



12/5/2018

# **HEE Modernization Index: Health, Energy, Education**

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## **Main goal:**

Evaluate the global pace of adaptation to a rapidly developing world through the analysis of a country's education level, efforts to move away from fossil fuels, and overall health of its peoples.

## **Background**

Economic statistics such as GDP, unemployment rate, annual exports, etc. are used too often recently to judge the success of a country or how modernized it is. Humans have the tendency to compare raw numbers from a single category because they're easier to understand and to draw conclusions from them. Sometimes, these conclusions are false since there's a lot more than just purchasing power or overall wealth that determines a country's levels of industrialization and modernization. It doesn't account for the other pillars that supports a country, which are social and environmental [1]. Indeed, one can argue that a larger GDP and income lead the way for better amenities, but those numbers do not tell the story of where the money goes. Thus, hundreds or even thousands of indexes and measures exist in order to gauge the well-being of a country in the 21st century. One classic example is the Genuine Progress Indicator (GPI), which combines a country's raw GDP with other factors from the pillars to evaluate the country's economic welfare [2]. Even so, this approach is still flawed. The problems that exist with GDP and GPI is the existence of income inequality within countries, thus not everyone has equal access to the same types of needs that make up the social factors like healthcare and education [3].

This paper aims to create one more index to be added into the ever-proliferating list of measures of a country's progress, called the Modernization Index. It evaluates statistics from fields that would fall mostly into the social and environmental pillars – energy, education, and health. This index considers how a country uses their budget for things such as medicine and renewable energy, as well as the education level of its peoples. The concern that is being addressed with evaluating renewable energy as part of this index is the stigma around nonrenewable sources that produce carbon emissions. Coal and oil can be thought of as relics from the age of rapid industrialization that has led to the crisis of global warming, and the modernization of a nation can be attributed to its efforts to reduce emissions through alternative energy sources. The other fields follow suit, as one may assume that greener nations would have

a relatively well-educated and healthier population. Hopefully this index can be used to either confirm or dispel these preconceptions and be utilized more effectively than GDP by itself.

## **Scope and characteristics of study area**

When you think of modernized countries there is an abundant of different factors you could consider. When we thought of modernized countries the first things to come to mind was the lives of the people in those countries, and the best three ways to base their quality of life was through their health, education and access to energy. Once we established our three measures, we expanded on them individually and came up with indicators that we believed were crucial to a modern country. And for our HEE Modernization index we chose the following indicators:

### Health

- Physicians per capita
- Suicide rates
- Infant mortality
- Life expectancy
- Medical expenditure as part of GDP

### Energy

- Energy usage
- Electrical access
- Percent of total energy that is renewable
- Percent of total energy that is high emissions
- Percent of total energy that is nuclear

### Education

- Gross enrollment
- Education expenditure
- Male literacy
- Female literacy

Based off these indicators we believe our index will accurately rank countries on how modernized and sustainable they are. We understand that there are more indicators we could add to improve our results but for this project and the time constraint these should be more than enough to achieve our main goal. Hopefully one day we come back and improve our index with more indicators and better data.

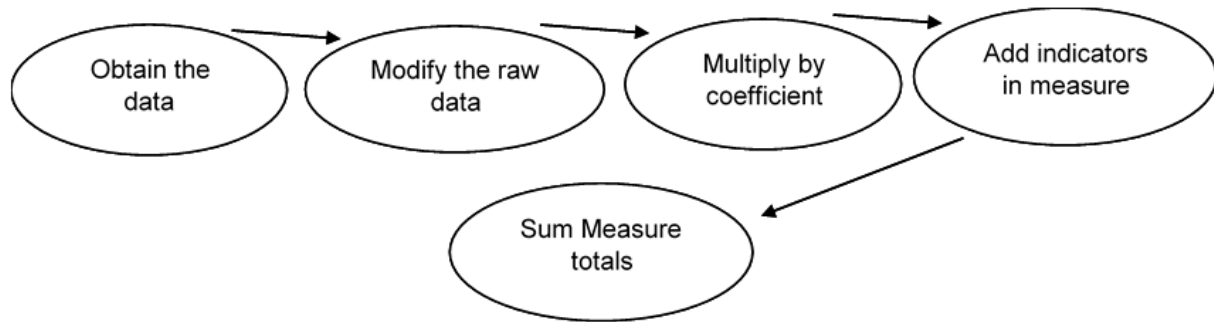
## **Objectives for accomplishing our main goal**

As we know the earth suffering from global warming from greenhouse gases in the atmosphere. Mainly from countries that modernized first and used fossil fuels and didn't know that all the emissions they were releasing was slowly warming the planet. But now that they know the effects of fossil fuels, they are moving away from them it is the responsibility of these modernized countries to help the newly or currently modernizing countries from making the same mistakes of depending on fossil fuels and help establish dependable, renewable sources of energy so the planet doesn't further get damaged before it's too late. With the help of our index we can determine what countries are struggling with moving away from fossil fuels and need help modernizing.

Furthermore, our index will also point out countries that are struggling even on the more basic aspects of quality of life like health or education. The index will point out what countries will need help in what specific areas so we as a global community can give them aid in the most helpful area possible. And not only just send them supplies but go over and impact their quality of life directly by maybe building a hospital or water filtration plant. Even though sending supplies is good but it is only a temporary fix, but by taking the extra step we could change their lives completely.

Finally, as stated in background countries tend to use GDP as an indicator to determine how modernized a country which even though a country is producing produces it doesn't mean they are improving the quality of life of its people. So, with our index we aim to demonstrate that we should move away from using GDP and focus on different indexes like our index or GPI.

## Methodology



Going through the flow chart step by step, first we had to obtain the data. Some of the data like life expectancy was given to us in ArcGIS. Other values such as physicians in the population and the percent of energy production that produces high emissions had to be found in other locations. The health indicators of physicians in the population, suicide rates, and percent of GDP expenditure on health were obtained from the WHO. The energy indicators of high emission and low emission production, and energy usage were obtained from the World Bank. The World Bank does not have a high and low emission data sheet, but it does have the percentages of coal, oil, nuclear, etc. and these were manually combined to obtain the figures for high and low emission production. Finally, the education indicator of gross enrollment by country was found at [ourworldindata.org](http://ourworldindata.org). All these indicators were formatted into excel files for ease of modification.

After the data was obtained, the raw data had to be modified. The obtained data sets included different countries, so the WHO dataset was the basis for which countries would be included in the index. Additionally, information on commonwealths (Bermuda), territories (Guam), or non-states (Palestine Authority) was excluded from the index because these areas were already counted in the parent state. Another piece of unused data was the year the indicator was recorded. Each country records data in different years so the most recent year was used with the other older years being deleted from the table. Finally, many countries were missing data from the literacy rate indicator. The literacy rates had to be manually inputted into the countries according to gender. For countries that did not have published data on literacy rates, the average for that region was inserted instead. This was necessary because literacy rates are an important indicator in the education measure.

