Course Number: DATA 301 *Instructor: Dr. Osei Tweneboah*

Global Environmental Indicators

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Abstract: Global Environmental Indicators are important measures for monitoring the health of the planet and identifying potential environmental issues. This research examines the Energy and Minerals, Land and Agriculture, Natural Disasters, and Waste categories of the Global Environmental Indicators dataset to provide meaningful insights into the state of the environment. Utilizing data collected by the United Nations Statistics Division from various international sources, including pre-existing sources and self-reported country data. The data is analyzed to identify patterns and trends in the four categories. From the data analysis, it is found that natural disasters occur with varying frequency and intensity across different regions of the world. Energy production is more plentiful in wealthier countries, with many of the largest markets in the world having low percentages of renewable energy production. Waste reporting consistency varies among countries, and agricultural land use and fertilizer consumption show no noticeable patterns. These results conclude that data collected from Global Environmental Indicators can provide valuable insights into the state of the planet, enabling policymakers and regulators to address issues before they reach a critical level. The findings of this research highlight the importance of examining multiple categories of environmental statistics, as issues tend to be interlinked. The research also emphasizes the need for reliable and consistent reporting across countries to ensure accurate analysis and decision-making.

Keywords: Global Environmental Indicators; Energy and Minerals; Land and Agriculture; Natural Disasters; Waste Management; Data Analysis; Data Visualization; Climate Change

1. Introduction

The United Nations Statistics Division (UNSD) has pieced together the Global Environmental Indicators dataset primarily from pre-existing sources and self-reported country data [1]. National statistical offices or similar institutions provide some statistics for Water and Waste, based on the biennial UNSD/UNEP Questionnaire on Environment Statistics. Additionally, UNSD has integrated comparable data from OECD and Eurostat, and water resource statistics from FAO Aquastat [1]. The UNSD compiled data on other themes from various international sources, with minimal modifications to the source values [1]. Our research and analysis aims to utilize these simple measurements to provide meaningful insights and interpretations of what these indicators could potentially mean to the state of our environment.

The data categorizes various environmental statistics, such as Air and Climate, Biodiversity, Energy and Minerals, Forest, Governance, Inland Water Resources, Land

and Agriculture, Marine and Coastal Areas, Natural Disasters, and Waste with simple measurements [1]. Each category represents different facets of the environment, with specific information on the quality and status of each component.

Our specific focus was on Energy and Minerals, Land and Agriculture, Natural Disasters and Waste indicators. Insights into the production and consumption of fossil fuels, renewable energy sources, and mineral resources are offered by energy and minerals, providing a wealth of information on energy use and renewable energy production. Data on agricultural land use offers information on fertilizer consumption, land usage, and terrestrial protected areas. These statistics help show how we use our land for farming purposes and what geographical patterns arise when examining country data. Furthermore, the waste indicator provides data on the production, management, and disposal of waste materials. These indicators offer insights into the amount of waste generated, recycling rates, and landfill use. Lastly, the natural disaster indicator provides information on the frequency, intensity, and location of natural disasters such as hurricanes, earthquakes, and floods. Which helps us understand the vulnerability of populations to natural disasters.

Together, these four indicators - though providing very different information - can help showcase a broad range of issues that may be interlinked. Examining each one individually could be useful for not only a specific analysis, but potential relationships between the categories. It also provides an introduction, or sort of a stepping stone, into how to go about analyzing global environmental indicators and doing more large-scale research on the rest of the environmental statistics. In essence, as environmental stresses tend to be caused by a whole host of issues, not on one specific indicator, our focus would have been limited looking at only one type of statistic. Branching out into these four categories gives us the largest range and opportunity to provide useful insights.

Global Environmental Indicators provide valuable insight into the state of the planet, enabling analysis and comprehension of its health. They are straightforward measures that offer an effective and economical means of monitoring the environment, potentially alerting us to upcoming environmental issues [1]. Therefore, recording and understanding these indicators can strengthen the ability of policymakers and regulators to address issues before they reach a critical level. Ultimately, these indicators play a crucial role in guiding policy and decision-making by providing essential information on the state of the planet and identifying potential environmental issues

2. Materials and Methods

The dataset comprises a vast collection of indicators and their measurement statistics, ranging from highly specific to general information. They are separated into several files based on their respective environmental factors. For instance, the land and agriculture indicator contains three data frames on agricultural land, fertilizer consumption and terrestrial protected areas. This structure holds true for most of the remaining indicators, with several subsections of data contained within each environmental factor. In addition, the data typically has measurements for each indicator per country. These characteristics are critical to our exploratory data analysis and data preparation, as we must take into account the data set's structure. We examined specific indicators in isolation, resulting in similar data processing and cleaning. For specific data processing and reproducibility, it is encouraged to view *Appendix A* which includes codes for each indicator. All of our work was done with Python and the pandas library

There are several noteworthy cleaning techniques we employed and considered regarding the datasets in question. Specifically, we observed that there were missing values in the dataset, indicated by the presence of ellipses (i.e., "...", "…"). However, imputing these missing values is not a feasible option due to the nature of the data being country-specific, and such imputation could potentially lead to inaccurate and misleading results. While we did consider imputing these values based on surrounding regions or countries, such an approach may still be susceptible to accuracy issues thus it was avoided. There was also missing data that was expected to be there, i.e. countries that should have been in the datasets were not there. These were not missing values, e.g. null values, but rather data that was simply absent from ever being recorded. We did find some interesting results on missing this, specifically with how countries self-reported their statistics, which will be investigated in our results section.

