.30
Russia	0.22	North Korea	0.05	Ghana	-0.07	Costa Rica	-0.31
Cambodia	0.22	Ukraine	0.05	Jamaica	-0.07	Egypt	-0.34
Bhutan	0.21	Panama	0.04	Philippines	-0.08	Iran	-0.35
Macedonia	0.20	Venezuela	0.04	Mauritania	-0.09	Mexico	-0.36
Bosnia & H.	0.19	Kyrgyzstan	0.04	Ethiopia	-0.09	Nepal	-0.37
Mongolia	0.19	Peru	0.03	Sierra Leone	-0.10	El Salvador	-0.38
DR Congo	0.18	Argentina	0.02	Hungary	-0.10	Pakistan	-0.45
Cameroon	0.16	Senegal	0.02	Benin	-0.11	Lebanon	-0.47
Namibia	0.15	Serbia & Montenegro	0.01	Chile	-0.12	Morocco	-0.50
Brazil	0.15	Nicaragua	0.01	China	-0.15	Haiti	-0.50

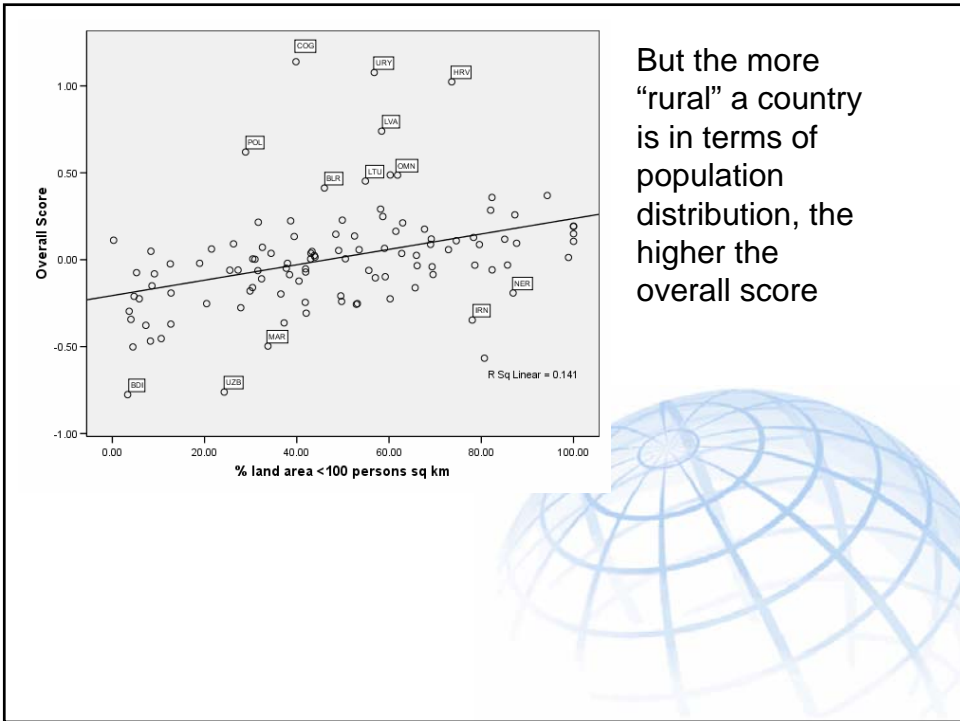
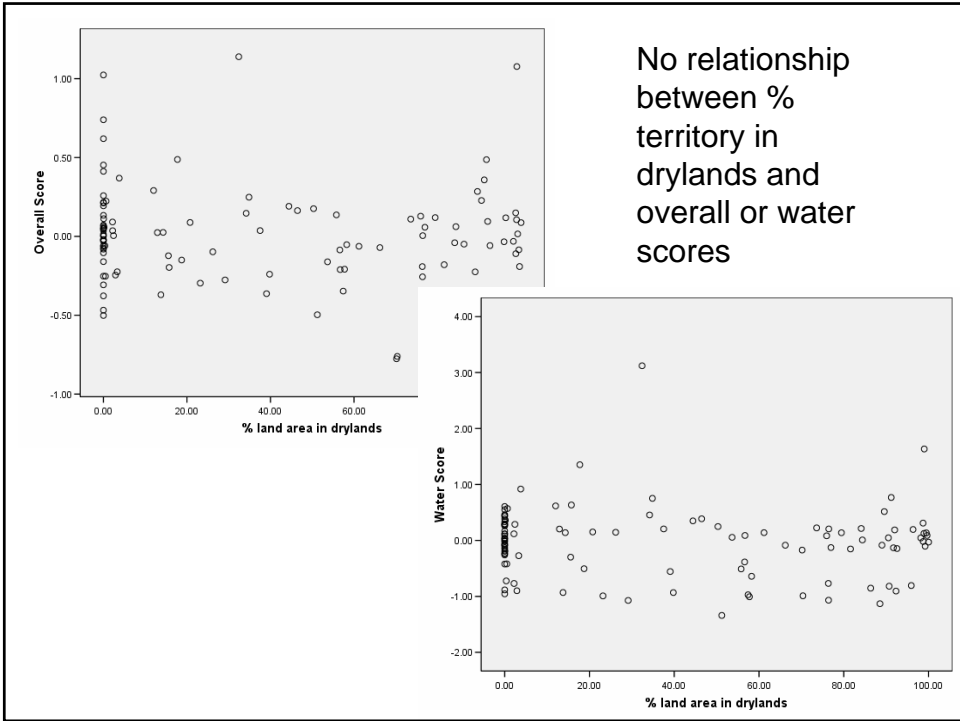
Average Scores by Region