Now that the data has been modified to fit our needs, an appropriate coefficient needed to be selected. Negative parts of modern society were multiplied by negative one so that they would subtract from the totals. The suicide rate, infant mortality rate, percent of energy produced by high emissions, and the tons of CO<sub>2</sub> produced per capita were all multiplied by negative one to reflect their negative impact on society. Two indicators needed to be scaled to fit the data ranges of the index. The number of physicians per 1000 people in the population was multiplied by ten to increase its impact on the health measure total. No country had a value over ten so by multiplying that value by ten, this indicator had a greater impact on the health measure. The amount of CO<sub>2</sub> produced per capita was divided by 100,000 to put it in an appropriate range for the countries that produce more. Countries that produce very little CO<sub>2</sub> were unaffected as the negative value added to their score was extremely small. On the other hand, countries like the United States and China who produce large amounts of CO<sub>2</sub> were penalized and they moved several slots down in the modernization index total.

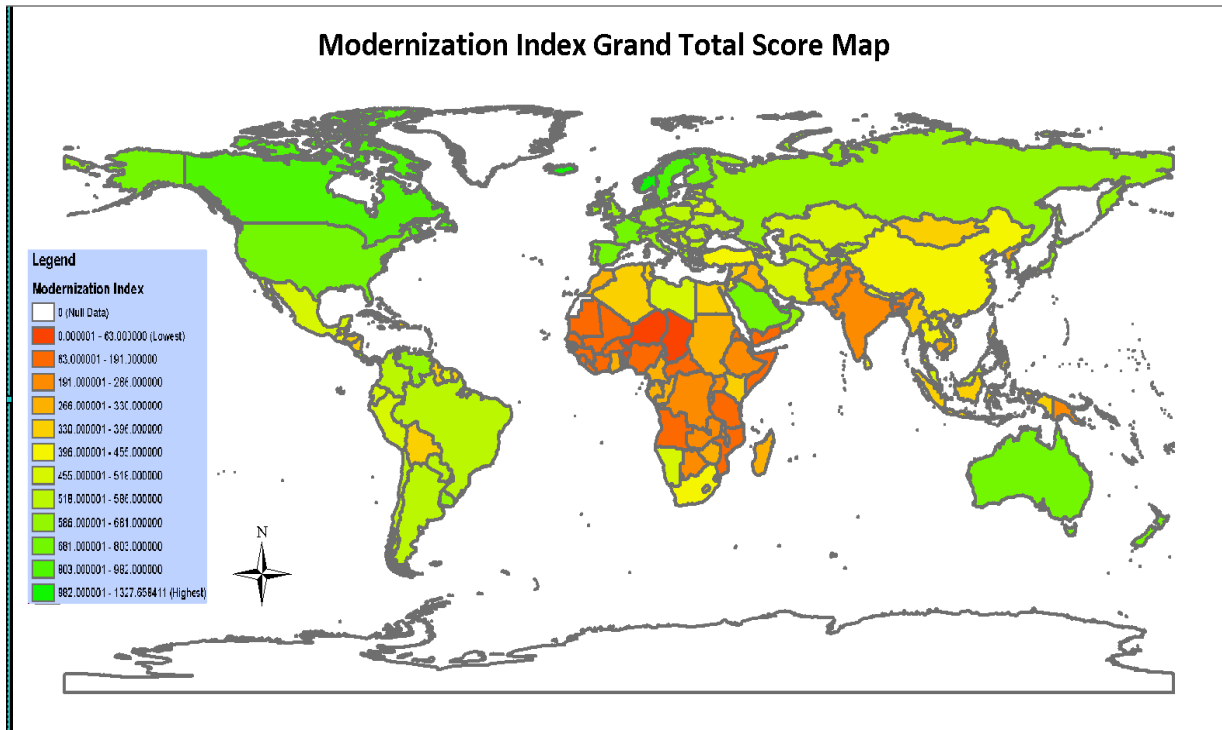
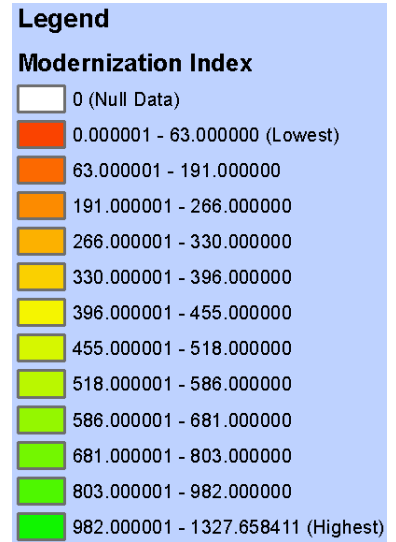
After the appropriate coefficients were applied to the indicators, the indicators in each measure were added up to obtain the total for that measure. Negative values are possible and is reflective of a society that has very little modernization.

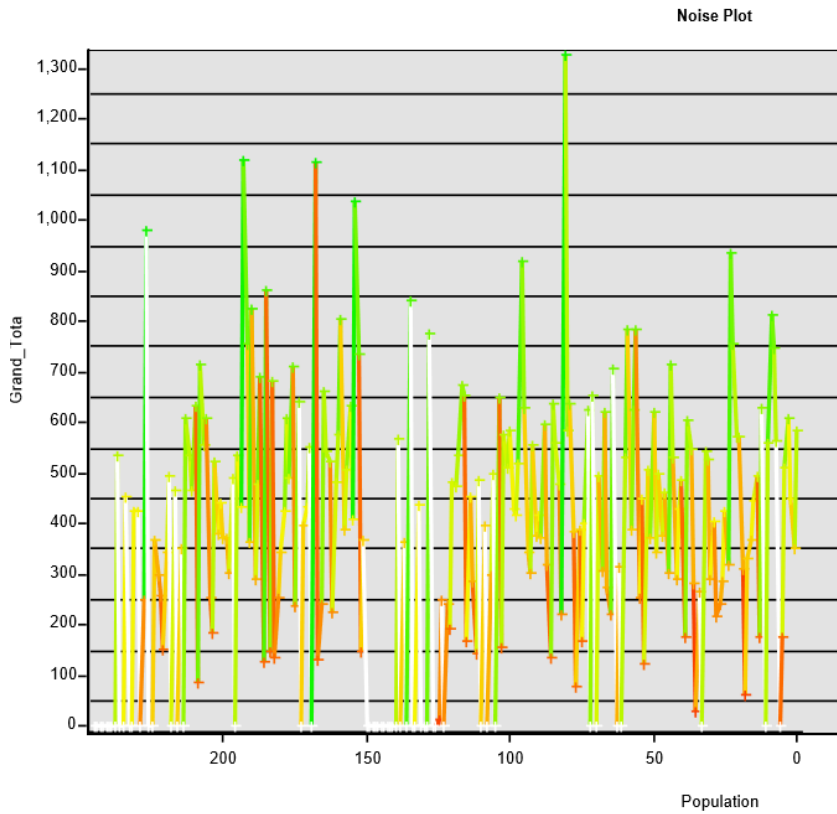
The final step was to take the three measure totals and sum them together to get the final modernization index score.