Moreover, we encountered some empty columns in the dataset, which was likely a result of how the .csv files were formatted. In order to facilitate data analysis and avoid any potential complications, we opted to drop this column. In addition, we identified some observations in the dataset where values exceeded 1000 and were represented using white spaces to indicate their magnitude. To continue with the analysis, we first removed these white spaces and then converted the column to a numeric data type. This was necessary to ensure the accuracy and validity of subsequent analyses.

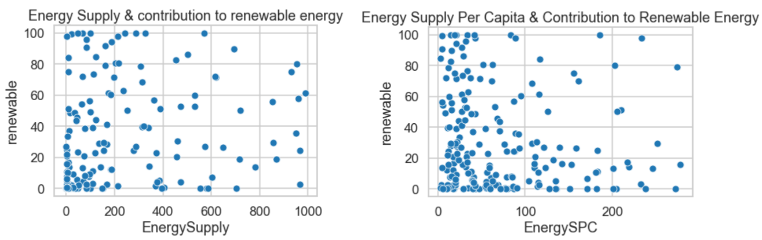
As for visualizations and exploratory data analysis, we used a combination of ggplot, plotly, seaborn and matplotlib python libraries. For operations like summary statistics, we used a combination of built-in functions, pandas, and scipy. Once again it is encouraged to look at specific codes for creating these graphs that are all listed in *Appendix A* (our jupyter notebook file) as they provide better insight into our exact methods.

3. Results

3.1 Energy

The energy dataset is a dataset that contains information about energy indicators across different countries over the world. The dataset is eighty-eight percent full. Because of this, it was appropriate to drop rows with missing values since a large number of countries would still remain. The key features of the dataset are country name, the total energy supply in gigajoules, the energy supply per capita in petajoules and percentage of contribution of renewable energy production

3.1.1 Correlation of energy dataset



(a) (b)

Figure 1. This figure shows the correlation between total energy supply and percentage of contribution to renewable energy(a) and the correlation between energy supply per capita and contribution to renewable energy(b).

3.1.2 Correlation between Energy Per Capita and Country Totals

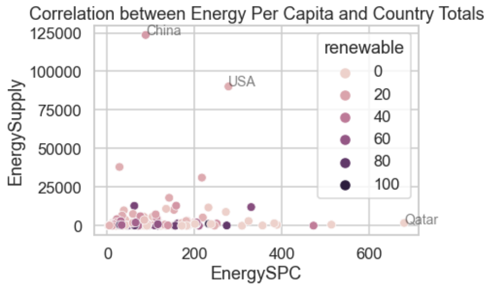
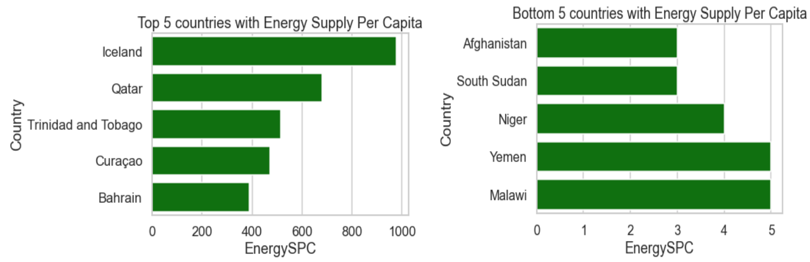


Figure 2. This figure shows the correlation between total energy supply and the energy supply per capita. The hue of this graph indicates the percentage of renewable energy in that country.

3.1.3 Energy supply per capita



(a) (b)

Figure 3. This figure shows the top five countries(a) and the bottom five countries(b) in terms of energy supply per capita.

3.1.4 GDP per capita and Oil Deposits of The Middle East

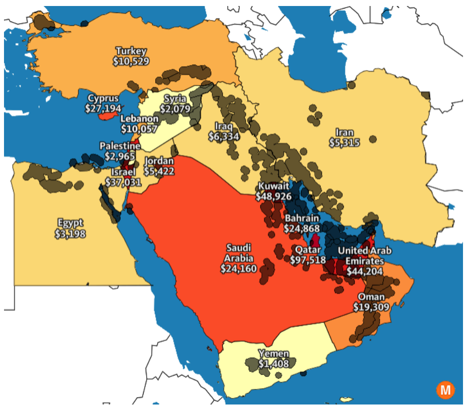


Figure 4. This figure shows the GDP per capita of some countries in the middle east. The black dots on this map indicate oil deposits[2].

