APPLIED DATA SCIENCE 1
ASSIGNMENT 2: STATISTICS AND TRENDS

ANALYSIS OF WORLD BANK DATA REPORT

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GITHUB LINK:
https://github.com/rkrohith23/ADS1_Assignment_2.git

DATASET LINK:
https://data.worldbank.org/topic/climate-change

ABSTRACT: FOR THIS ANALYSIS, 7 COUNTRIES FROM DIFFERENT CONTINENTS WERE SELECTED. THIS STUDY EXPLORES THE INTERCONNECTED DYNAMICS OF KEY INDICATORS, NAMELY RENEWABLE ENERGY CONSUMPTION, FOSSIL FUEL ENERGY CONSUMPTION, TOTAL GREENHOUSE GAS EMISSIONS, CO2 EMISSIONS, POPULATION GROWTH, AND GDP GROWTH. BY EXAMINING THESE VARIABLES, WE AIM TO UNDERSTAND THEIR INTERPLAY AND POTENTIAL IMPLICATIONS ON THE ENVIRONMENTAL AND ECONOMIC LANDSCAPE. THE ANALYSIS ENCOMPASSES A COMPREHENSIVE INVESTIGATION INTO THE TRENDS AND PATTERNS OF RENEWABLE AND FOSSIL FUEL ENERGY CONSUMPTION AND THE ASSOCIATED ENVIRONMENTAL IMPACTS MEASURED THROUGH GREENHOUSE GAS AND CO2 EMISSIONS. ADDITIONALLY, THE STUDY DELVES INTO THE DEMOGRAPHIC ASPECT, CONSIDERING THE POPULATION GROWTH RATE, AND THE ECONOMIC DIMENSION THROUGH GDP GROWTH. THROUGH A MULTIFACETED EXAMINATION, WE SEEK TO DISCERN POTENTIAL CORRELATIONS AND DEPENDENCIES AMONG THESE INDICATORS.
ANALYSED THE FOLLOWING USING PYTHON LIBRARIES SUCH AS PANDAS, NUMPY, SCIPY, MATPLOTLIB, AND SEABORN.

12 December 2023

INVESTIGATING GLOBAL SHIFTS IN ENERGY CONSUMPTION AND GHG EMISSION PATTERNS : A COMPREHENSIVE ANALYSIS [1990-2020]

As the contemporary goal of world nations is to reverse the damage caused to the environment over all these years, the key focus is on collectively reducing the growth of any of the factors causing damage. To come up with any of the strategies to achieve this, it is important to analyze the relationship between key variables, particularly regarding energy usage and Greenhouse gas emission patterns. The following work analyses the environmental impact of 7 different nations and their shift in trends observed in population growth, Fossil fuel energy consumption and Renewable energy consumption, CO2 emissions, and Total Greenhouse gas emissions.

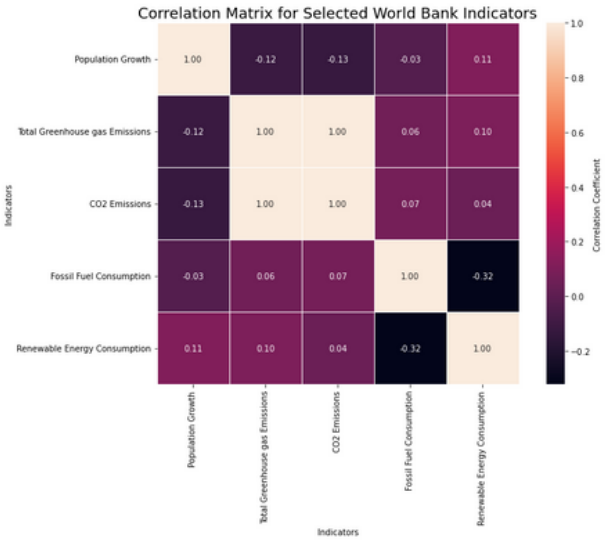

FIG 1: CORRELATION MATRIX

Fig1 shows the variation in one trend affecting the other factors indicating Energy consumption and GHG emission. A positive correlation with Total Greenhouse Gas Emissions and CO2 Emissions would suggest that an increase in renewable energy adoption may contribute to lower emissions. On the other hand, exploring the correlation with Fossil Fuel Energy Consumption would provide insights into the potential substitution effect between renewable and fossil fuel sources. the correlation between Fossil Fuel Energy Consumption and environmental indicators is crucial. A positive correlation between greenhouse gas and CO2 emissions would underscore the environmental impact of fossil fuel consumption. A positive correlation coefficient of value r = 0.11 shows the directly proportional relationship between population growth and R.E consumption whereas a negative value of r = -0.32 shows an inverse proportionality relationship between R.E consumption and Fossil fuel consumption and similarly direct proportionality nature of CO2 emissions is shown with Fossil fuel consumption and Total GreenHouse emissions with positive r value overall. Additionally, understanding the relationship with Population Growth can illuminate the role of energy demand in tandem with demographic changes.

