Human Development Index 2021

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Introduction

The **Human Development Index (HDI)** is a statistic developed by the United Nations since 1990 to measure various countries' levels of social and economic development. It is a summary measurement of basic achievement levels in human development.

The HDI of a country is calculated by taking the geometric mean of the indices of the following three aspects:

- **Knowledge and Understanding:** Education is measured by the *mean years of schooling* for residents of a country, and the *expected years of schooling* that a child has at the average age for starting school. These are each separately normalized so that both 15 mean years of schooling and 18 years of expected schooling equal 1, and an arithmetic mean of the two is calculated.
- **A Long and Healthy Life:** This aspect of the HDI is measured by the *life expectancy*, as calculated at the time of birth, in each country, and normalized so that this component is equal to 0 when life expectancy is 20 and equal to 1 when life expectancy is 85.
- **An Acceptable Standard of Living:** Standard of living represented by is *GNI per capita* based on purchasing power parity (PPP), a common metric used to reflect average income. The standard of living is normalized so that it is equal to 1 when GNI per capita is $75,000 and equal to 0 when GNI per capita is $100.

$$HDI = \sqrt[3]{(I_h * I_e * I_i)}$$

where
I_h is the indicator for health,
I_e is the indicator for education and
I_i is the indicator for income.

This project aims to analyse patterns of HDI values across different regions and growth patterns over the years. We study the factors contributing to HDI and visualise the relationships between them. We also study how the HDI is distributed across continents.

Data Description

Dataset

The variables of interest are as follows:

For 2021 -

1. `Country`: Name of the country
2. `HDI Value`: Value of HDI
3. `Life Expectancy at Birth`: Number of years a newborn infant could expect to live if prevailing patterns of age-specific mortality rates at the time of birth stay the same throughout the infant's life.

4. `Expected years of schooling`: Number of years of schooling that a child of school entrance age can expect to receive if prevailing patterns of age-specific enrolment rates persist throughout the child's life.
5. `Mean years of schooling`: Average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level.
6. `HDI Level`: A categorical variable indicating whether the level of HDI is "Very High", "High", "Medium", "Low" or "Other".
7. `Gross National Income per capita`: Aggregate income of an economy generated by its production and its ownership of factors of production.

For Other Years -

7. `HDI Value`: 1990, 2000, 2010, 2015, 2018, 2019, 2020
8. `Average Annual HDI Growth %`: 1990-2000, 2000-2010, 2010-2021, 1990-2021
9. `Change in HDI rank`: Change in HDI rank from 2015 to 2021

Exploratory Data Analysis

HDI Across the World (2021)

The graph displayed below represents a heatmap illustrating the distribution of Human Development Index (HDI) values for countries across the world in the year 2021. In this map, the colour scale ranges from green, representing countries with high HDI scores, to red, indicating countries with low HDI values. Countries with data unavailable are coloured grey.