3.1.5 Renewable Electricity Production Percentage by Country

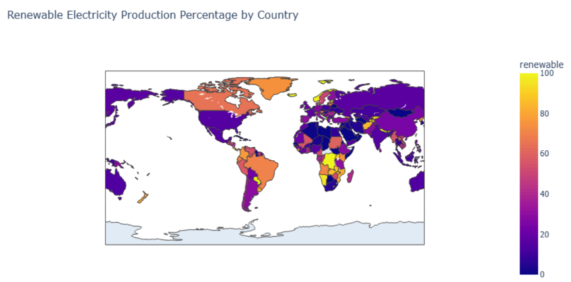


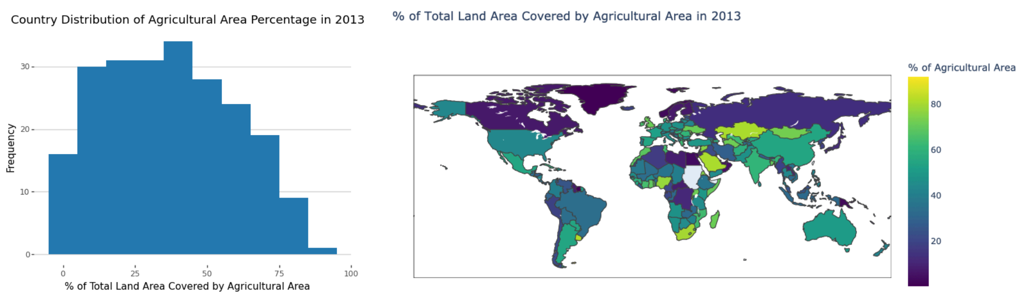
Figure 5. This map shows the percentage of contribution to renewable energy across different countries around the world.

3.2 Land and Agriculture

The land and agriculture global environmental indicator was subdivided into three main categories: agricultural land usage, fertilizer consumption and terrestrial protected areas. Agricultural land usage refers to the amount of land used for agricultural purposes, such as farming and grazing. This indicator is important because it reflects the amount of land that is available for food production and the potential impact on natural habitats. Fertilizer consumption is directly impacted by agricultural land, as it was measured based on that subcategory - specifically in tonnes of nutrients per 1000 hectares of agricultural land area. Terrestrial protected areas refer to areas of land that are set aside for conservation and biodiversity purposes. These areas can include national parks, wildlife reserves, and other protected areas.

Our main goal was to understand if agricultural land was influenced by geographical region, i.e. does a country location on the map influence land usage for agricultural purposes. Furthermore, our interests also were on how much total land area is actually used for agriculture. With discerning any geographical patterns from fertilizer consumption, mainly can we find any patterns in how a country consumes fertilizer. Lastly, we wanted to analyze similar questions for terrestrial protected areas.

3.2.1 Agricultural Land Percentage per Country



(a) (b)

Figure 6. This figure shows the distribution of the percent of total land area covered by agricultural area for all reported countries(a) and the map shows percent of total land area covered by agricultural area for all reported countries around the world based on 2013 (b) both based on 2013 data.

3.2.2 Distribution of Fertilizer Consumption per Country

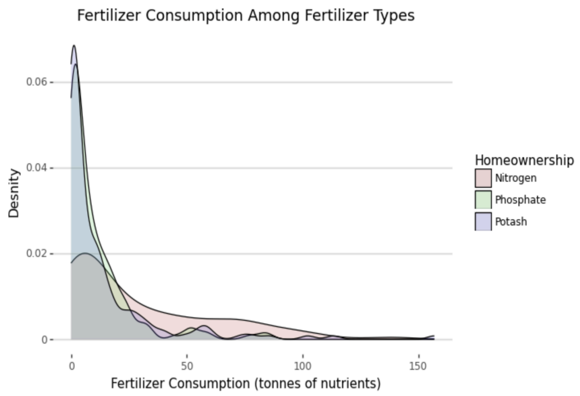
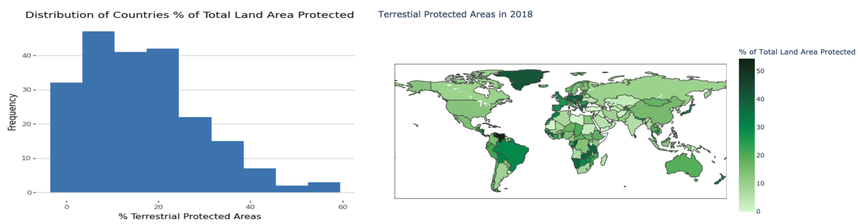


Figure 7. This figure shows the distribution of types of fertilizer consumption (in tonnes of nutrients) for all countries reported.

