

PENNSSTATE



Center for Statistical Ecology and Environmental Statistics

ON QUANTITATIVE FORMULATION OF NATIONWIDE HUMAN
ENVIRONMENT INDEX: VISUALIZATION, EVALUATION, AND
VALIDATION-II:

Proposed Human Environment Index in Light of Quantiles and Clusters Protocols

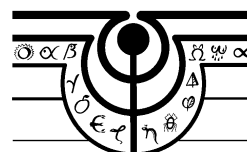
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On Quantitative Formulation of Nationwide Human Environment Index

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SECTION 1: QUINTILE METHOD

A simple way to compare different countries can be adapted from the magazine *Consumer Reports*. When rating products, *Consumer Reports* provides relative scores on performance or features to help the consumer decide which brand to purchase. Each indicator forming HEI could be considered as a guide to relative country performance for that particular aspect of environment condition.

All countries first are divided in five groups, according to the quintiles of the Air, Land and Water distributions. Tables showing countries rank according to the number of indicators belonging to the “best” or “worst” group are presented. The country ranks for each indicator are presented in *Consumer Reports* format. It is possible to get an idea of relative country conditions by reading across a row and observing the number of cells of a particular color. Countries dominated by green and brown are in better relative conditions than those dominated by yellow and red. The color scheme bright green, dark green, brown, yellow and red represent the first through fifth ranked groups of countries.

Quintile Analysis

Country	Air	Water	Land	# green	# red
Albania				1	0
Algeria				1	0
Angola				2	0
Argentina				0	0
Armenia				0	0

Australia	Yellow	Green	Dark Green	1	0
Austria	Dark Green	Green	Olive	1	0
Azerbaijan	Red	Red	Red	0	3
Bangladesh	Green	Green	Red	2	1
Belarus	Red	Green	Yellow	1	1
Belgium	Yellow	Red	Red	0	2
Benin	Green	Yellow	Green	2	0
Bolivia	Olive	Dark Green	Green	1	0
Brazil	Dark Green	Dark Green	Dark Green	0	0
Bulgaria	Red	Red	Red	0	3
Cameroon	Green	Olive	Green	2	0
Canada	Yellow	Green	Dark Green	1	0
Chile	Olive	Green	Dark Green	1	0
China	Olive	Yellow	Olive	0	0
Colombia	Green	Green	Dark Green	2	0
Congo, D.R.	Green	Yellow	Green	2	0
Congo, Rep.	Dark Green	Yellow	Green	1	0
Costa Rica	Green	Green	Dark Green	2	0
Czech Rep.	Red	Green	Yellow	1	1
Denmark	Olive	Dark Green	Red	0	1
Dominican Republic	Dark Green	Olive	Dark Green	0	0
Ecuador	Olive	Olive	Dark Green	0	0
Egypt	Yellow	Red	Green	1	1
El Salvador	Green	Olive	Yellow	1	0
Estonia	Red	Dark Green	Olive	0	1
Ethiopia	Green	Red	Dark Green	1	1
Finland	Yellow	Green	Green	2	0
France	Olive	Dark Green	Red	0	1
Gabon	Dark Green	Olive	Green	1	0
Georgia	Olive	Olive	Olive	0	0
Germany	Red	Yellow	Red	0	2
Ghana	Green	Olive	Dark Green	1	0
Greece	Olive	Dark Green	Yellow	0	0
Guatemala	Green	Green	Olive	2	0
Haiti	Green	Yellow	Yellow	1	0
Honduras	Green	Dark Green	Dark Green	1	0
Hungary	Yellow	Red	Red	0	2
India	Dark Green	Olive	Red	0	1
Indonesia	Olive	Dark Green	Olive	0	0
Iran	Red	Yellow	Dark Green	0	1
Ireland	Olive	Green	Red	1	1
Israel	Olive	Red	Yellow	0	1

Italy				0	0
Jamaica				0	0
Japan				0	0
Jordan				1	1
Kazakhstan				0	1
Kenya				0	0
Korea, South				0	0
Kuwait				1	2
Kyrgyzstan				0	0
Latvia				1	0
Lebanon				0	0
Lithuania				0	1
Malaysia				0	1
Mexico				0	0
Moldova				0	3
Morocco				2	0
Mozambique				1	0
Nepal				1	0
Netherlands				0	2
New Zealand				1	0
Nicaragua				0	0
Nigeria				1	0
Norway				2	0
Pakistan				0	1
Panama				0	0
Peru				2	0
Philippines				1	1
Poland				0	1
Portugal				0	0
Romania				0	2
Russia				1	1
Saudi Arabia				1	2
Senegal				0	0
Singapore				0	1
Slovakia				1	1
Slovenia				1	0
South Africa				0	0
Spain				0	1
Sri Lanka				1	0
Sweden				2	0
Switzerland				1	0
Syria				0	1

Tanzania	Green	Yellow	Olive	0	0
Thailand	Olive	Yellow	Red	0	1
Trinidad and Tobago	Red	Green	Red	0	2
Tunisia	Green	Red	Green	0	1
Turkey	Olive	Olive	Yellow	0	0
Turkmenistan	Red	Red	Green	0	2
Ukraine	Red	Yellow	Red	0	2
United Arab Emirates	Red	Red	Light Green	1	2
United Kingdom	Yellow	Green	Red	0	1
United States	Yellow	Green	Olive	0	0
Uruguay	Light Green	Light Green	Red	2	1
Uzbekistan	Red	Red	Olive	0	2
Venezuela	Red	Green	Light Green	1	1
Vietnam	Green	Yellow	Yellow	0	0
Yemen	Yellow	Red	Light Green	1	1
Zambia	Green	Olive	Green	0	0
Zimbabwe	Green	Green	Olive	0	0

Legend:

Rank	Color
1	Light Green
2	Green
3	Olive
4	Yellow
5	Red

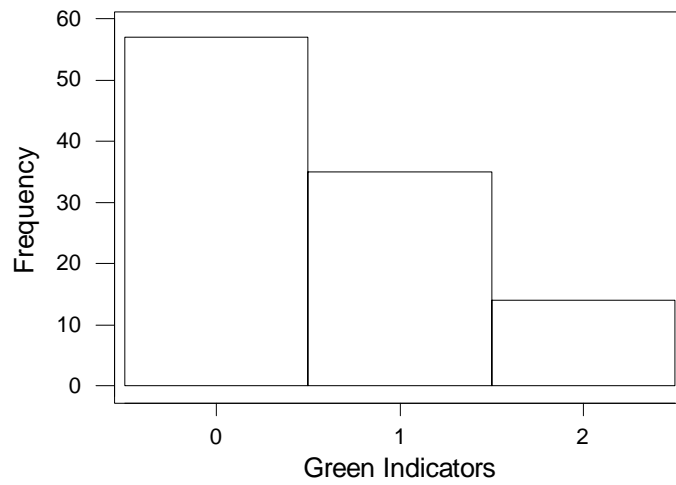
Countries Ranked by the Number of Green Indicators:

Rank	Number of Green	Number of Countries	Countries
1	2	14	Angola, Bangladesh, Benin, Cameroon, Colombia, Congo(Dem. Rep.), Costa Rica, Finland, Guatemala, Morocco, Norway, Peru, Sweden, Uruguay,
2	1	35	Albania, Algeria, Australia, Austria, Belarus, Bolivia, Canada, Chile, Congo(Dem.), Czech Rep., Egypt, El Salvador, Ethiopia, Gabon, Ghana, Haiti, Honduras, Ireland, Jordan, Kuwait, Latvia, Mozambique, Nepal, New Zealand, Nigeria, Philippines, Russia, Saudi Arabia, Slovakia, Slovenia, Sri Lanka, Switzerland, United Arab Emirates, Venezuela, Yemen
3	0	57	Argentina, Armenia, Azerbaijan, Belgium, Brazil, Bulgaria, China, Denmark, Dominican Republic, Ecuador, Estonia, France, Georgia, Germany, Greece, Hungary, India, Indonesia, Iran, Israel, Italy, Jamaica, Japan, Kazakhstan, Kenya, Korea(South), Kyrgyzstan, Lebanon, Lithuania, Malaysia, Mexico, Moldova, Netherlands, Nicaragua, Pakistan, Panama, Poland, Portugal, Romania, Senegal, Singapore, South Africa, Spain, Syria, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, United Kingdom, United States, Uzbekistan, Vietnam, Zambia, Zimbabwe

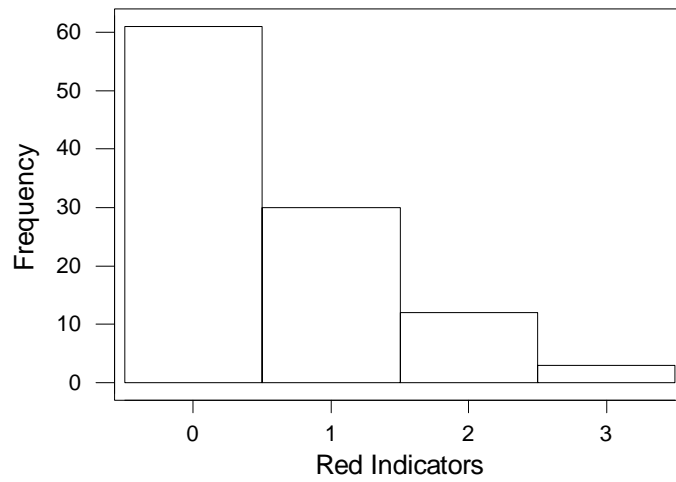
Countries Ranked by number of Red Indicators

Rank	Number of Red	Number of Countries	Countries
1	0	61	Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Benin, Bolivia, Brazil, Cameroon, Canada, Chile, China, Colombia, Congo (Dem. Rep.), Congo (Dem.), Costa Rica, Dominican Republic, Ecuador, El Salvador, Finland, Gabon, Georgia, Ghana, Greece, Guatemala, Haiti, Honduras, Indonesia, Italy, Jamaica, Japan, Kenya, Korea (South), Kyrgyzstan, Latvia, Lebanon, Mexico, Morocco, Mozambique, Nepal, New Zealand, Nicaragua, Nigeria, Norway, Panama, Peru, Portugal, Senegal, Slovenia, South Africa, Sri Lanka, Sweden, Switzerland, Tanzania, Turkey, United States, Vietnam, Zambia, Zimbabwe
2	1	30	Bangladesh, Belarus, Czech Republic, Denmark, Egypt, Estonia, Ethiopia, France, India, Iran, Ireland, Israel, Jordan, Kazakhstan, Lithuania, Malaysia, Pakistan, Philippines, Poland, Russia, Singapore, Slovakia, Spain, Syria, Thailand, Tunisia, United Kingdom, Uruguay, Venezuela, Yemen
3	2	12	Belgium, Germany, Hungary, Kuwait, Netherlands, Romania, Saudi Arabia, Trinidad and Tobago, Turkmenistan, Ukraine, United Arab Emirates, Uzbekistan
4	3	3	Azerbaijan, Bulgaria, Moldova