HDI for Various Countries on the World Map
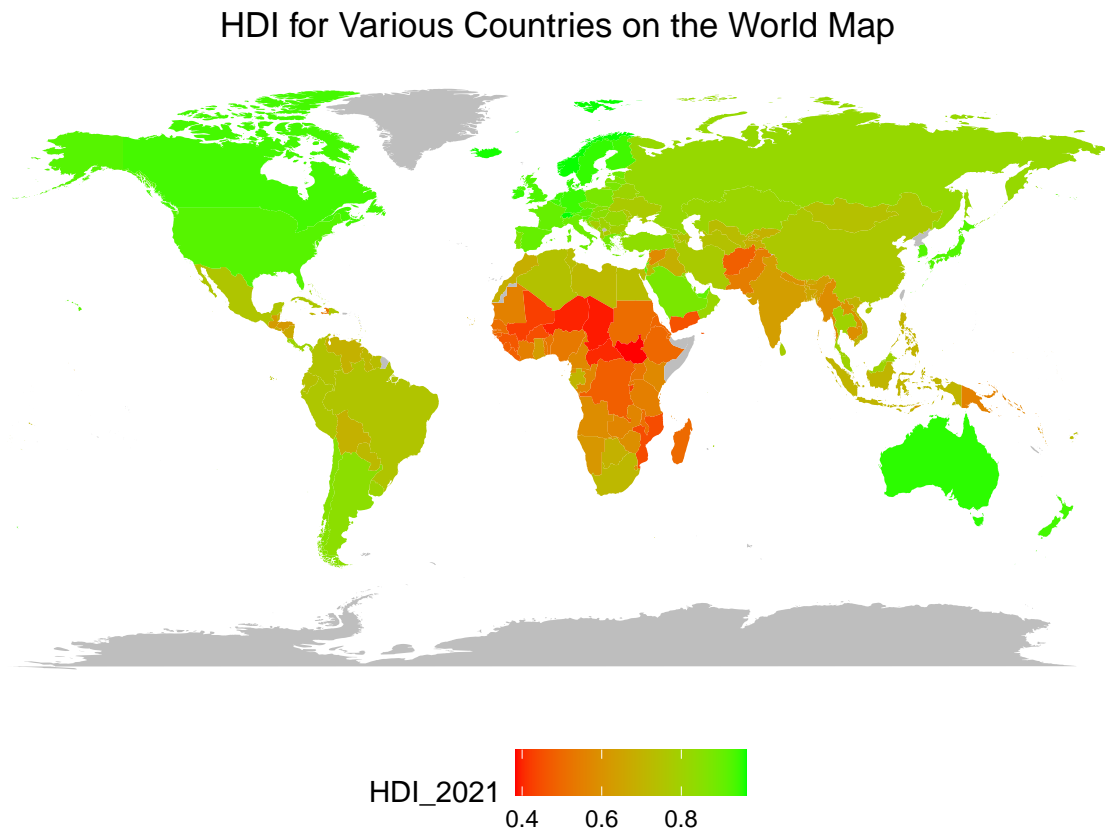
Countries with green shades on the map are considered to have a higher overall development status. These nations typically offer longer life expectancy, better access to education, and higher income levels for their populations. Conversely, countries shaded in red on the map exhibit lower levels of human development. This may be due to factors such as limited access to quality healthcare, education, and economic opportunities.

We can observe how HDI values tend to cluster regionally. Neighboring countries often share similar colors, indicating similarities in development profiles within specific geographic areas.

This heatmap reveals the global landscape of human development, showcasing disparities and trends in well-being across countries.

Growth Across the World, 2015-2021

This map offers a visualization of the Average Annual Human Development Index (HDI) Growth % for countries spanning the period from 2010 to 2021.