3.2.3 Terrestrial Protected Areas



(a) (b)

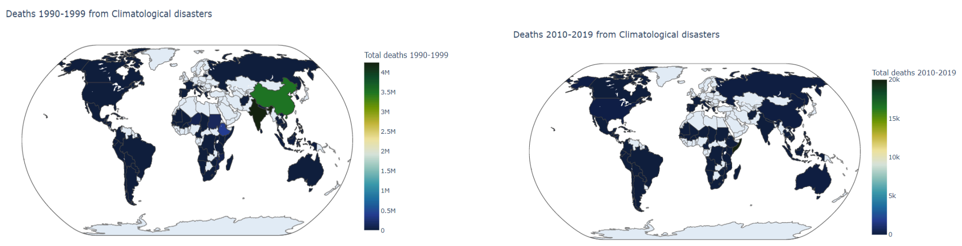
Figure 8. This figure shows the distribution of the percent of total land area covered by terrestrial protected areas for all reported countries(a) and the map shows percent of total land area covered by terrestrial protected areas for all reported countries around the (b) both based on 2018 data**.**

3.3 Natural Disasters

The classification for natural disasters includes four categories: climatological, geophysical, hydrological, and meteorological. Climatological hazards arise from long-term atmospheric processes that vary from seasonal to decadal in terms of climate variability; e.g. drought and wildfires [1]. Hydrological disasters are formed from water, either it be movement or interaction between fresh and saltwater; e.g. floods, landslides, and waves [1]. Meteorological disasters are, on the other hand, caused by short-lived extreme weather and atmospheric conditions that last from minutes to days [1]. These weather conditions include extreme temperature, fog, and storms [1]. Disasters are only recognized when they meet at least one of the following criteria: 10 or more deaths, 100 or more people affected/injured/homeless, or a declaration by a country of a state of emergency and/or appeal for international assistance [1].

Our main interest is to explore the relationships between the four categories of natural disasters - climatological, geophysical, hydrological, and meteorological - and how they have changed over time. More specifically if each disaster has some sort of pattern between each other or if in general they have increased over time.

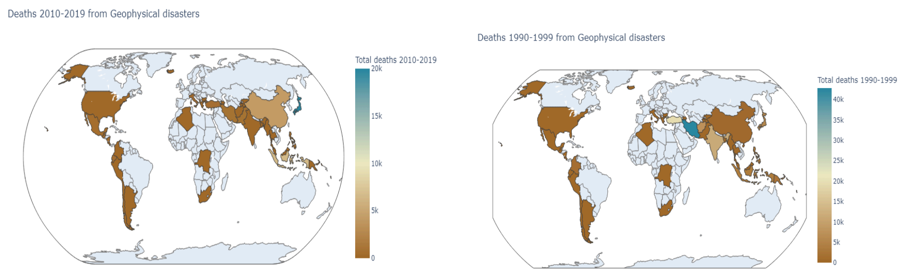
3.3.1 Climatological Disasters



(a) (b)

Figure 9. This figure shows the Choropleth of total deaths reported in the countries reported from 1990-1999 caused by Climatological disasters (a) and the map to the right shows the total number of deaths 2010 - 2019 caused by climatological disasters (b).

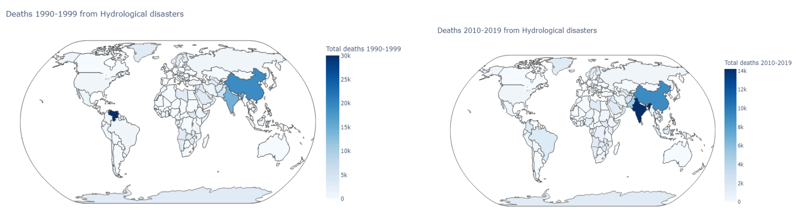
3.3.2 Geophysical Disasters



(a) (b)

Figure 10. This figure shows the Choropleth of total deaths reported in the countries reported from 1990-1999 caused by Geophysical Disasters (a) and the map to the right shows the total number of deaths 2010 - 2019 caused by Geophysical Disasters(b).

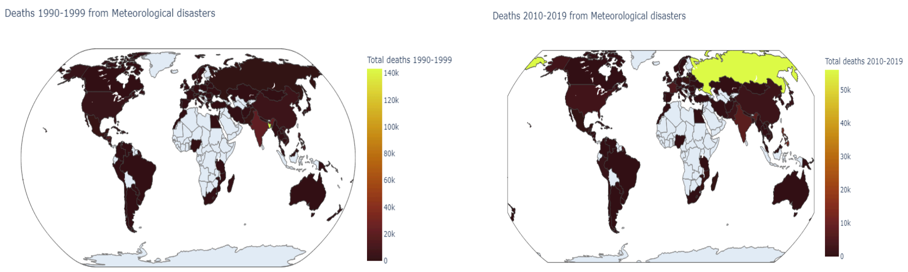
3.3.3 Hydrological Disasters



(a) (b)

Figure 11. This figure shows the Choropleth of total deaths reported in the countries reported from 1990-1999 caused by Hydrological Disasters (a) and the map to the right shows the total number of deaths 2010 - 2019 caused by Hydrological Disasters (b).

3.3.4 Meteorological Disasters



(a) (b)

Figure 12. This figure shows the Choropleth of Total deaths reported in the countries reported from 1990-1999 caused by Meteorological Disasters (a) and the map to the right shows the total number of deaths 2010 - 2019 caused by Meteorological Disasters (b).