# Results and Discussion

## Modernization Index Grand Total Scoring Results

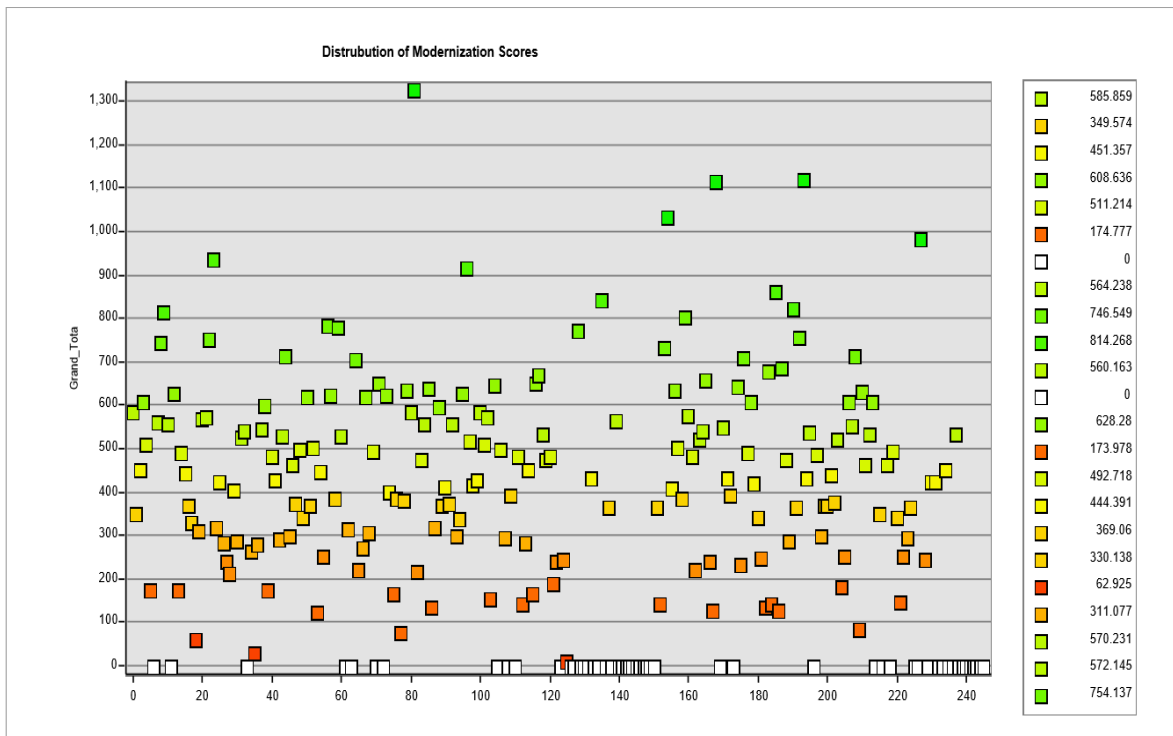
- Total of 194 countries analyzed.
  - 47 (24.23%) Outperformed
    - Index scores larger than 586
  - 93 (47.94%) were intermediate
    - Index scores larger than 330 but lower than 586
  - 54 (27.83%) underperformed.
    - Index scores under 330.
  - Average Score: 459.4022



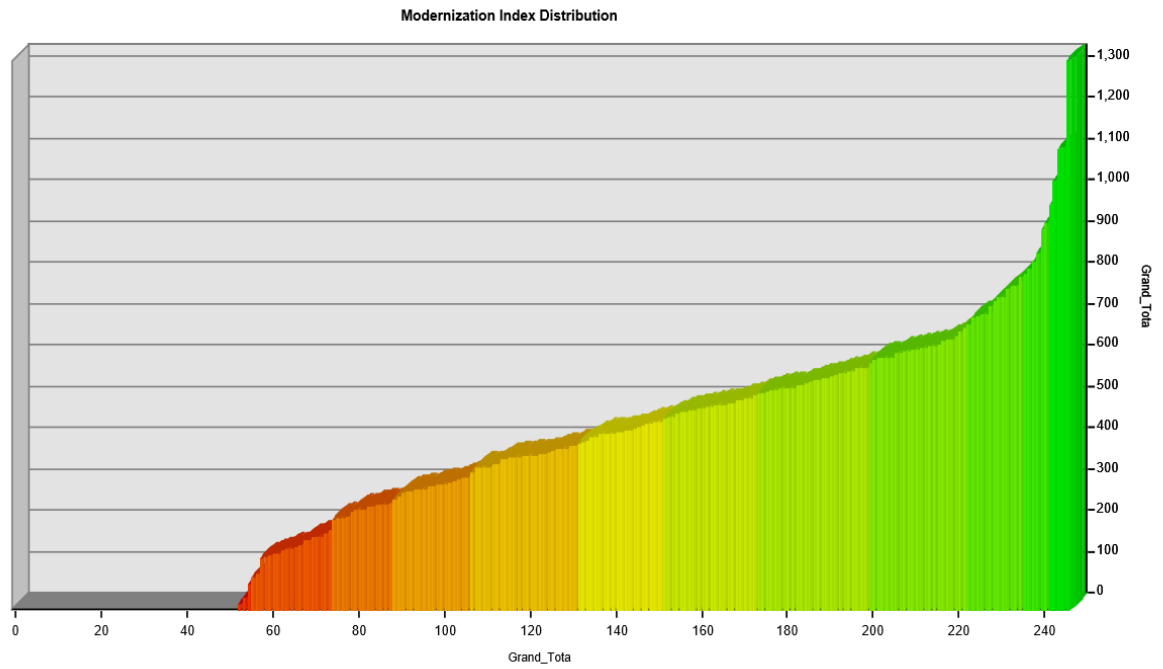


● This Noise Plot represents the frequency of Grand Total Index Scores from countries. As a result, the overall average of scores can be determined as acceptable when removing outliers.

● Scatter Plot of all Grand Total Modernization Index scores.