## Average Annual HDI Growth % on the World Map
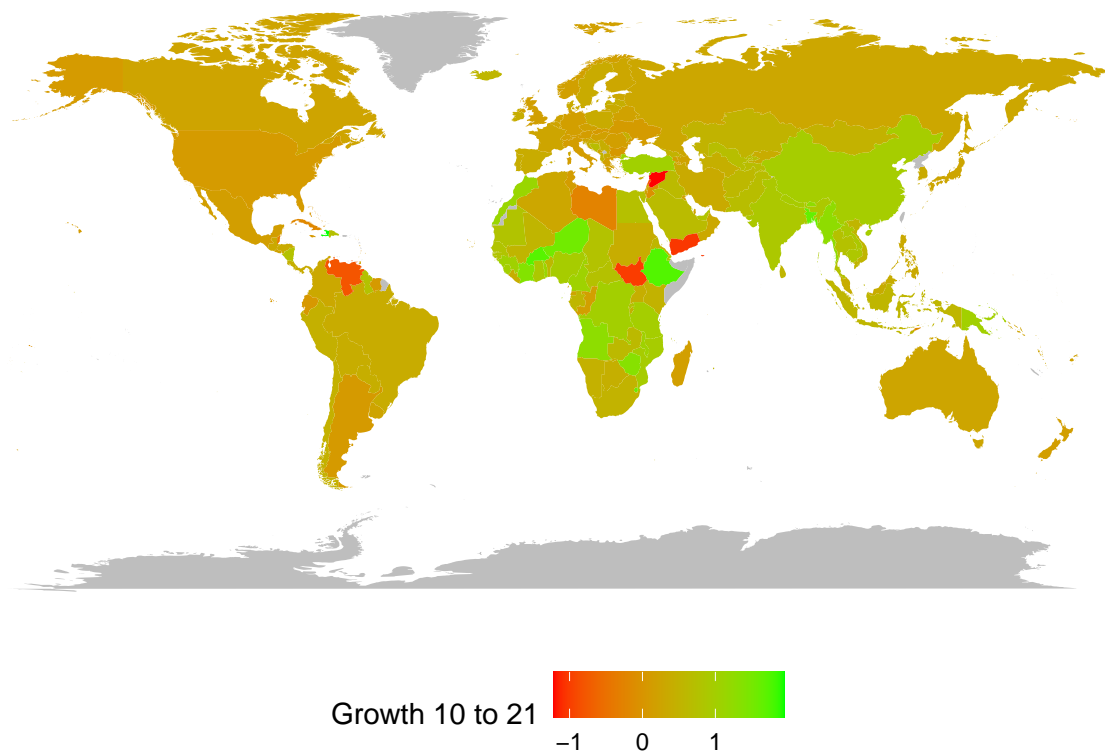
Patterns Observed:

- **High HDI, Slower Growth:** Countries characterized by robust HDI values in 2021, exhibit the trend that their HDI growth rates during the 2010-2021 period have been notably moderate. These nations have already reached relatively high levels of development, and as a result, are experiencing slower progress in further enhancing their human development indicators.

- **Low HDI, Rapid Growth:** In stark contrast, nations shown in red on the map, indicating lower HDI levels in 2021, have demonstrated remarkably rapid growth in the preceding decade. Their significant HDI growth underscores efforts in areas such as education, healthcare, and economic opportunities.

Thus, it is observed that underdeveloped economies tend to grow more rapidly than wealthier economies.

Correlation between Factors Contributing to HDI

Since HDI is calculated as the geometric mean of indices on education, life expectancy and income, it is anticipated that these variables will exhibit a strong positive correlation with HDI. Higher values in these variables contribute to higher HDI scores.
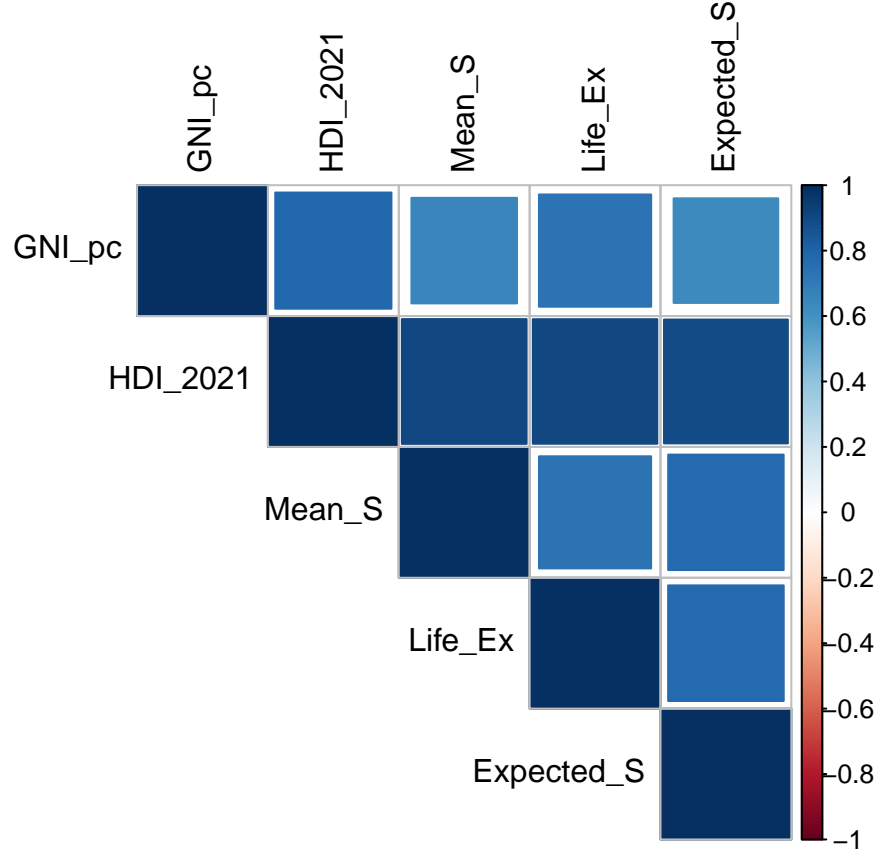
As per the graph, a strong positive correlation observed among the variables themselves, beyond their relationship with HDI. This interconnectedness reveals that there is a relationship between these human development indicators. For example, Life Expectancy (Life_Ex) and Mean Years of Schooling (Mean_S) display a substantial positive correlation, implying that nations with longer life expectancy tend to have higher levels of mean years of schooling.