3.4 Waste

Waste has many forms and organizations like the United Nations have developed reporting programs for countries so the UN can keep track of waste. The UNSD/UNEP Questionnaire gives countries the opportunity to report on their waste compositions, population served by waste collection, waste generated per capita, and other waste topics. The three examples mentioned will be used for analysis, and all of them are located in their own commas separated file. Countries, like the U.S. and EU members, use separate databases to record their data and are not inherently included in the UNSD/UNEP results. Therefore, many of the countries that have data belong to the South American, African, and Asian continents. Similar to the other files belonging to the Kaggle dataset, missing data was an issue. Based on the scope of the project, it would not be reasonable to impute the data. The data that was collected is the only data that was used.

3.4.1 Research Questions

Three questions were asked when looking at the three waste topics: what does the composition of municipal waste look like and how does it compare to global statistics, is there a relationship between population served by waste collection and waste generated, and how does the missing data affect conducting analysis? The third question will be answered as part of the discussion portion of this paper.

3.4.2 Describing the Composition of Municipal Waste and Testing

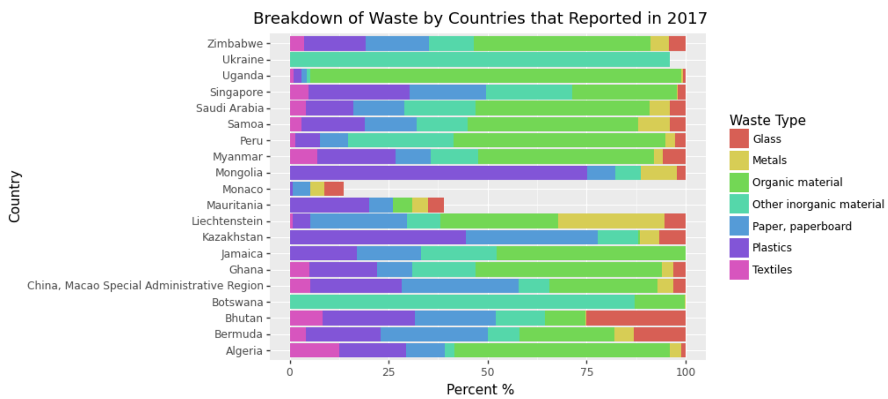
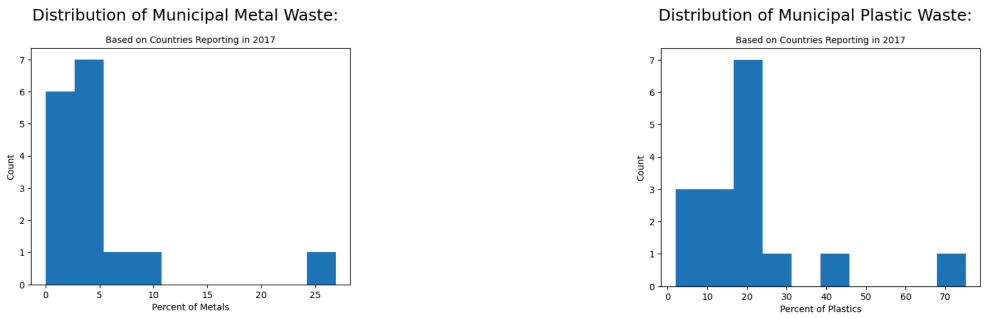


Figure 13. This graphic displays the composition between all different waste types from the 20 countries that reported most recently (2017).



(a) (b)

```
TtestResult(statistic=0.5591521966943062, pvalue=0.5843103641924565, df=15)
```

(c) Metal Waste Hypothesis Test

```
TtestResult(statistic=-5.272508891505925, pvalue=9.382911855104886e-05, df=15)
```

(d) Plastic Waste Hypothesis Test

Figure 14. Graphs (a) and (b) represent the distributions of the top 20 countries based on a specific waste category. (a) shows the metal waste, and (b) shows the plastic waste. (c) and (d) represent the results of two-sided hypothesis tests. (c) displays the results of the metal hypothesis test. (d) shows the results of the plastic hypothesis test.

3.4.3 Relationship Between Population Served by Waste Collection and Waste Generated

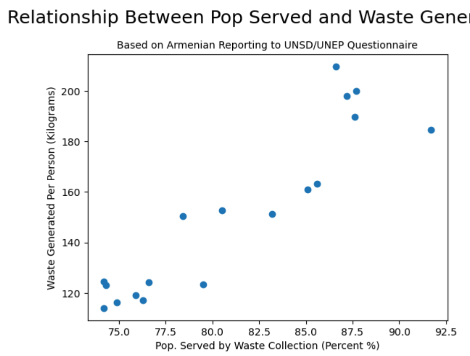


Figure 15. Shows the correlation between waste generated and population served using Armenia's self-reported data.

4. Discussion

4.1 Energy

4.1.1 Correlation

Analyzing figure 1, we can see that there appears to be no correlation between energy supply per country(a) and energy supply per capita(b) to the percentage of that country's energy that is renewable. Therefore, we can see not conclude that a country converting to renewable energy will yield a higher supply of energy. This is an unfortunate finding as it would have been evidence to present in order to push the initiative of renewable energy.