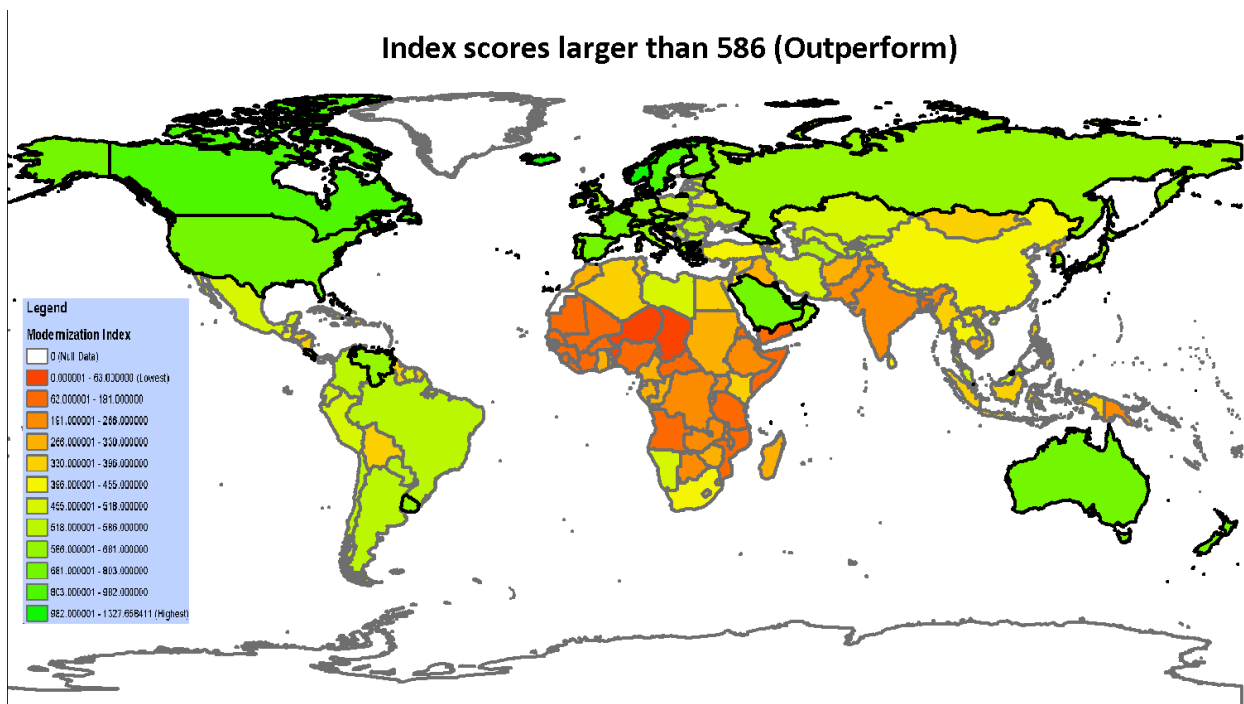






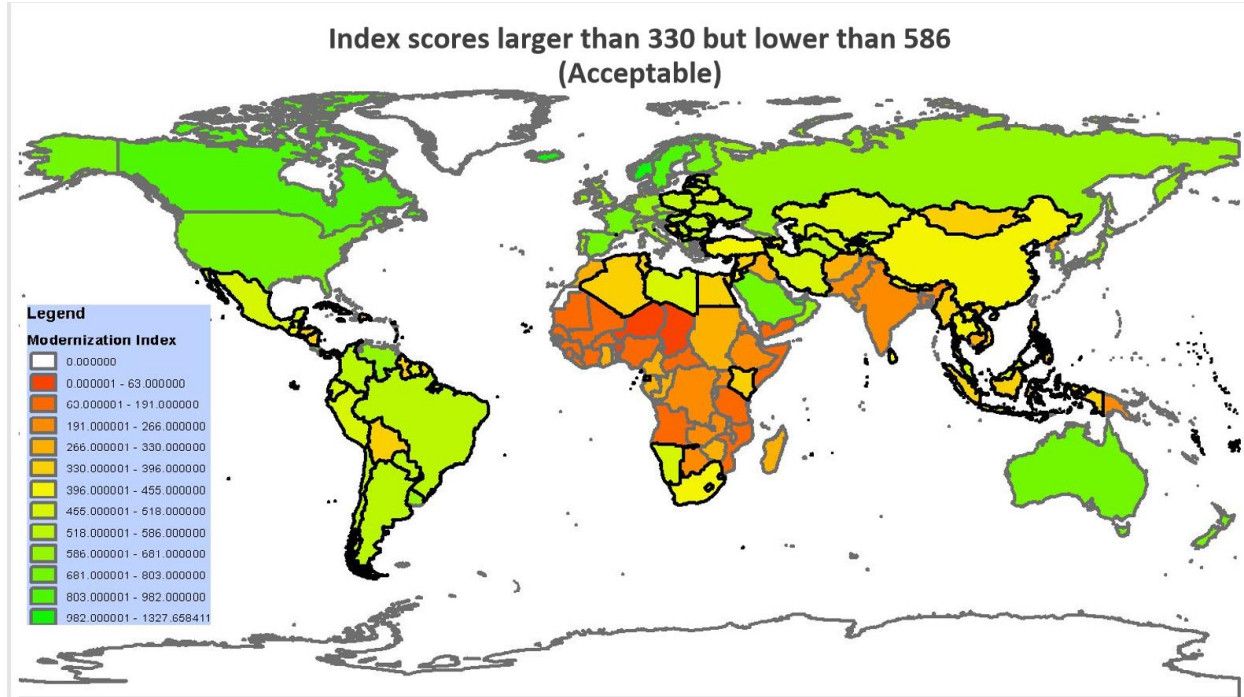
- Distribution of Grand Total Modernization Index scores

## **Analysis of Grand Total Index Scores by Performance**



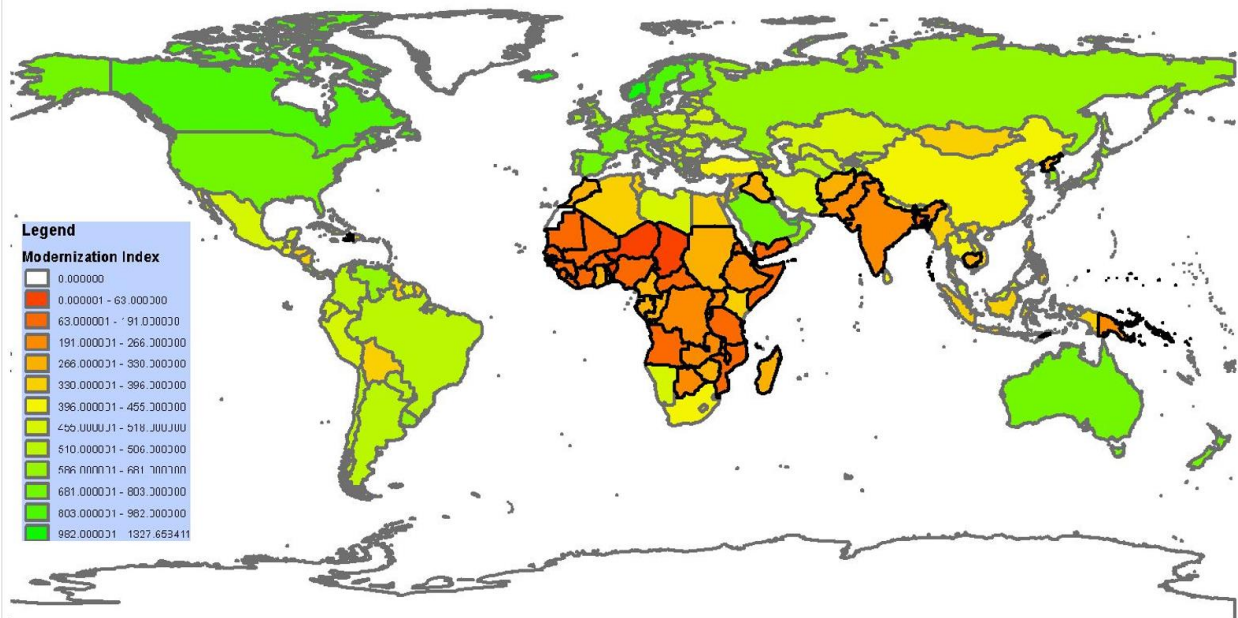


- European Countries accounted for half of all countries that scored Index Ratings larger than 586, which is deemed as outperforming.



- From this map, it can be determined that the majority of South America and Asia are moderately modernized and thus shows potentially to grow.