The implication is that among the variables national income, education and life expectancy, if a country performs well (or, poorly) in one factor, it is likely to perform well (or, poorly) in the other two factors as well.

Table 1: Correlation Matrix

	HDI_2021	Life_Ex	Expected_S	Mean_S	GNI_pc
HDI_2021	1.0000000	0.9058326	0.8955481	0.9090683	0.7880344
Life_Ex	0.9058326	1.0000000	0.7799285	0.7340464	0.7355562
Expected_S	0.8955481	0.7799285	1.0000000	0.7781145	0.6391404
Mean_S	0.9090683	0.7340464	0.7781145	1.0000000	0.6506939
GNI_pc	0.7880344	0.7355562	0.6391404	0.6506939	1.0000000

Gross National Income v/s Education and Life Expectancy

A striking observation is the non-linear nature of the relationships depicted in the scatter plot. We observe that improvements in education and life expectancy indicators tend to saturate at higher GNI levels.
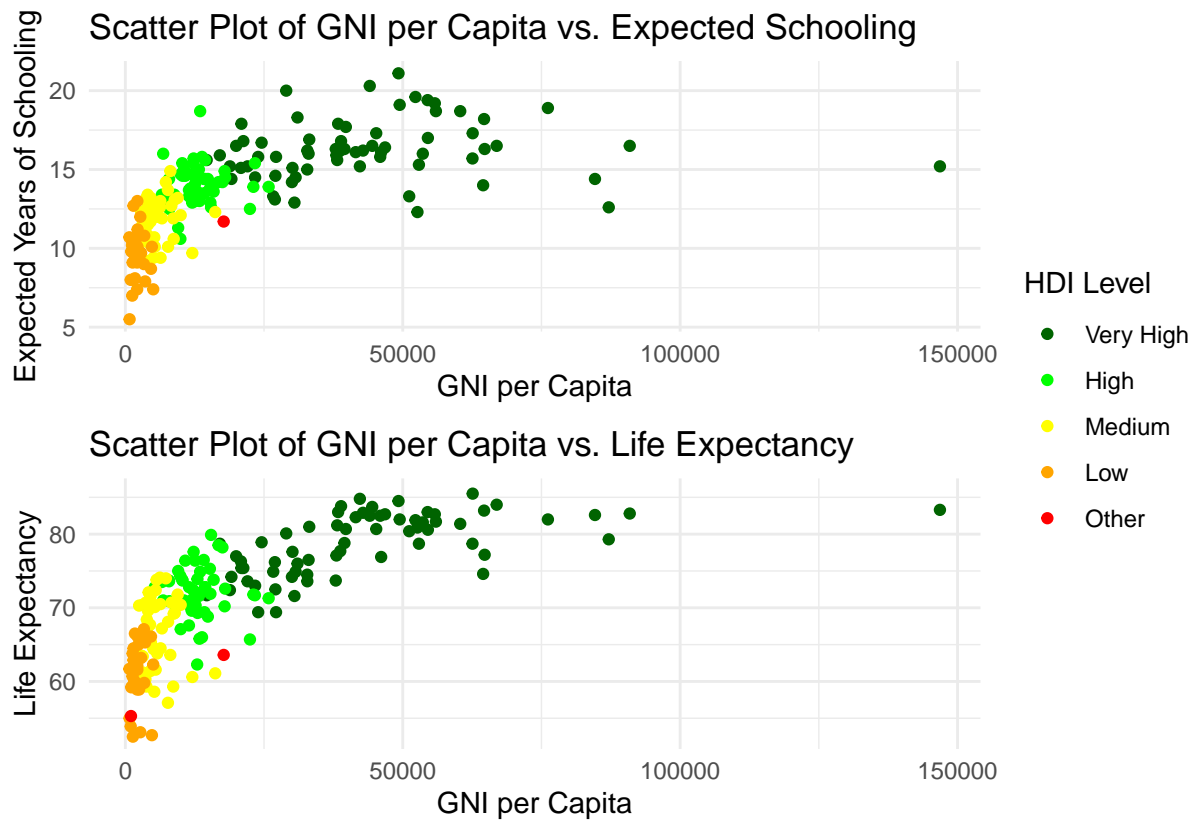
- **Diminishing Returns:** As GNI increases, the rate of improvement in education and life expectancy tends to slow down. While higher income contributes positively to these indicators, it does not guarantee indefinite increases. After a point, additional income may not lead to significant gains in education or life expectancy.