Analyzing figure 2, we can see that there does not seem to be a correlation between energy supply per capita and the total supply of energy in a given country. That being said, there are some interesting outliers here which yield interesting results. First looking at China, we notice that although it has one of the highest total energy amounts, it has a pretty low average energy supply per capita. Secondly, looking at the United States, we see a very high total energy supply as well as an above average energy supply per capita. Lastly, looking at Qatar we notice a very low total energy supply but one of the highest energy supplies per capita.

4.1.2 Energy Supply Per Capita

Analyzing figure 3, we can see that the middle east has two countries in the top five energy supply per capita(Qatar, Bahrain) as well as two countries in the bottom five energy supply per capita(Afghanistan, Yemen). To explore the reasoning for this further, additional information had to be retrieved. Using figure 5, we can see that Bahrain and Qatar have a significantly higher GDP per capita than Yemen. Although not included in figure 4, as of 2021, Afghanistan has an even lower GDP per capita than Yemen at 368.8 USD [2] via worldbank. This leads us to the conclusion that countries in the middle east with more energy end up having more energy per capita.

4.1.3 Renewable Electricity Production by Country

Analyzing figure 5, we can see that the three biggest economies (China, U.S. , Europe) have a fairly low percentage. There also seems to have been some sort of renewable electricity initiative in some of the southern African countries.

4.2 Land and Agricultural

4.2.1 Agricultural Land Usage

Analyzing the histogram represented in Figure 6(a), it showcases an interesting and informative view of the global agricultural landscape, portraying the extent to which agricultural land coverage constitutes a major portion of the total land area in various countries around the world. The data in Figure 6(a) is indicative of the fact that a considerable proportion of land across the globe is reserved for agricultural purposes, with the percentages varying significantly from one region to another. This finding shows that approximately 40% of the world's total land area is used for agricultural purposes when looking at an average for per country basis.

Moreover, Figure 6(b) provides a much more detailed representation of the distribution of agricultural land coverage at the country level. The data in this figure reveals that a significant portion of the world's countries maintain agricultural lands. There are some geographic patterns. mostly there is less agricultural land percentage in more northern areas. But the main result is that most countries' land usage is for agricultural purposes. In essence Figure 6(b) shows that a majority of countries across the globe reserve a considerable amount of land for agricultural purposes

4.2.2 Fertilizer Consumption

From Figure 7, A1, A2, and A3, it can be analyzed that there is no clear pattern in fertilizer consumption based on the percentage of agricultural land. Figure 6, which is a ridge plot of three fertilizers - Nitrogen, Phosphate, and Potash - shows that the distribution of fertilizer consumption is generally low for all three types, with each being around 10 tonnes of nutrients per 1000 hectares of agricultural land area for each country.

Additionally, Figures A1, A2, and A3, which show choropleths of Nitrogen, Phosphate, and Potash, respectively, reveal no discernible pattern in terms of geographical location. The majority of countries exhibit similar consumption rates for fertilizers, with most countries having low and comparable consumption rates, and only a few outliers. Therefore, it can be inferred that the level of fertilizer consumption is not significantly influenced by the percentage of agricultural land or geographical location.

4.2.3 Terrestrial Protected Areas

Based on Figures 8(a) and 8(b), it is apparent that the distribution of percent of total land area covered by terrestrial protected areas does not seem to follow a clear pattern based on the size of a country or its region. Figure 8(a) presents the distribution of percent of total land area covered by terrestrial protected areas for each country, and it can be observed that the range of values varies widely, from 0% to over 50%, with most lying at around 17%. However, there is no apparent pattern between the total land area of a country and the percentage of protected land. This suggests that the size of a nation does not necessarily influence how much area is protected.

Moreover, Figure 8(b), which shows a choropleth map of percent of total land area covered by terrestrial protected areas, further supports this conclusion. The map displays a range of colors indicating different levels of protected land, and it is evident that there is no clear pattern based on the region. Countries in the same region may have vastly different levels of protected land. It appears that the region does not significantly influence how much land is protected. Overall, the average of 17% of total land area protected per country provides some insight into the global picture of terrestrial protected areas. However, it is essential to note that this average may not accurately represent the distribution of protected areas across different regions or country sizes. Further analysis and exploration may be necessary to understand the factors that influence the percentage of protected land in different countries.

4.3. Natural Disasters

There are multiple types of natural disasters while I would be more interested in breaking down the specifics of what each disaster was caused specifically. In this case the data didn't include those numbers. In addition to that there were a lot of missing values which needed to be dropped. With that in mind the years were in connection within 9 years of each other and I was unable to do a time series technique in that regard.

4.3.1 Climatological Disasters

In this section we focused heavily on the total deaths from 1990-1999 and from 2010-2019 in regards to Climatological Disasters shown in figure 9. From this part the Cholorpeths didn't show a discernable pattern. The country with the most deaths from 1990-1999 was that of China with over 3 million dead and the highest number of deaths from 2010-2019 is that of the United States with 202 deaths. From these two graphs we can confidently state there is no pattern in regards to the specific countries and the deaths after the natural disaster section of Climatological Disasters.