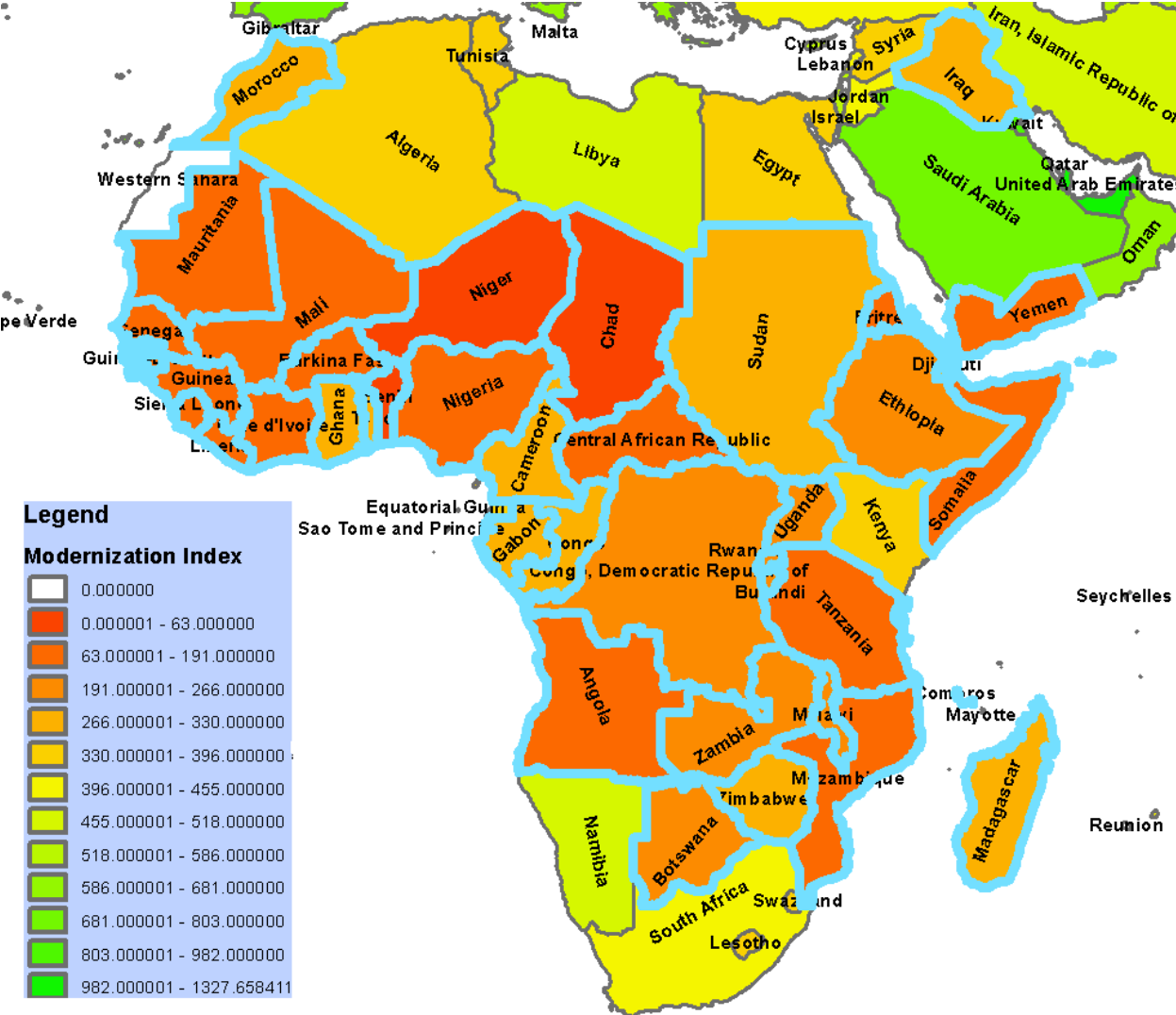
### Index scores under 330 (Fail)



- Scoring results show that most poorly modernized countries are in Africa and regions surrounding India. The struggles of African nations are further analyzed below.

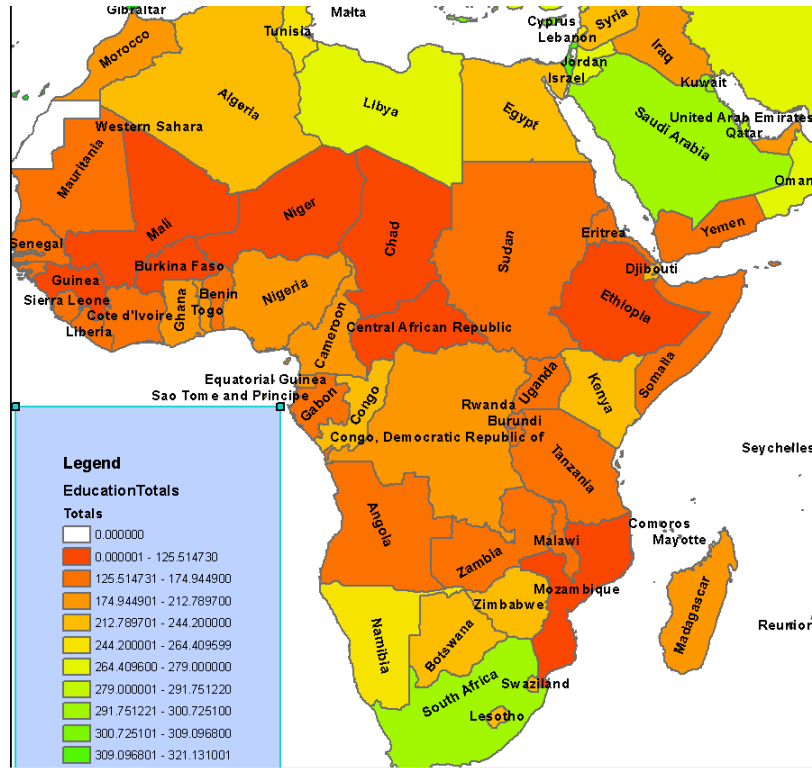
# Break Down Analysis of the least modernized continent, Africa