Region	Agricultural Land Score	Forest Score	Water Score	Overall Score
East Asia & Pacific (n = 12)	.21	-.24	.14	.04
Europe & Central Asia (n = 25)	.15	.33	-.23	.08
Latin America & Caribbean (n = 22)	.05	-.30	.35	.03
Middle East & North Africa (n = 12)	.15	.09	-.85	-.20
South Asia (n = 6)	.28	-.26	-.54	-.17
Sub-Saharan Africa (n = 37)	.44	-.51	.20	.04

Color Coding

	= .10 - .50 above SD
	= .09 below - .09 above SD
	= .10 - .50 below SD
	> .51 below SD

Note: z-scores are calculated based on the full set of 146 ESI countries. Difference in means significant at .001 level



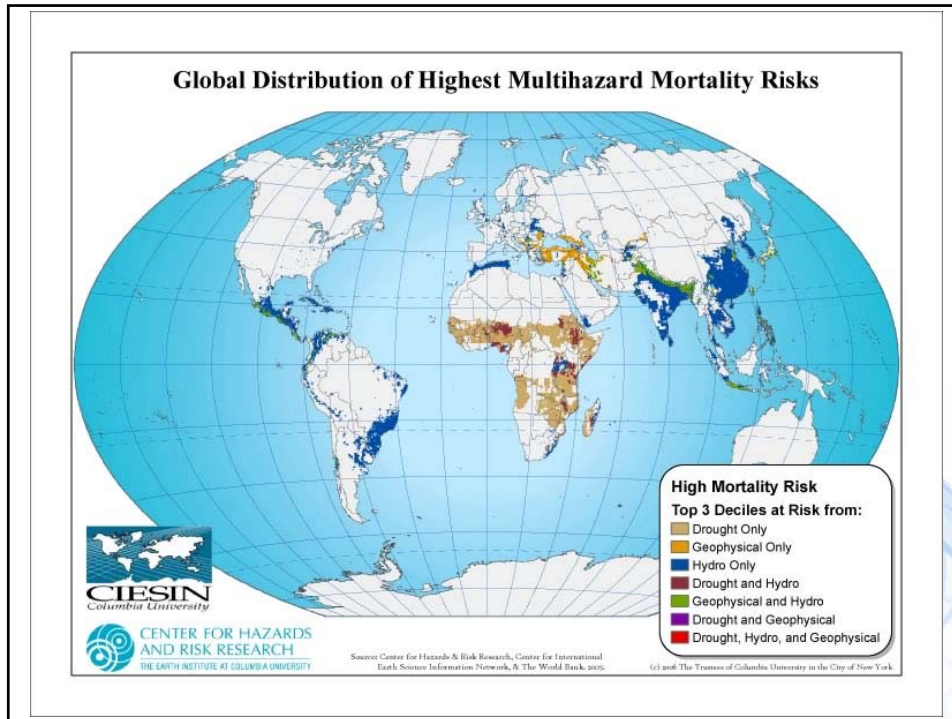
Potential New Variables

- % of irrigation that is unsustainable
- Drought related mortality (time series or area extent)



Country	UNUSIRR	Japan	30.53	Bulgaria	10.65
Saudi Arabia	99.94	Iran	30.25	North Korea	9.60
Yemen	99.94	Iraq	28.39	Brazil	8.13
Oman	95.38	Georgia	28.28	Venezuela	7.07
Libya	83.25	Algeria	27.45	Belarus	5.27
Morocco	80.54	Tunisia	27.23	Chile	4.93
China	70.53	Spain	27.08	Ecuador	4.58
Canada	63.34	Sri Lanka	26.40	Germany	4.41
Mexico	60.03	Malaysia	25.54	Mozambique	4.14
Mongolia	55.26	Italy	24.98	Dominican Rep	4.12
Peru	54.99	Chad	24.93	Ethiopia	4.12
Pakistan	54.21	Syria	23.13	Greece	3.29
South Africa	53.07	Afghanistan	21.00	Tanzania	2.57
Egypt	52.04	Turkey	20.81	Burkina Faso	2.51
Kazakhstan	50.51	Azerbaijan	20.72	Zimbabwe	1.64
Ukraine	47.46	Botswana	18.38	Uganda	1.07
Mauritania	45.60	Russia	17.06	Nigeria	0.67
USA	45.33	Poland	16.45		
Sudan	45.14	Somalia	16.37		
India	40.05	Namibia	15.39		
Gaza Strip	38.18	Australia	14.97		
Uzbekistan	36.97	Angola	14.72		