4.3.2 Geophysical Disasters

In this section we focused heavily on the total deaths from 1990-1999 and from 2010-2019 in regards to Geophysical Disasters shown in figure 10. from this part the Cholorpeths didn't show a discernable pattern. The country with the most deaths from 1990-1999 was that of Iran with over 42 thousand dead and the highest number of deaths from 2010-2019 is that of Japan with over 20 thousand deaths. From these two graphs we can confidently state there is no pattern in regards to the specific countries and the deaths after the natural disaster section of Geophysical Disasters.

4.3.3 Hydrological Disasters

In this section we focused heavily on the total deaths from 1990-1999 and from 2010-2019 in regards to Hydrological Disasters shown in figure 11. from this part the

Cholorpeths didn't show a discernable pattern. The country with the most deaths from 1990-1999 was that of China with over 19k dead and the highest number of deaths from 2010-2019 is that of India with over 14k deaths. From these two graphs we can confidently state there is no pattern in regards to the specific countries and the deaths after the natural disaster section of Hydrological Disasters.

4.3.4 Meteorological Disasters

In this section we focused heavily on the total deaths from 1990-1999 and from 2010-2019 in regards to Meteorological Disasters shown in figure 12. from this part the Cholorpeths didn't show a discernable pattern. The country with the most deaths from 1990-1999 was that of Bangladesh with over 140k dead and the highest number of deaths from 2010-2019 is that of Russia with over 50k deaths. From these two graphs we can confidently state there is no pattern in regards to the specific countries and the deaths after the natural disaster section of Meteorological Disasters.

4.3. Waste

4.3.1 Describing the Composition of Municipal Waste and Testing

The composition of municipal waste is a file that describes the breakdown of reporting countries based on their most recent report. Out of 94 recorded countries, only 20 countries provided their most recent statistics in 2017. The stacked bar chart, Figure 13, shows three countries that do not add up to 100%. Ukraine, Mauritania, and Monaco all fail to properly report their composition of waste. The UNSD/UNEP questionnaire allows countries to add footnotes to adjust information; however, there are no footnotes explaining this discrepancy. Botswana, a country that does have data totaling 100%, has an odd composition. Of the variety of waste types, Botswana lists only organic and other inorganic waste. it might be the case that Botswana placed all of their inorganic waste into that category but that is speculation.

For the hypothesis tests, 16 countries were used out of the 20 from 2017. Ukraine, Mauritania, Monaco, and Botswana are excluded because of their discrepancies. The test will have a 99% confidence interval. Using information from a World Bank article in 2016 [7], two statistics, the global percentages of metal (4%) and plastic (44%) waste were taken to be used. Figure 14(c) shows that there is no significant difference in the questionnaire metal percentages and the global metal percentage. So, the results indicate that their percentages fall within the 99% confidence interval. Figure 14(d) shows that there is a significant difference between the collected global plastic percentage. This means that the percentages fall outside the 99% confidence interval.

4.3.2 Relationship Between Population Served by Waste Collection and Waste Generated

The second table, population served by waste collection, contains the percent of the municipal population over the years successfully served by waste services. The final table uses kilograms to describe the amount of waste generated per capita. Finding correlations between the two features was an incredibly difficult task. Unfortunately, many of the values were not consistently recorded over the years and few countries could be used to create visuals. To select candidates for visuals, selection was done to filter out all countries that had five or fewer missing values. Armenia was the only country that consistently reported data and filled out both population served and waste generated portions of the UNSD/UNEP Questionnaire. Figure 15 shows that there appears to be a positive correlation between the two variables.

4.3.3 Dealing with Missing Data

Missing data and misreported data was especially prevalent in waste research. In both of the research questions, missing data was present that contributed to preventing insightful comparisons between countries. Looking at the databases used by Europe and the U.S. to record waste information shows a stark contrast. Many countries that use the two databases consistently report their data. So, why is there such a difference? The answer is most likely not because of any particular reason but many. A possibility, and this is speculation, could be countries do not want to report poor numbers. Another idea might be that countries do not have the infrastructure to report waste data. It may be that data is recorded elsewhere and not properly shared.

5. Conclusions

This research shows how data collected from environmental indicators can be used to provide meaningful insight for groups around the world looking to improve the environment. Through data analysis, many insights were drawn that would never have been possible to see without data collection combined with data analysis. Some key insights found in this project research are; energy is more plentiful in countries that are richer. Just because countries are in the same regions with similar resources, does not mean they have the same access to energy, the main deciding factor in energy supply is that country's wealth. Also while looking at energy data, it was deduced that some of the largest markets in the world, United States, Europe, China, all did not have a high percentage of contribution to renewable energy production. It is great to see some countries make an effort for this type of energy, but that being said it is going to take the countries with the higher energy outputs to step up if the world really wants to help the environment by converting to renewable energy.