## Grand Index Score for Africa



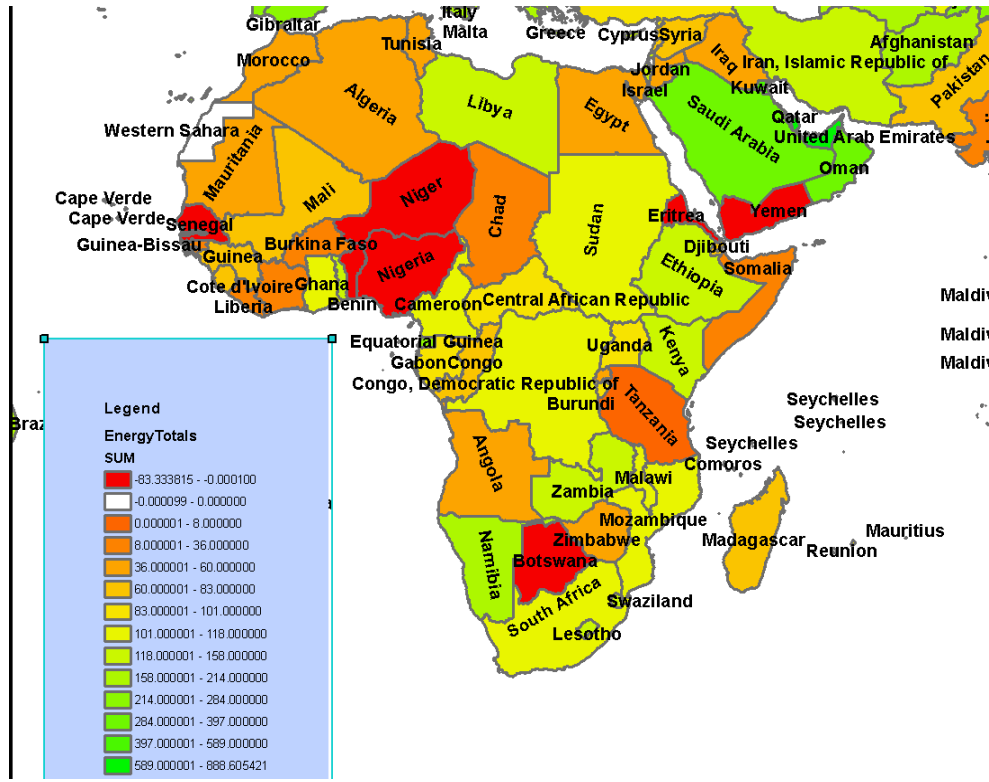
- Of the 54 countries to underperform, 39 of these countries are in Africa, making this continent the least modernized.

## Education Index Score for Africa



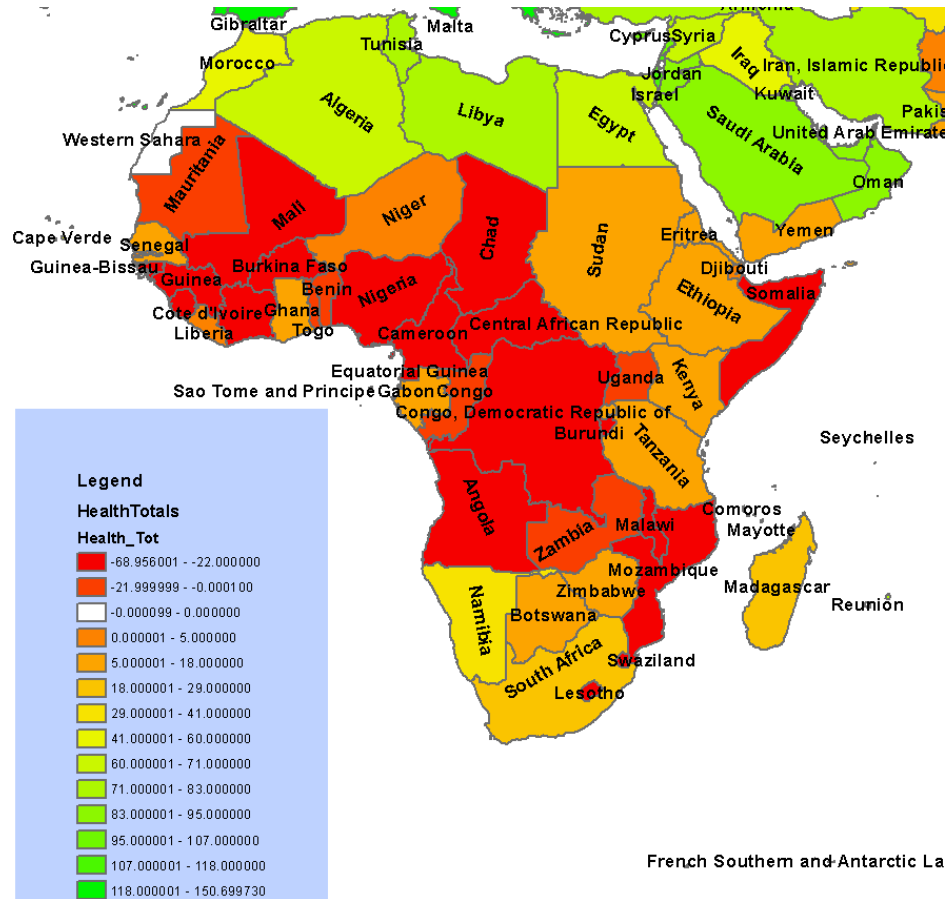
- Education total sub scores are primary low in African countries due to low male and female literacy rates and the absence of available higher education institutions.

## Energy Index Scores for Africa



- Although this is the best overall performing sector for African countries, the data is still grim. The continent of Africa had the largest cluster of countries with low energy accessibility and usage. Due to the low energy usage where low, which helped to boost many of the country's total energy scores.

## Health Index Scores for Africa

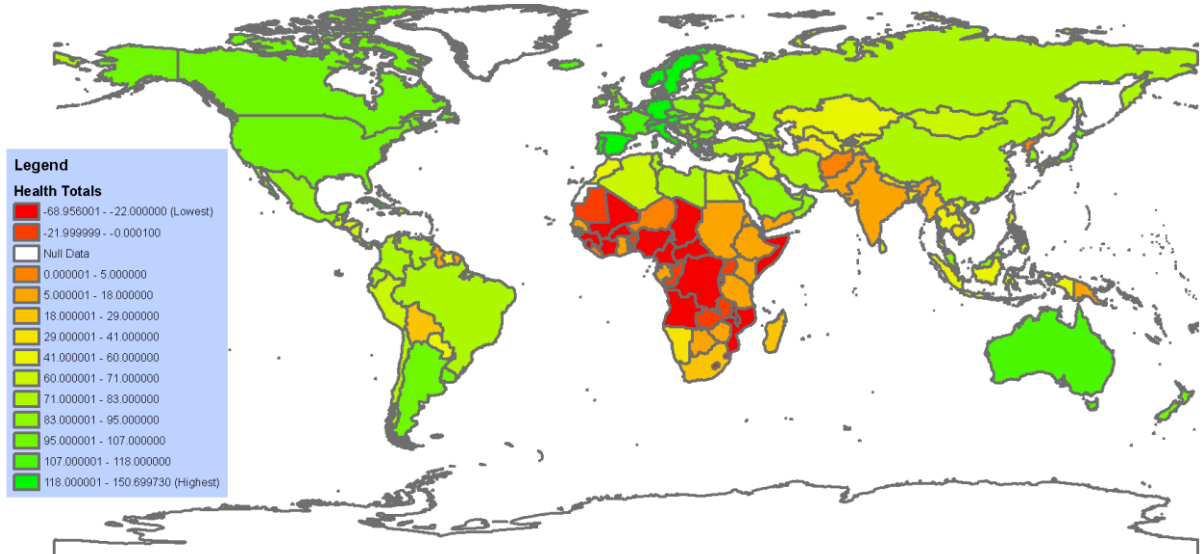


- As the worst performing sector, the bulk of African countries suffer in every health category, but suicide rates. As compared to global scores, the life expectancy, infant mortality rates, and available physicians is underwhelming low.