- **Distribution by HDI Levels:** Very High and High HDI countries tend to possess high GNI, education levels and life expectancy. Low HDI countries are situated at the bottom of the graph. Though some medium-income nations have managed to achieve progress in education and health, others face significant challenges.

Stacked Bar Chart of Continent by HDI Levels
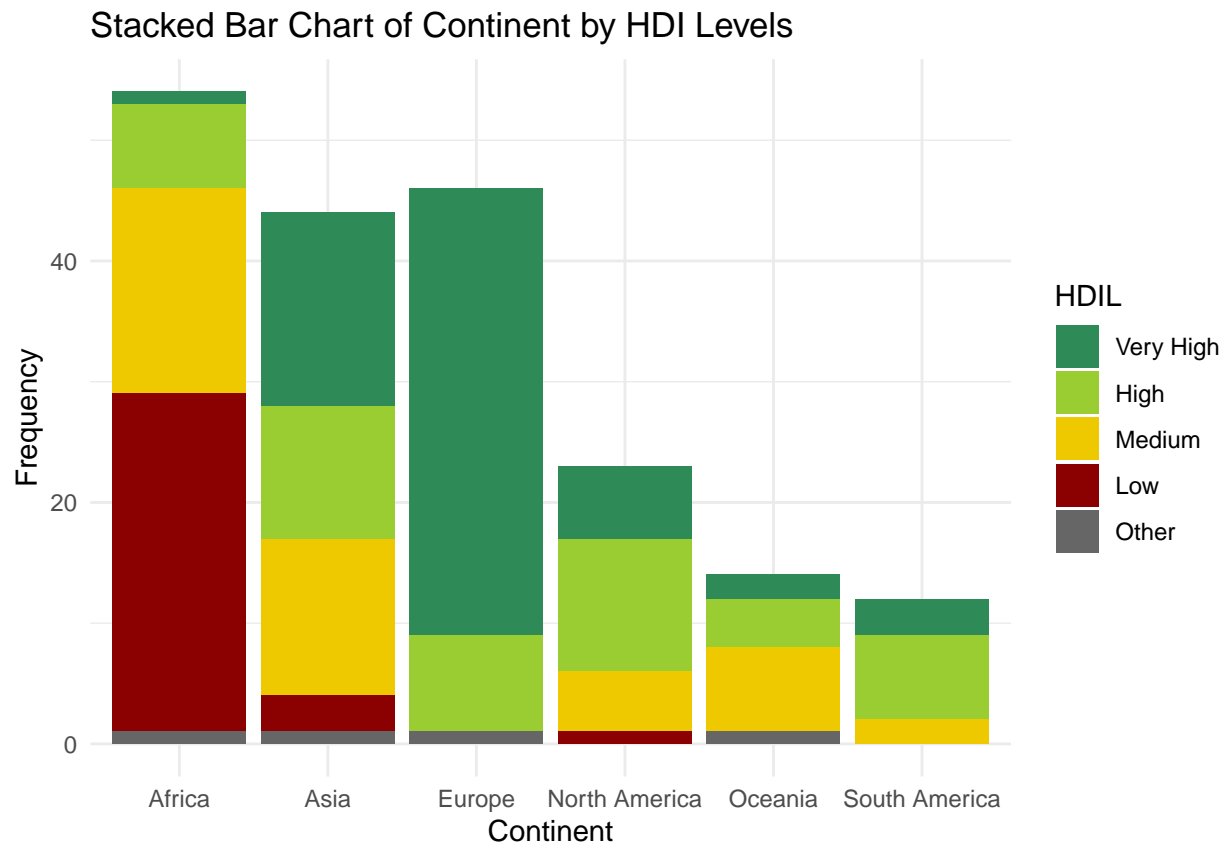
The following is observed from the stacked bar chart:

- **Africa:**

  - *Most Number of Countries:* Africa is the continent with the highest number of countries, encompassing a diverse range of HDI levels.
  - *Predominance of Low HDI:* A significant portion of African countries falls into the Low HDI category, highlighting the region's developmental challenges. Africa has the largest concentration of low HDI countries globally.
  - *Medium and High HDI Representation:* While Low HDI countries dominate, Africa also includes countries in the Medium and High HDI categories, though in smaller numbers.

- **Asia:**

  - *Few Low HDI Countries:* Asia has a smaller proportion of Low HDI countries compared to Africa.
  - *Distributiom of Very High, High and Medium HDIs:* Asia has a balanced distribution of Very High, High and Medium HDIs. We observe that the continent is not overwhelmingly dominated by any one level of HDI.

- **Europe:**

  - *High Proportion of Very High HDI:* A large number of European countries have Very High HDIs, emphasizing the region's advanced development status.
  - *Absence of Low HDI:* Europe does not have any Low HDI countries, signaling a notably higher overall development level.

- **North America, South America and Oceania:**

  - *High and Medium HDI Representation:* These continents predominantly consist of countries in the High and Medium HDI categories, highlighting their advanced development levels.
  - *Limited Low HDI Presence:* The presence of Low HDI countries is limited in North America, and no Low HDI country is present in South America and Oceania.