Then looking at waste, a big thing would be touching on the reporting consistency of waste from different countries. Many of the countries did not consistently report data. When they did, the data was not always reliable. Waste management is an issue that affects every country in the world. It is crucial to monitor and track waste generation and disposal rates to identify trends and improve waste management strategies. However, as highlighted in this discussion, the reporting consistency of waste data from different countries remains a significant challenge. The lack of consistency and reliability in waste data reporting makes it difficult to compare waste management practices between countries, and hinders efforts to develop effective waste reduction policies and programs.

Then looking at land and agriculture, we can see that Land area covered by agricultural land is quite high in terms of distribution, i.e. most countries have a lot of agricultural land area compared to their total land area. When looking at the distribution, it appears that on average roughly 40% of total land is used for agriculture[4]. Additionally, Fertilizer consumption has no noticeable pattern, and does not increase or decrease based on agricultural land percentage; most countries share similar consumption rates. Terrestrial Protected Areas also don't show a pattern based on total land area. The size of the nation and the region doesn't appear to change how much area is protected.

After analyzing country data on natural disasters from 1990 to 2019, we did not identify any consistent geographical or interlinked patterns between the four disaster types: Climatological, Geophysical, Hydrological, and Meteorological. However, it is important to note that the frequency and severity of natural disasters have increased in recent years, highlighting the urgent need for proactive measures to mitigate their impact. Though not finding any specific patterns in our data, besides a small general increase, our results still underscore the critical importance of taking action to address natural disasters.

In conclusion, this research demonstrates the value of environmental data collection and analysis in understanding global trends and developing effective strategies for improving the environment. Key insights were drawn from the analysis of energy, waste, land and agriculture, and natural disaster data, highlighting both challenges and opportunities for progress. The results underscore the importance of consistent and reliable data reporting, proactive measures to mitigate the impact of natural disasters, and a concerted global effort to transition to renewable energy sources. By leveraging the power of data to inform decision-making and action, we can work towards a more sustainable future for all.

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Data Availability Statement: The data used for this research comes from the United Nations. Their website contains information on several topics. For the purposes of this research, datasets relating to environment statistics were used.
Link to dataset : https://unstats.un.org/unsd/envstats/qindicators.cshtml

Appendix A

Our codes and direct methods for completing our visuals and analysis are contained within separate Jupyter Notebook Files [they are included as a .zip in our submission] each detailing a separate global environmental indicator: Energy and Minerals, Land and Agriculture, Natural Disaster, and Waste. Each approach was different based on the data each indicator provided. These codes provide a further explanation into how our research was conducted, and thus it is encouraged that it is viewed.

Appendix B

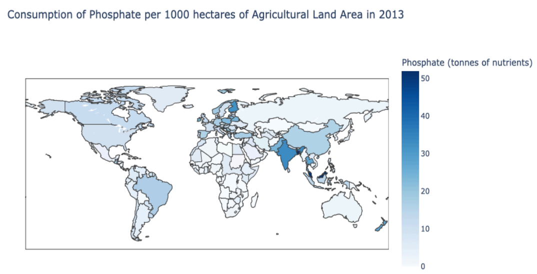

Figure A1. This map shows the consumption of phosphate fertilizer (in tonnes) per 1000 hectares of agricultural land areas per country in 2013.

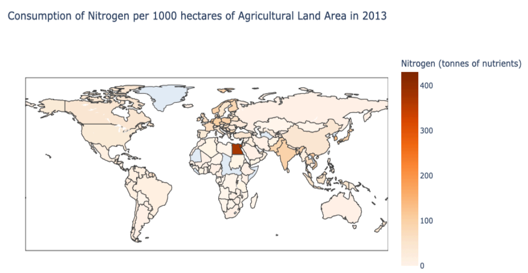

Figure A2. This map shows the consumption of nitrogen fertilizer (in tonnes) per 1000 hectares of agricultural land areas per country in 2013.

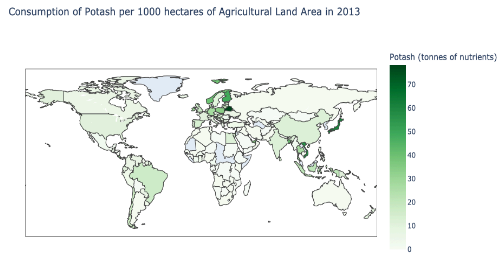

Figure A3. This map shows the consumption of potash fertilizer (in tonnes) per 1000 hectares of agricultural land areas per country in 2013.

References

1. UNSD Environmental Statistics: https://unstats.un.org/unsd/envstats/qindicators.cshtml (27/04/2023)
2. The World Bank.Available online: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=AF (28/04/2023)
3. Metrocosm. Available online: http://metrocosm.com/wp-content/uploads/2015/12/middle-east-wealth-oil-2.png (28/04/2023)
4. Our World in Data. Available online: https://ourworldindata.org/land-use (28/04/2023)
5. OECD Country Statistics online: https://stats.oecd.org/ (03/05/2023)
6. Eurostat Country Statistics online: https://ec.europa.eu/eurostat/data/database (03/05/2023)
7. What a Waste 2.0 online: Trends in Solid Waste Management (03/05/2023)