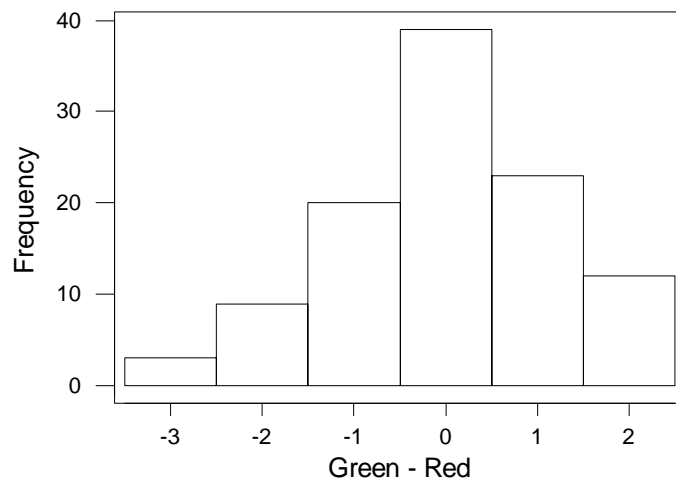
Histogram of Countries According to the Number of Green Indicators



Histogram of Countries According to the Number of Red Indicators



Histogram of Countries According to the Number of Green Indicators Minus the Number of Red Indicators



SECTION 2. CLUSTER ANALYSIS WITH LAND AIR WATER INDICATORS

A general question facing researchers in many areas of inquiry is how to *organize* observed data into meaningful structures, that is, to develop taxonomies. For example, biologists have to organize the different species of animals before a meaningful description of the differences between animals is possible. According to the modern system employed in biology, man belongs to the primates, the mammals, the amniotes, the vertebrates, and the animals. Note how in this classification, the higher the level of aggregation the less similar are the members in the respective class. Man has more in common with all other primates (e.g., apes) than it does with the more "distant" members of the mammals (e.g., dogs), etc. Cluster Analysis is a multivariate analysis technique that seeks to organize information about variables so that relatively homogenous groups, or "clusters," can be formed. The clusters formed with this family of methods should be highly internally homogenous (members are similar to one another) and highly externally heterogenous (members are *not* like members of other clusters).

In the analysis we performed, we used Euclidean distance and Ward linkage. Euclidean distance is probably the most commonly chosen type of distance. It simply is the geometric distance in the multidimensional space. It is computed as:

$$\text{distance}(x,y) = \{ \sum_i (x_i - y_i)^2 \}^{1/2} .$$

Ward linkage attempts to minimize the Sum of Squares (SS) of any two (hypothetical) clusters that can be formed at each step.

In the cluster analysis, we will use standardized variables. Therefore, we will get the same results using either the original indicators or the median rescaled indicators (each indicator is divided by the median of its distribution).

Standardized Variables, Euclidean Distance, Ward Linkage

Final Partition

Number of clusters: 5

	Number of observations	Within cluster sum of squares	Average distance from centroid	Maximum distance from centroid
Cluster1	38	42.893	0.964	2.329
Cluster2	29	18.161	0.759	1.283
Cluster3	20	18.306	0.857	2.319
Cluster4	10	4.172	0.602	1.072
Cluster5	9	6.446	0.808	1.194

Cluster Centroids

Variable	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5
Air	1.1087	-0.4450	-0.4540	-1.1406	-0.9712
Water	0.2318	0.5137	0.4935	-2.0095	-1.4980
Land	0.3728	0.5500	-1.1629	0.7954	-1.6458

Variable	Grand centrd
Air	-0.0000
Water	-0.0000
Land	0.0000

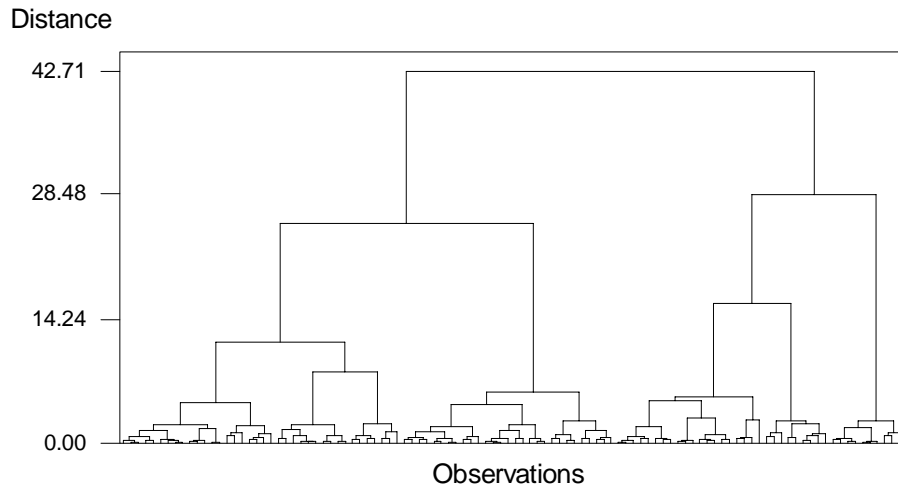
Distances Between Cluster Centroids

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5
Cluster1	0.0000	1.5890	2.2065	3.2034	3.3754
Cluster2	1.5890	0.0000	1.7130	2.6289	3.0242
Cluster3	2.2065	1.7130	0.0000	3.2513	2.1135
Cluster4	3.2034	2.6289	3.2513	0.0000	2.4999
Cluster5	3.3754	3.0242	2.1135	2.4999	0.0000

How to Read a Dendrogram

As a result we *link* more and more objects together and aggregate (*amalgamate*) larger and larger clusters of increasingly dissimilar elements. Finally, in the last step, all objects are joined together. In these plots, the vertical axis denotes the linkage distance. Thus, for each node in the graph (where a new cluster is formed) we can read off the criterion distance at which the respective elements were linked together into a new single cluster. When the data contain a clear "structure" in terms of clusters of objects that are similar to each other, then this structure will often be reflected in the hierarchical tree as distinct branches. As the result of a successful analysis with the joining method, one is able to detect clusters (branches) and interpret those branches