Jordan	35.34	Bolivia	14.64		
Turkmenistan	34.15	Cuba	14.13		
Argentina	32.72	Romania	13.30		
Kyrgyzstan	32.48	Kenya	12.74		
Mali	32.42	Hungary	11.35		
Niger	31.76	Madagascar	11.02		

Source: Univ. of New Hampshire Water Systems Analysis Group



ESI Approach

- Use **best available data**, but don't let "the perfect be the enemy of the good"; leverage poor quality or proxy data by combining several variables to provide a more accurate picture
- **Subnational variation** is important, so we derive selected indicators from spatial data sets (e.g., anthropogenic land impacts, water availability/stress, disaster vulnerability, % land area in threatened ecoregions)
- Index/component/indicator/variable structure allows users to "drill down" and **diagnose** the cause of low scores
- Given that science cannot yet guide us on an "objective" weighting scheme, weight indicators **equally**
- **Impute** data sparingly, where there is a clear correlation between the target variable and independent variables for which data are available
- Be **transparent** about data strengths and weaknesses
- **Challenge** the global community to invest more in monitoring and data development

Environmental Performance Index (EPI) Approach

- Identify performance targets for 16 indicators
- Measure each country's proximity to target
- Group indicators in 6 policy categories
- Focus on policy-mutable indicators; avoid measures that relate to natural endowments or past environmental impacts



The 2005 ESI is available at:

<http://www.yale.edu/esi>

For more on sustainability indicators visit:

<http://sedac.ciesin.columbia.edu/es/>