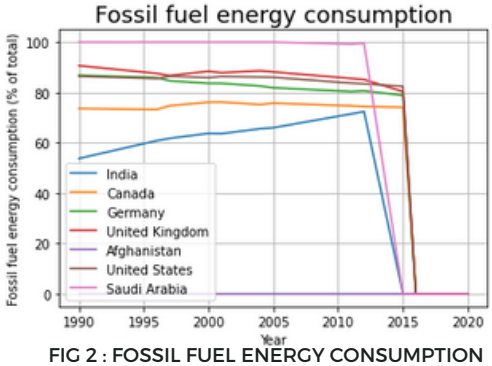

FIG 2 : FOSSIL FUEL ENERGY CONSUMPTION

Fig 2 depicts the fossil fuel energy consumption trends of 7 nations observed from year 1990 to 2020. All these nations showed a significant fall in Fossil Fuel Consumption in the decade 2010 to 2020 after a steady or slow growth from 1990 to 2010 representing the growing awareness of nations in responsible usage of resources and environmental concerns by indirectly choosing some alternatives. Major consumption was by Saudi Arabia and UK, Germany, etc. nations but Saudi Arabia was early to realize and cut down its Fossil Fuel consumption. Economically developing nations like India showed consumption growth and later also cut down their consumption. Afghanistan did not rely much on Fossil Fuels indicating its slow economic growth.

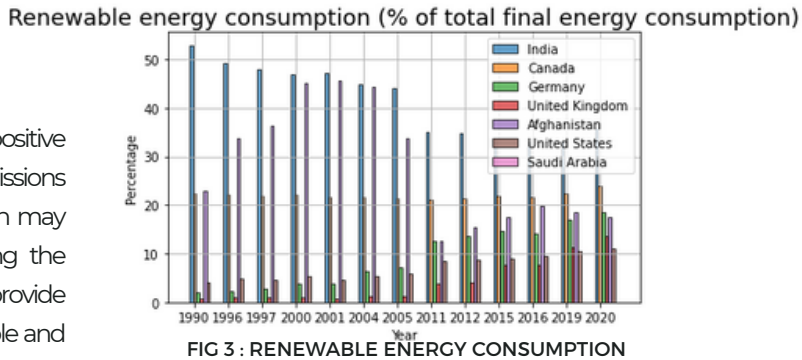

FIG 3 : RENEWABLE ENERGY CONSUMPTION

The better alternative for limited fossil fuels is renewable energy and here Fig 3 shows the percentage usage of Renewable energy consumption out of Final energy consumption. Different nations due to different reasons changed their percentage consumption of Renewable energy and dependency on it. Countries like India, the USA, and Afghanistan have shown a noticeable reduction in the percentage consumption of Renewable Energy whereas other nations like Canada, Germany, the UK, and Saudi Arabia maintained a steady growth in dependency on renewable energy out of total final energy consumption.

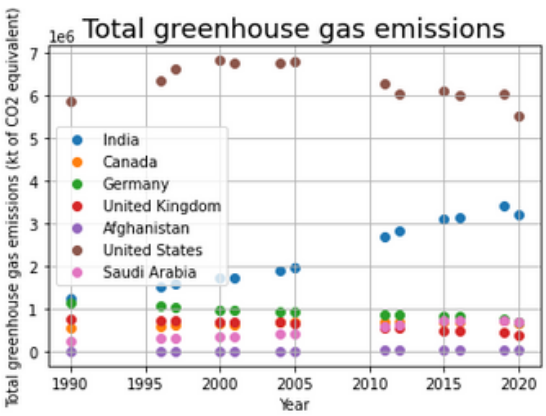

FIG 4: TOTAL GREENHOUSE GAS EMISSIONS

Consumption of any energy emits gases into the atmosphere and here Fig 4 shows the total greenhouse gas emissions of observed nations from 1990-2020 in terms of kt of CO2 Equivalent. Nations like the UK, Saudi Arabia, Afghanistan, Germany, and Canada have noticeably maintained their Greenhouse gas emissions in 0 to 1 kt of CO2 equivalents. whereas India showed a steady growth in Greenhouse gas emissions till 2005 and a rapid increase later. And the USA which has been highly emitting from the beginning remained at higher than 6 kt emissions and gradually reduced after the year 2010.