Dendrogram of Cluster Analysis with Modified Indicators



Cluster	# Countries	Countries
1	38	Costa Rica, Norway, Columbia, Guatemala, Ghana, Cameroon, Peru, Honduras, Brazil, Gabon, Benin, Albania, Congo (Dem. Rep.), Senegal, Morocco, Panama, Angola, El Salvador, Mozambique, Dominican Republic, Austria, Nigeria, Zambia, Congo (Rep.), Switzerland, Nicaragua, Bangladesh, Sri Lanka, Nepal, Uruguay, Ethiopia, Tanzania, Kenya, Haiti, Vietnam, Philippines, Tunisia, Pakistan
2	29	Chile, Sweden, Finland, New Zealand, Bolivia, Canada, Australia, Zimbabwe, Indonesia, Argentina, Japan, Algeria, Ecuador, Latvia, Slovenia, Mexico, Venezuela, Georgia, Russia, Jamaica, Estonia, United States, Kyrgyzstan, China, Iran, South Korea, Singapore, South Africa, Kazakhstan
3	20	Italy, Turkey, Portugal, Greece, Slovakia, India, Belarus, Czech Republic, Spain, Thailand, Armenia, France, Denmark, Lebanon, Ireland, Lithuania, United Kingdom, Poland, Germany, Trinidad and Tobago
4	10	Egypt, Yemen, Jordan, Kuwait, Malaysia, United Arab Emirates, Saudi Arabia, Syria, Turkmenistan, Uzbekistan
5	9	Israel, Bulgaria, Romania, Azerbaijan, Ukraine, Belgium, Netherlands, Hungary, Moldova

The ranking was done by reading down the three columns (according to air, water and land) and marking the two cluster means with lowest values. The number of extreme values (in bold letter) was counted in each row. The count is interpreted as a measure of relative environmental impact for that group of countries. The score was then used to rank the group. Higher score suggests better environment condition.

SECTION 3: DECILE ANALYSIS

We will now look at some another possible division for ranking the data, the decile:

Decile Analysis

Country	Air	Water	Land	# of Indicators with Rank:									
				1	2	3	4	5	6	7	8	9	10
Albania				1	·	·	1	·	·	1	·	·	·
Algeria				1	·	·	·	·	1	1	·	·	·
Angola				·	2	·	·	·	·	·	1	·	·
Argentina				·	·	·	2	1	·	·	·	·	·
Armenia				·	·	·	·	·	1	1	1	·	·
Australia				·	1	1	·	·	·	1	·	·	·
Austria				·	1	·	1	·	1	·	·	·	·
Azerbaijan				·	·	·	·	·	·	·	·	2	1
Bangladesh				1	1	·	·	·	·	·	·	1	·
Belarus				·	1	·	·	·	·	·	1	1	·
Belgium				·	·	·	·	·	·	·	1	1	1
Benin				·	1	1	·	·	·	1	·	·	·
Bolivia				1	·	·	1	·	1	·	·	·	·
Brazil				·	·	2	1	·	·	·	·	·	·
Bulgaria				·	·	·	·	·	·	·	·	2	1
Cameroon				·	2	·	·	·	1	·	·	·	·
Canada				1	·	1	·	·	·	1	·	·	·
Chile				·	·	2	·	1	·	·	·	·	·
China				·	·	·	·	·	2	1	·	·	·
Colombia				·	2	1	·	·	·	·	·	·	·
Congo, D.R.				·	2	·	·	·	·	·	1	·	·
Congo, Rep.				1	·	·	1	·	·	·	1	·	·
Costa Rica				2	·	·	1	·	·	·	·	·	·

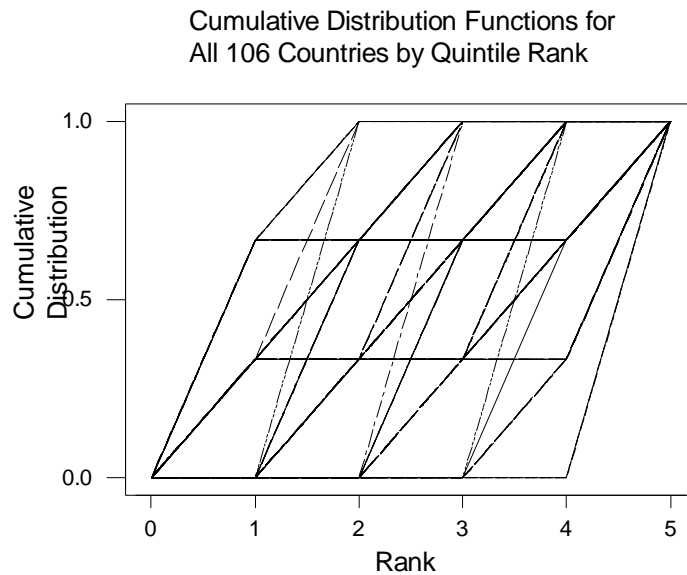
Czech Rep.				·	1	·	·	·	·	·	·	1	1	·
Denmark				·	·	1	·	1	·	·	·	·	·	1
Dominican Republic				·	·	1	1	·	1	·	·	·	·	·
Ecuador				·	·	·	1	1	1	·	·	·	·	·
Egypt				·	1	·	·	·	·	1	·	·	·	1
El Salvador				1	·	·	·	1	·	1	·	·	·	·
Estonia				·	·	·	1	1	·	·	1	·	·	·
Ethiopia				·	1	·	1	·	·	·	·	·	1	·
Finland				2	·	·	·	·	·	1	·	·	·	·
France				·	·	·	1	·	1	·	·	·	1	·
Gabon				1	·	1	·	1	·	·	·	·	·	·
Georgia				·	·	·	·	2	1	·	·	·	·	·
Germany				·	·	·	·	·	·	1	·	·	2	·
Ghana				1	·	1	·	·	1	·	·	·	·	·
Greece				·	·	1	·	·	1	·	1	·	·	·
Guatemala				1	1	·	·	1	·	·	·	·	·	·
Haiti				1	·	·	·	·	·	1	1	·	·	·
Honduras				·	1	1	1	·	·	·	·	·	·	·
Hungary				·	·	·	·	·	·	1	·	1	1	1
India				·	·	·	1	1	·	·	·	·	1	·
Indonesia				·	·	·	1	2	·	·	·	·	·	·
Iran				·	·	1	·	·	·	·	1	1	·	·
Ireland				1	·	·	·	1	·	·	·	·	·	1
Israel				·	·	·	·	·	1	·	1	1	·	·
Italy				·	·	·	·	1	1	·	1	·	·	·
Jamaica				·	·	1	·	1	·	·	1	·	·	·
Japan				·	·	·	2	·	1	·	·	·	·	·
Jordan				·	·	1	·	·	·	·	1	·	1	·
Kazakhstan				·	·	·	·	·	·	2	·	·	·	1
Kenya				·	·	1	·	1	·	·	1	·	·	·
Korea, South				·	·	·	·	1	·	·	2	·	·	·
Kuwait				1	·	·	·	·	·	·	·	·	1	1
Kyrgyzstan				·	·	·	·	1	·	2	·	·	·	·
Latvia				·	1	·	·	·	2	·	·	·	·	·
Lebanon				·	·	·	·	1	·	·	2	·	·	·
Lithuania				·	·	·	·	1	·	·	1	1	·	·
Malaysia				·	·	·	·	1	·	1	·	·	·	1
Mexico				·	·	·	1	·	2	·	·	·	·	·
Moldova				·	·	·	·	·	·	·	·	·	2	1
Morocco				·	2	·	·	·	·	·	1	·	·	·
Mozambique				·	1	·	·	1	·	1	·	·	·	·
Nepal				1	·	1	·	·	·	1	·	·	·	·