Mean HDI Values of the Continents for Different Years

The line graph presented below provides a view of how HDI values have evolved across the world's continents over the years.
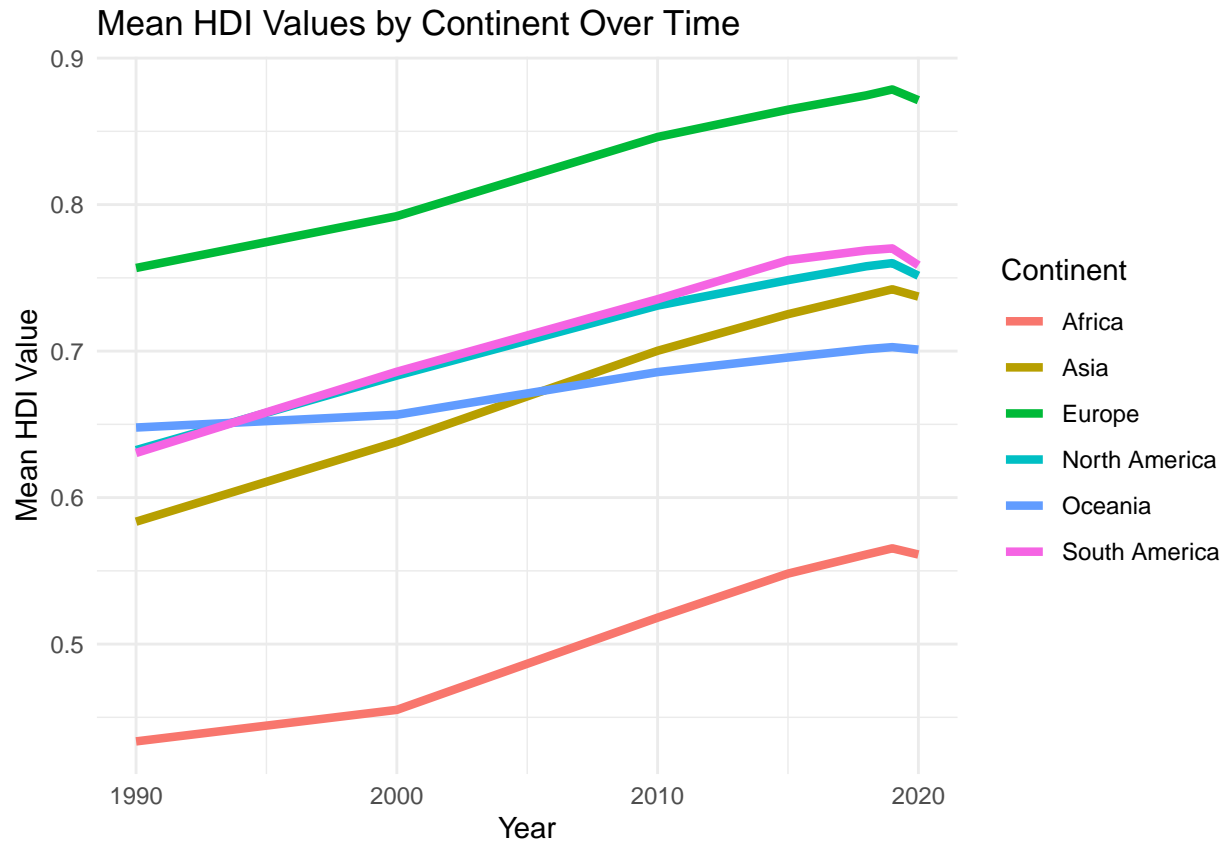

From the graph, we observe the following key takeaways:

- **Global Progress:** Over the years, the global HDI landscape has generally improved, reflecting advancements in education, healthcare, and economic well-being worldwide.

- **Continental Diversity:** The graph highlights the diverse HDI trajectories followed by different continents. We observe consistently since 1990, that Europe and Africa have been the continents with the maximum and minimum mean HDI values respectively.

Human Development Index ranks serve as a measure of a nation's progress in improving the well-being of its citizens, relative to other nations. The following graph describes the changes in HDI ranks from 2015 to 2021, offering insights into countries that have witnessed significant advancements and those which face challenges in their journey toward human development.