## Modernization Index Total Scoring Results (By Sector)

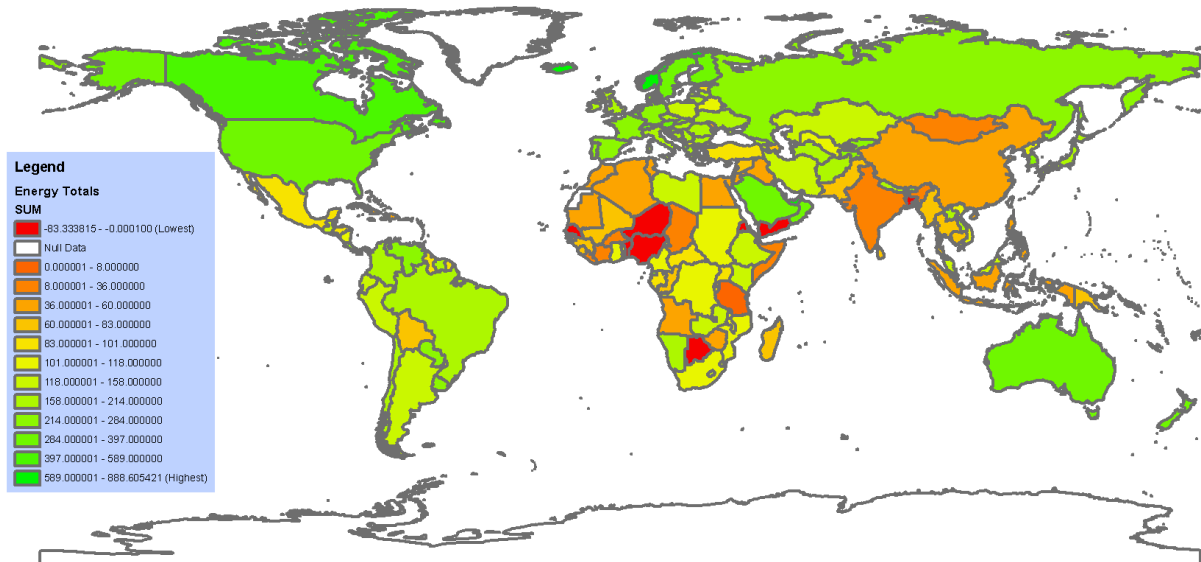
### ● Health

- 37 (19.07%) fail, 34 of which are African.
- 93 (47.94%) are acceptable
- 64 (32.99%) excel
- Average Score: 52.3



### ● Energy

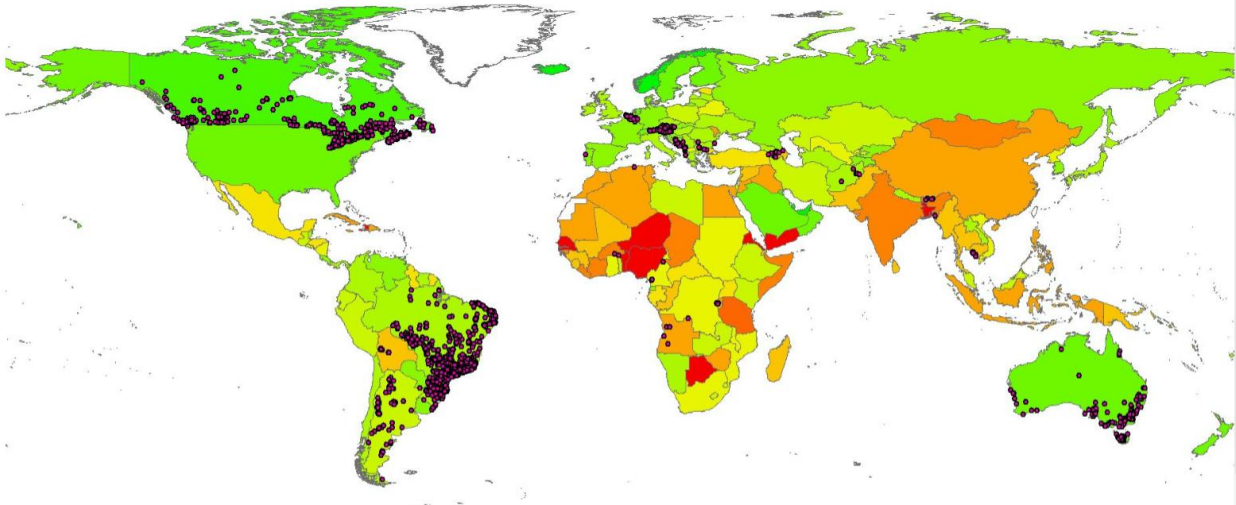
- 41 (21.13%) fail
- 108 (55.67%) acceptable
- 45 (23.20%) excel
- Average Score: 159.3685