Netherlands				.	.	.	.	.	.	1		1	1
New Zealand				1	.	1	.	1	.	.	.	.	.
Nicaragua				.	.	1	1	.	1	.	.	.	.
Nigeria				.	1	.	1	.	.	1	.	.	.
Norway				2	.	.	1	.	.	.	.	.	.
Pakistan				.	.	.	1	.	.	1	1	.	.
Panama				.	.	2	.	.	1	.	.	.	.
Peru				.	2	.	.	.	1	.	.	.	.
Philippines				.	1	.	1	.	.	.	.	1	.
Poland				.	.	.	.	.	1	.	1	1	.
Portugal				.	.	.	1	.	1	.	1	.	.
Romania				.	.	.	.	.	.	1	.	1	1
Russia				.	1	.	1	.	.	.	.	.	1
Saudi Arabia				1	.	.	.	.	.	.	.	.	2
Senegal				.	.	1	2	.	.	.	.	.	.
Singapore				.	.	.	.	1	1	.	.	1	.
Slovakia				.	1	.	.	.	.	1	.	1	.
Slovenia				1	.	.	.	1	.	1	.	.	.
South Africa				.	.	.	.	.	.	2	1	.	.
Spain				.	.	.	.	2	.	.	.	1	.
Sri Lanka				1	.	.	.	1	.	1	.	.	.
Sweden				1	1	.	.	.	1	.	.	.	.
Switzerland				1	.	.	1	.	1	.	.	.	.
Syria				.	.	.	.	1	.	.	1	.	1
Tanzania				.	.	1	.	.	1	1	.	.	.
Thailand				.	.	.	.	1	.	1	1	.	.
Trinidad and Tobago				.	.	1	.	.	.	.	.	.	2
Tunisia				.	.	1	1	.	.	.	.	1	.
Turkey				.	.	.	.	1	1	.	1	.	.
Turkmenistan				.	.	1	.	.	.	.	.	.	2
Ukraine				.	.	.	.	.	.	.	1	.	2
United Arab Emirates				1	.	.	.	.	.	.	.	.	2
United Kingdom				.	.	1	.	.	.	1	.	.	1
United States				.	.	1	.	.	1	.	1	.	.
Uruguay				2	.	.	.	.	.	.	.	1	.
Uzbekistan				.	.	.	.	.	1	.	.	.	2
Venezuela				.	1	1	.	.	.	.	.	1	.
Vietnam				.	.	1	.	.	.	1	1	.	.
Yemen				1	.	.	.	.	.	.	1	.	1
Zambia				.	.	1	1	.	1	.	.	.	.
Zimbabwe				.	.	.	2	1	.	.	.	.	.

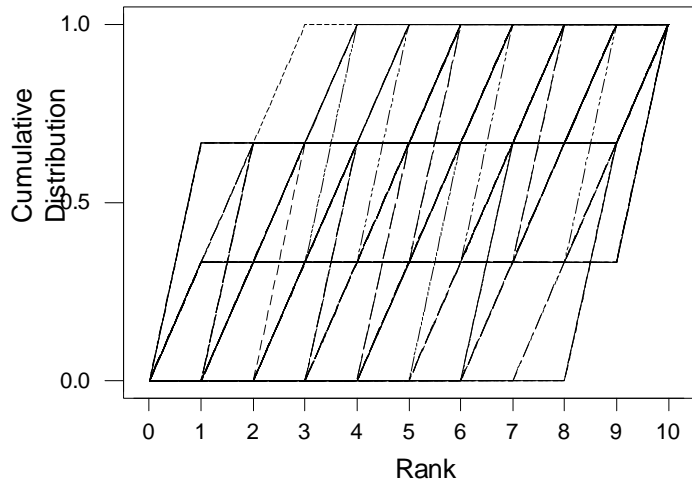
Legend:

Rank	Color
1	Green
2	Teal
3	Dark Green
4	Olive
5	Brown
6	Yellow
7	Light Yellow
8	Orange
9	Dark Orange
10	Red