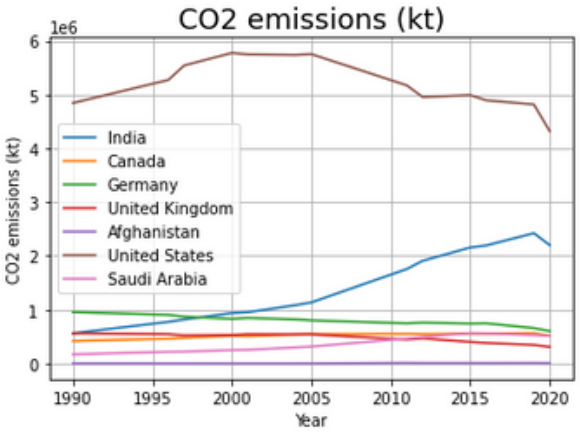

FIG 5 : CO2 EMISSIONS(KT)

One of the major contributors to Greenhouse gas emissions is inevitably CO2. Fig 5 shows the CO2 emission pattern of 7 nations from 1990 -2020, measured in kilo tonnes(kt). The US from the beginning of 1990 remained as highest contributor to CO2 and started to steadily decline following 2010 and India increased its emissions after 2005 in a noticeable manner. Whereas remaining countries like the UK, Canada, Afghanistan, and Saudi Arabia remained as comparatively low contributors to CO2 emissions. Saudi Arabia being a major consumer of fossil fuels in the beginning but contributing less to CO2 emissions represents its smart usage of energy in a sustainable way.

FIG 6 : POPULATION GROWTH(ANNUAL %)

The major driver of shifts in energy consumption patterns is population growth. Population growth demands better management of resources and affects consumption and emission patterns. Fig 6 shows the percentage of population growth in different nations. Major growth in population over the year 2020 compared to the last 2 decades is observed in Afghanistan with a 44% increase but its low contribution to consumption or emissions depicts a hindering and stagnant economic growth. However, countries with meagr population growth but following high consumption and emission patterns are a matter of concern as they depict rapid and unsustainable usage of resources.

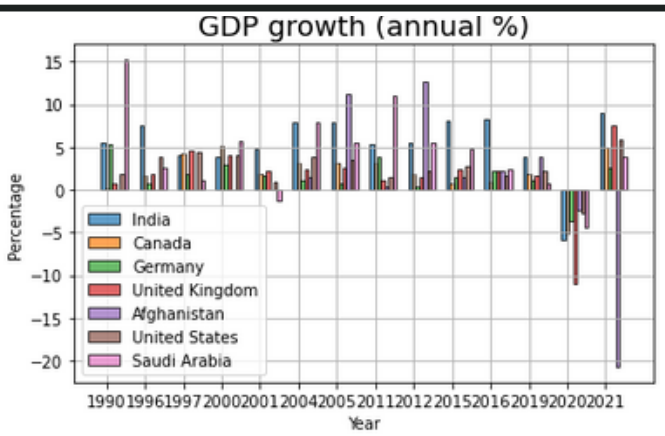

FIG 7 : GDP GROWTH(ANNUAL %)

An increase in consumption patterns and population also alters a nation's GDP and it is observed over two decades 1990 - 2020 in Fig 7. At the beginning of 1990, GDP growth for Saudi Arabia was highest which shows its efficient generation of revenue from fossil fuels as observed earlier, but started declining rapidly over the years. India also had a steady GDP growth up to the year 2000 and it also increased its GDP in later years probably due to population growth or other factors. The fluctuating nature of Afghanistan's GDP except in the years from 2005 to 2015 depicts economic instability in that nation. Other countries maintained a steady GDP growth. A reversal of growth charts is observed in the year 2020 with negative values as the global pandemic forced an economic slowdown. Later, countries recovered from this situation except Afghanistan due to its underlying reasons

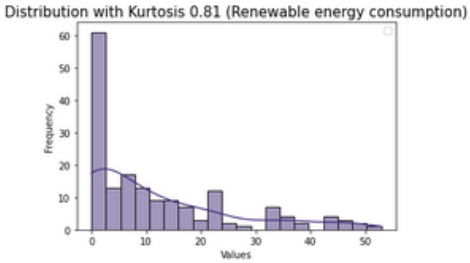

FIG 8 : KURTOSIS DISTRIBUTION (RENEWABLE ENERGY CONSUMPTION)

The kurtosis value of (0.8050) for Renewable Energy Consumption over countries provides information about the shape of the distribution of this variable. A positive kurtosis value indicates that the distribution has fatter tails than a normal distribution. The skewness value of (-0.4860) for the Fossil Fuel Energy consumption over countries indicates the asymmetry in the distribution of this variable. Specifically, a negative skewness suggests that the distribution is skewed to the left, meaning that the tail on the left side of the distribution is longer or fatter than the right side.

CONCLUSION: As we have observed different indicators of environmental concern which directly and indirectly are playing their role in increasing CO2 emissions, with interdependent nature, this kind of analysis acts as an input to qualitative research in their respective fields. Better research helps in understanding key focus areas of nations' interest and designing policies on that path. The early realization of a few nations like the United Kingdom and its efforts towards mitigation measures and sustainable development can be appreciated by the policies it is implementing. International cooperation with clear motives helps bring back the environment to a balance.