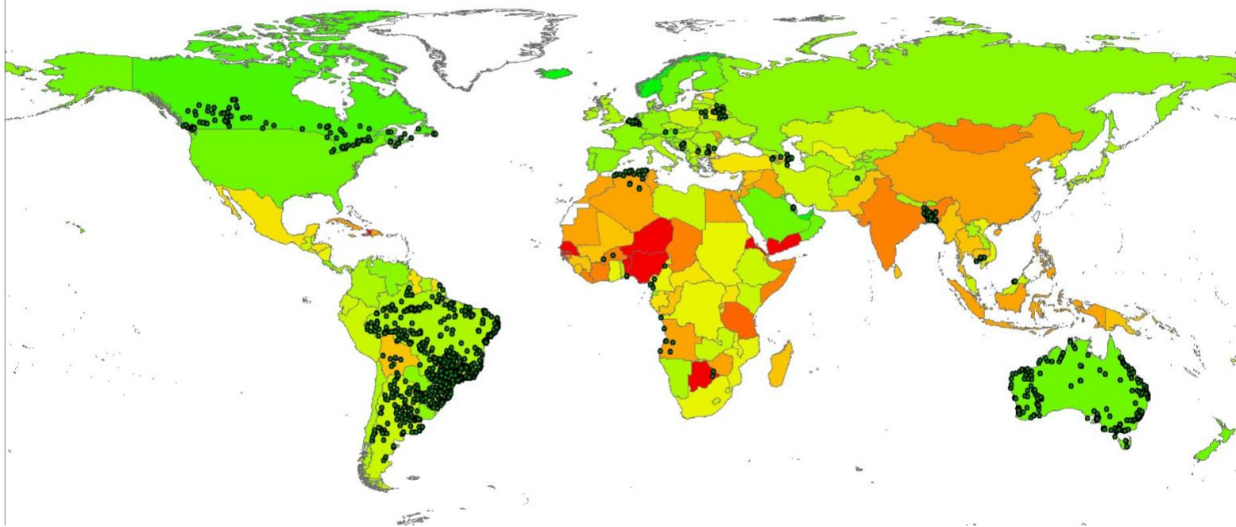


## Looking at Power Plants to Energy Rating

Zero-Emission Power Plants

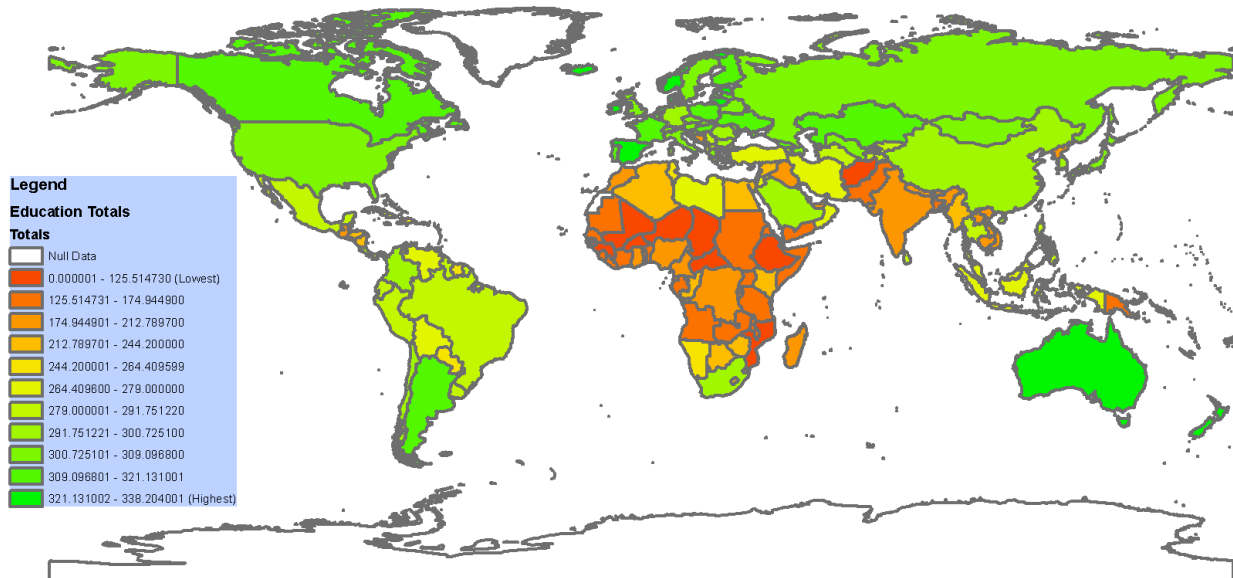


High-Emission Power Plants



- As seen, countries, like Canada, have more zero-emission power plants than high-emission plants, a reason for their exceptionally high energy index score.

- Education
  - 74 (38.14%) fail
  - 73 (37.63%) acceptable
  - 47 (24.23%) pass
  - Average Score: 247.6649



Top 25 Highest Indexed Countries					Top 25 Lowest Indexed Countries				
NAME	Grand Total	Health Total	Energy Total	Education Total	NAME	Grand Total	Health Total	Energy Total	Education Total
Iceland	1327.658411	113.451199	888.605421	325.601	Niger	10.241784	2.911499	-83.393815	90.664101
Trinidad and Tobago	1120.366401	56.9727	767.6999	295.6938	Chad	29.663914	-55.294102	8.358016	76.6
Qatar	1116.30829	88.78963	738.31866	289.7	Benin	62.925369	-19.669998	-56.733733	139.3291
Norway	1036.084396	122.61725	589.131846	324.3358	Haiti	76.387396	19.824101	-41.436705	98
United Arab Emirates	982.168167	87.39189	717.976277	176.8	Burkina Faso	84.651061	-22.579001	31.230062	76
Canada	936.520927	102.37089	521.975637	312.174	Eritrea	123.008	10.798599	-51.423979	163.63338
Kuwait	919.33665	93.48573	525.12577	300.7251	Somalia	127.637833	-32.600099	20.237932	140
Singapore	861.424962	99.58422	563.371743	198.468	Guinea-Bissau	130.302792	<null>	20.75859	149
Luxembourg	842.36254	103.25097	442.11157	297	Cote d'Ivoire	135.3889	-40.953297	15.534797	160.8074
Sweden	825.667355	120.635	396.789155	308.2432	Senegal	135.93809	6.897798	-3.981609	138.021901
Bahrain	814.2678	78.33856	467.72924	268.2	Mali	145.016715	-34.121897	71.013412	108.1252
New Zealand	802.771056	105.03127	361.259586	336.4802	Sierra Leone	145.060076	-68.956001	80.412877	133.603199
Austria	783.84405	129.14414	348.48831	306.2116	Nigeria	145.379814	-33.964599	-2.955586	182.3
Finland	782.485288	105.71554	359.087248	317.6825	Yemen	150.209977	6.168702	-12.758724	156.8
Belgium	774.35713	102.17349	354.94834	317.2353	Liberia	154.281275	1.1046	11.176675	142
Switzerland	756.908308	122.14567	326.356038	308.4068	Guinea	167.123471	-22.881698	78.23987	111.7643
Brunei Darussalam	754.136651	89.82343	372.913221	291.4	Mauritania	168.49979	-11.8826	47.48239	132.9
Australia	746.549054	111.18612	302.363934	333	Bangladesh	173.977599	39.3324	-29.432102	164.0773
Netherlands	735.462063	113.18874	284.069322	338.204001	Angola	174.777111	-49.0991	54.776211	169.1
United States	714.919425	101.53233	306.344294	307.042801	Central African Republic	175.232067	-49.656098	99.373435	125.51473
Denmark	714.742743	113.58243	263.777864	337.382	Tanzania	184.891625	9.361701	2.829624	172.7
Saudi Arabia	710.520421	92.2795	313.687821	299.553098	Mozambique	190.956939	-26.598803	111.755743	105.8
France	705.294369	109.91345	277.810219	317.5707	Burundi	216.297976	-39.625904	88.186179	167.7377
Spain	688.57646	120.68398	232.37028	335.0222	India	219.923494	17.481101	12.242393	190.2
Slovenia	680.615943	100.08526	269.505383	311.0253	Gambia	221.160534	1.148	47.205784	172.80675

[For the full Modernization Index scoring report please download this file.](#)

## **Conclusions**

In conclusion, the results from the Modernization Index scores seem to be accurate and telling. Unlike common global indicators, like GDP, the Modernization Index accounts for the fundamental sectors of civilizations; Health, Energy, and Education, to be assessed. As a result, the generated scores of Modernization helped to indicate the extent to which countries performed for its entire population. For example, India is ranked third in the world in terms of GDP, however the bulk of its population is still not modernized and in poverty. Therefore, India was 170<sup>th</sup> of 194 in this index.

## **References**

- [1] I. Kubiszewski, R. Costanza, C. Franco, P. Lawn, J. Talberth, T. Jackson and C. Aylmer, "Beyond GDP: Measuring and achieving global genuine progress", *Ecological Economics*, vol. 93, pp. 57-68, 2013.
- [2] I. Kubiszewski, "The Genuine Progress Indicator: A Measure of Net Economic Welfare", *Encyclopedia of Ecology*, pp. 327-335, 2018.
- [3] E. Grifell-Tatjé, C. Lovell and P. Turon, "The business foundations of social economic progress", *BRQ Business Research Quarterly*, vol. 21, no. 4, pp. 278-292, 2018.