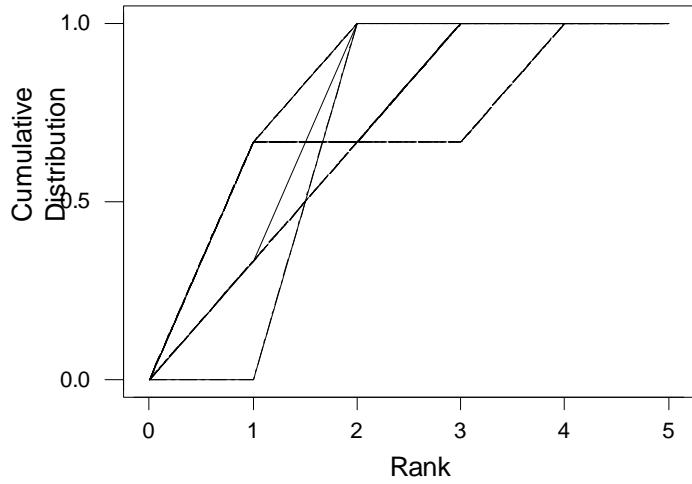
The first comparisons we will make are related to the cumulative distribution functions. To begin, we will compare the quintile and decile cumulative distribution functions for all countries, and then for the top twenty and the bottom twenty countries in each grouping.



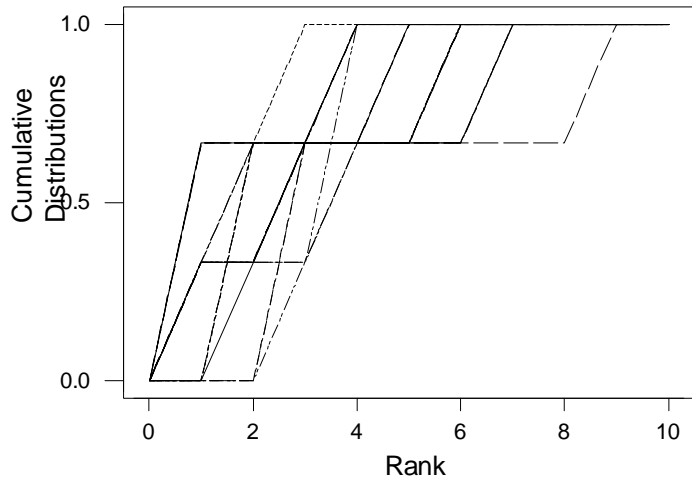
Cumulative Distribution Functions for All 106 Countries by Decile Rank



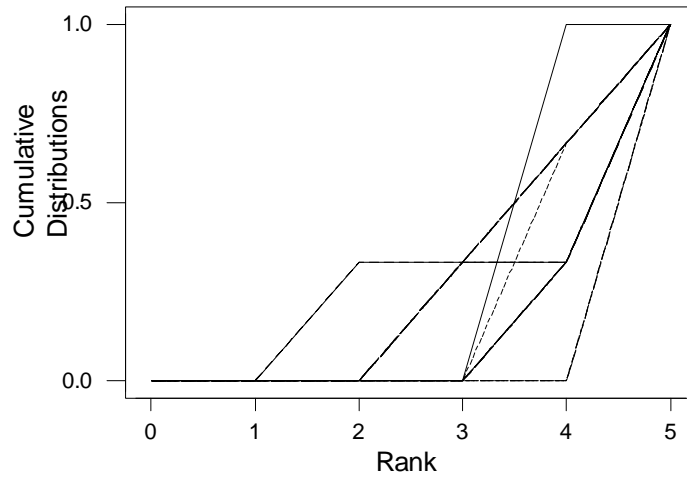
Cumulative Distribution Functions for Top 20 Countries by Quintile CDF - Index



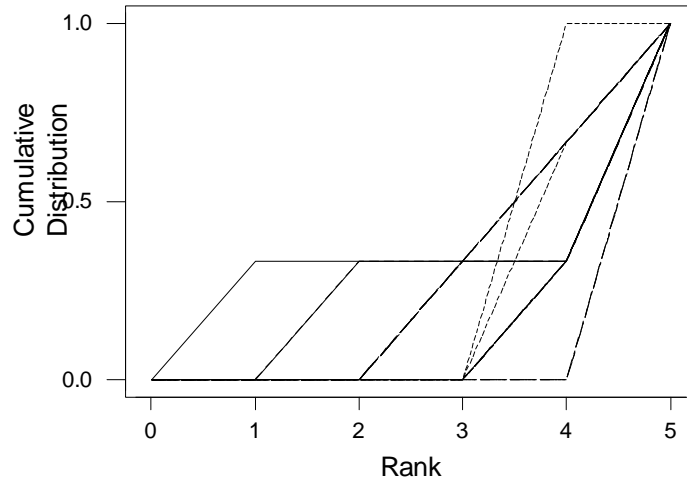
Cumulative Distribution Functions for the Top 20 Countries by Decile CDF - Index



Cumulative Distribution Functions for the Bottom 20 Countries by Quintile CDF - Index



Cumulative Distribution Functions for the Bottom 20 Countries by Decile CDF - Index



Top 20 Quintiles			Top 20 Deciles		
Rank	Country	CDF – Index	Rank	Country	CDF – Index
1	Costa Rica	4.667	1	Costa Rica	9
2	Norway	4.667	2	Norway	9
3	Colombia	4.667	3	Colombia	8.667
4	Guatemala	4.333	4	Guatemala	8.334
5	Cameroon	4.333	5	Finland	8
6	Peru	4.333	6	Sweden	8
7	Sweden	4.333	7	Gabon	8
8	Honduras	4.333	8	Honduras	8
9	Benin	4	9	New Zealand	8
10	Congo, Dem. Rep.	4	10	Cameroon	7.667
11	Morocco	4	11	Peru	7.667
12	Finland	4	12	Brazil	7.667
13	Angola	4	13	Ghana	7.667
14	Ghana	4	14	Uruguay	7.333
15	Brazil	4	15	Canada	7.333
16	Gabon	4	16	Chile	7.333
17	Chile	4	17	Nepal	7.333
18	Senegal	4	18	Bolivia	7.333
19	New Zealand	4	19	Senegal	7.333
20	Austria	4	20	Switzerland	7.333

Bottom 20 Quintiles			Bottom 20 Deciles		
Rank	Country	CDF – Index	Rank	Country	CDF – Index
87	South Africa	2	87	United Arab Emirates	4
88	Thailand	2	88	Malaysia	3.667
89	Malaysia	2	89	South Africa	3.667
90	Lithuania	2	90	Lithuania	3.667
91	Poland	2	91	Israel	3.333
92	Syria	2	92	Poland	3.333
93	Israel	2	93	Syria	3.333
94	Turkmenistan	2	94	Trinidad and Tobago	3.333
95	Trinidad and Tobago	2	95	Turkmenistan	3.333
96	Kazakhstan	1.667	96	Kazakhstan	3
97	Uzbekistan	1.667	97	Germany	2.667
98	Germany	1.333	98	Hungary	2.333
99	Romania	1.333	99	Netherlands	2.333
100	Ukraine	1.333	100	Romania	2.333
101	Belgium	1.333	101	Uzbekistan	2.333
102	Netherlands	1.333	102	Belgium	2
103	Hungary	1.333	103	Azerbaijan	1.667
104	Bulgaria	1	104	Bulgaria	1.667
105	Azerbaijan	1	105	Moldova	1.667
106	Moldova	1	106	Ukraine	1.667

To determine the top 20 and bottom 20 countries, we used the following equations:

For Quintiles:

$$\sum [F(x)] = F(1) + F(2) + F(3) + F(4) + F(5)$$

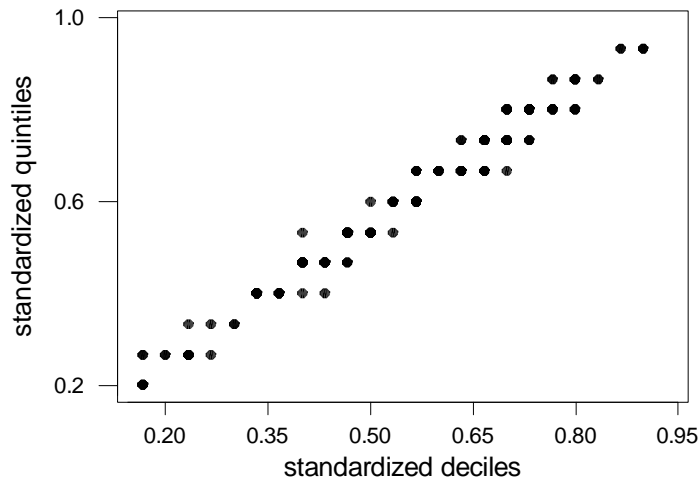
and for Deciles:

$$\sum [F(x)] = F(1) + F(2) + F(3) + F(4) + F(5) + F(6) + F(7) + F(8) + F(9) + F(10)$$

We refer to each of these sums as a *CDF-index* value. Larger CDF-index values indicate better environmental health for a country. This is the case because a country with a large number of rank 1 scores will have a larger CDF-index value than a country with a small number of rank 1 scores. When looking at the top 20 and bottom 20 countries, we can note that having a rank of 1 (5) for any of the indicators has a strong positive (negative) effect on a country's status according to these CDF – index scores. This is a result of there being a small number of indicators that we are measuring, giving that value a larger overall effect. While you can see by looking at the charts of the top and bottom 20 countries, one can also note that there exists some adjustment in rank, but it is relatively minor, which gives this data set a robust quality.

We can also examine scatterplots of the CDF-index values. In these plots, we have transformed the sums listed in the tables above, again using the transformation $1/N$, with N again representing the number of ranks within that ranking option. We plotted the standardized quintile sums against the standardized decile sums. The scatterplot follows:

Scatterplot - Standardized Quintiles vs. Standardized Deciles



You can see that there is high correlation between the standardized scores for differing rank options.

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Biosketches

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Appendix

HEI with revised data:

For land - % undomesticated land to total land area

For air – $(\text{air indicator1} + \text{air indicator2}) / 2$, where **air indicator1** = renewable energy use to total energy use; **air indicator2** = GDP per unit energy use, based on maximum and minimum concept

For water – $(\text{water indicator1} + \text{water indicator2}) / 2$, where **water indicator1** = ratio of water available after annual withdrawals to internal water resources; **water indicator2** = ratio of people having access to an improved water source to total population

HEI.Rank	Country	HEI	Land	Air	Water
1	Costa Rica	0.8503	0.8951	0.6729	0.9829
2	Norway	0.8078	0.9955	0.4305	0.9974
3	Colombia	0.7996	0.9376	0.5087	0.9525
4	Guatemala	0.7988	0.8606	0.5789	0.9569
5	Ghana	0.7856	0.9467	0.5950	0.8150
6	Cameroon	0.7810	0.9665	0.5671	0.8093
7	Peru	0.7806	0.9847	0.5484	0.8088
8	Honduras	0.7764	0.8832	0.5097	0.9363
9	Brazil	0.7759	0.9112	0.4850	0.9315
10	Gabon	0.7757	0.9977	0.4797	0.8498
11	Benin	0.7670	0.9888	0.5042	0.8080
12	Albania	0.7537	0.6411	0.7500	0.8700
13	Congo, Dem Rep	0.7528	0.9833	0.5503	0.7248
14	Chile	0.7526	0.9487	0.3571	0.9521
15	Sweden	0.7519	0.9818	0.2824	0.9917
16	Senegal	0.7479	0.8951	0.4845	0.8642
17	Morocco	0.7441	0.9785	0.5247	0.7292
18	Finland	0.7423	0.9951	0.2418	0.9900
19	New Zealand	0.7353	0.9256	0.2984	0.9819
20	Panama	0.7347	0.7987	0.4750	0.9305
21	Angola	0.7342	0.9710	0.5429	0.6887
22	El Salvador	0.7336	0.7258	0.6250	0.8500
23	Mozambique	0.7303	0.8756	0.5182	0.7970
24	Dominican Republic	0.7284	0.8817	0.4826	0.8208
25	Austria	0.7273	0.7924	0.4105	0.9790
26	Bolivia	0.7272	0.9951	0.2934	0.8929
27	Nigeria	0.7228	0.9804	0.4111	0.7768
28	Zambia	0.7227	0.8828	0.4761	0.8094
29	Congo, Rep	0.7193	0.9905	0.4126	0.7549

30	Switzerland	0.7169	0.7533	0.4113	0.9860
31	Nicaragua	0.7159	0.7919	0.4634	0.8925
32	Canada	0.7147	0.9407	0.2113	0.9921
33	Bangladesh	0.7135	0.4075	0.7563	0.9767
34	Sri Lanka	0.7116	0.6088	0.6839	0.8421
35	Australia	0.7085	0.9381	0.2087	0.9787
36	Nepal	0.7074	0.6229	0.6021	0.8971
37	Uruguay	0.7073	0.4683	0.6689	0.9845
38	Zimbabwe	0.7037	0.8227	0.4066	0.8817
39	Indonesia	0.6973	0.8451	0.3700	0.8767
40	Argentina	0.6950	0.8279	0.3821	0.8751
41	Japan	0.6942	0.8918	0.2937	0.8970
42	Ethiopia	0.6906	0.9183	0.5434	0.6100
43	Algeria	0.6853	0.9960	0.2521	0.8078
44	Tanzania	0.6821	0.7928	0.4908	0.7627
45	Ecuador	0.6814	0.9137	0.2842	0.8461
46	Latvia	0.6810	0.7766	0.2868	0.9797
47	Slovenia	0.6788	0.8219	0.2295	0.9850
48	Mexico	0.6775	0.9247	0.2866	0.8214
49	Venezuela	0.6727	0.9712	0.1292	0.9176
50	Kenya	0.6703	0.8435	0.4732	0.6943
51	Haiti	0.6652	0.6657	0.6018	0.7282
52	Georgia	0.6582	0.7884	0.3411	0.8451
53	Russia	0.6569	0.9170	0.0724	0.9813
54	Viet Nam	0.6408	0.7075	0.4734	0.7416
55	Jamaica	0.6380	0.9295	0.1487	0.8357
56	Philippines	0.6346	0.4783	0.5363	0.8893
57	Tunisia	0.6316	0.9301	0.4061	0.5586
58	Estonia	0.6290	0.8704	0.1445	0.8721
59	United States	0.6208	0.7746	0.1829	0.9050
60	Kyrgyzstan	0.6145	0.7319	0.3434	0.7682
61	China	0.6140	0.7806	0.2684	0.7929
62	Iran	0.5916	0.9365	0.1366	0.7019
63	Italy	0.5912	0.5775	0.3724	0.8237
64	Turkey	0.5883	0.5924	0.3382	0.8344
65	Portugal	0.5875	0.5670	0.3813	0.8141
66	Greece	0.5849	0.5325	0.2879	0.9342
67	Korea, South	0.5846	0.8290	0.1734	0.7513
68	Pakistan	0.5780	0.7243	0.3834	0.6263
69	Slovakia	0.5767	0.6177	0.1413	0.9712
70	Singapore	0.5709	0.7500	0.1211	0.8417
71	India	0.5691	0.4708	0.3992	0.8373
72	Egypt	0.5614	0.9740	0.2353	0.4750

73	Belarus	0.5607	0.6064	0.1045	0.9712
74	Czech Republic	0.5560	0.5551	0.1363	0.9765
75	South Africa	0.5546	0.6958	0.1866	0.7815
76	Spain	0.5524	0.4981	0.2984	0.8606
77	Yemen	0.5488	0.9963	0.1626	0.4874
78	Thailand	0.5437	0.5149	0.3613	0.7550
79	Armenia	0.5310	0.5437	0.2192	0.8302
80	Jordan	0.5278	0.9560	0.1474	0.4800
81	France	0.5277	0.4320	0.2561	0.8952
82	Denmark	0.5271	0.3011	0.3347	0.9455
83	Lebanon	0.5265	0.5609	0.1726	0.8461
84	Kazakhstan	0.5232	0.7190	0.0626	0.7879
85	Kuwait	0.5228	1.0000	0.0684	0.5000
86	Malaysia	0.5205	0.8788	0.1932	0.4897
87	United Arab Emirates	0.5141	0.9997	0.0526	0.4900
88	Saudi Arabia	0.5137	0.9977	0.0684	0.4750
89	Ireland	0.5039	0.2155	0.3047	0.9916
90	Lithuania	0.4992	0.5270	0.1300	0.8406
91	United Kingdom	0.4878	0.2994	0.2471	0.9170
92	Poland	0.4715	0.4424	0.1513	0.8207
93	Syria	0.4567	0.8085	0.1616	0.4000
94	Israel	0.4488	0.5735	0.2729	0.5000
95	Germany	0.4461	0.4400	0.1391	0.7590
96	Turkmenistan	0.4145	0.9324	0.0211	0.2900
97	Uzbekistan	0.3955	0.7409	0.0208	0.4250
98	Bulgaria	0.3638	0.4044	0.0732	0.6139
99	Romania	0.3583	0.4392	0.1971	0.4386
100	Azerbaijan	0.3492	0.5058	0.0418	0.5000
101	Ukraine	0.3415	0.3117	0.0261	0.6867
102	Belgium	0.3366	0.3205	0.1892	0.5000
103	Netherlands	0.3313	0.1635	0.2208	0.6097
104	Hungary	0.3129	0.2495	0.1942	0.4950
105	Trinidad and Tobago	0.3104	0.0000	0.0158	0.9153
106	Moldova	0.2563	0.1851	0.0837	0.5000