Changes in HDI Ranks from 2015 to 2021
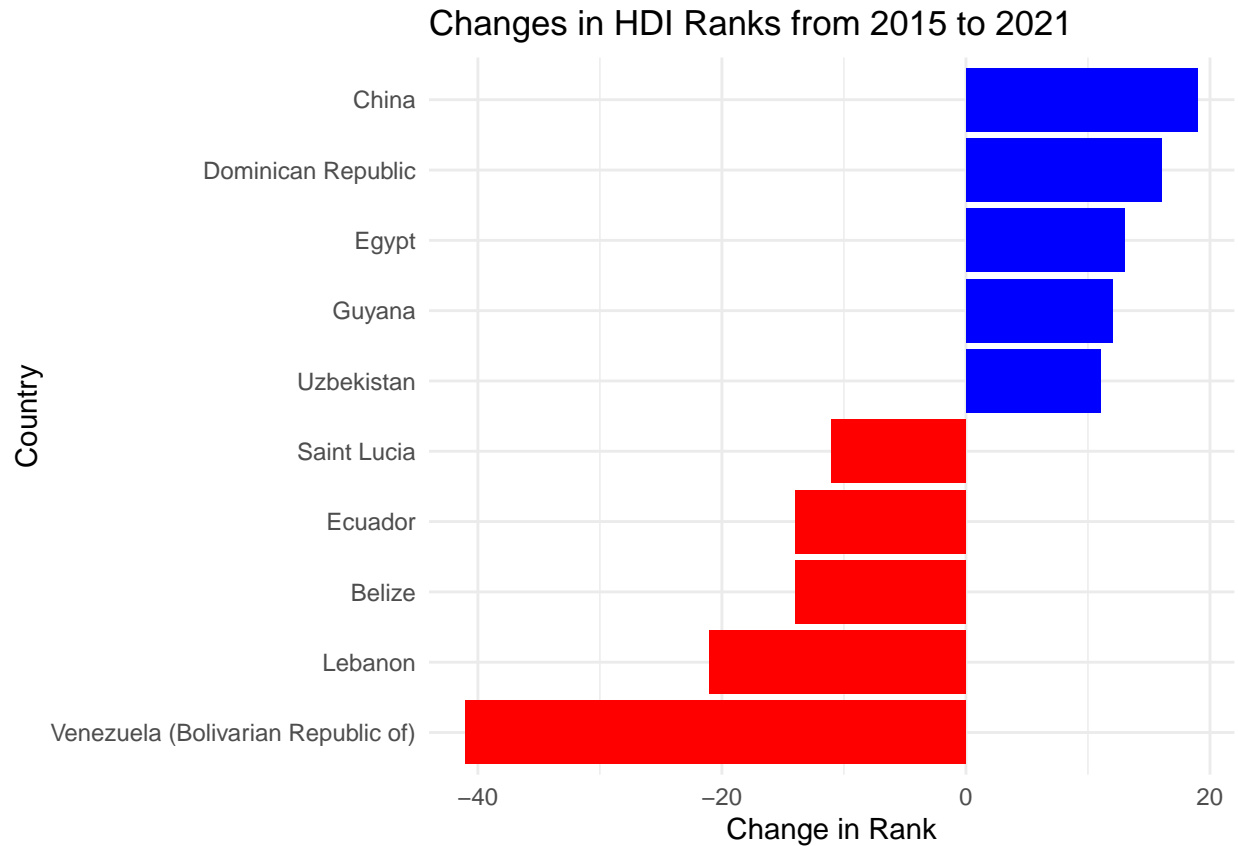
It can be observed from the graph that **China** has demonstrated the greatest positive change in HDI Rank, ascending significantly during this period. **Venezuela** on the other hand, fell more than 40 ranks, implying that the country faced severe challenges during this period.

Results

- HDI values tend to cluster regionally, i.e., neighboring countries often share similar HDI values.

- High HDI countries show moderate growth, whereas Low HDI countries experience rapid progress. This implies that underdeveloped economies tend to grow more rapidly than wealthier economies.

- There exists strong positive correlations among education, life expectancy, income, and HDI. Nations excelling in one factor tend to excel in others.

- On comparing Gross National Income with Education and Life Expectancy, we observe that improvements tend to saturate at higher GNI levels. This implies that returns diminish with higher income.

- Africa has the most countries in the world, and the maximum proportion of Low HDI countries. Europe is dominated by Very High HDI countries while Asia has a balanced distribution.

- It is observed with consistency that Europe and Africa have been the continents with the maximum and minimum mean HDI values respectively.

- With respect to change in HDI Ranks from 2015 to 2021, China has had a significant positive change while Venezuela has suffered a substantial drop in ranks.

Conclusion

The implications of these results offer insights into global development challenges and opportunities. It portrays a need for tailored development strategies in areas with lower human development. We also observe that for development of a region, simply increasing income may not guarantee improved quality of life. Instead, targeted interventions are required.

The multidimensional nature of human development reveals disparities, growth patterns, and interconnectedness among factors. The implications extend to policy formulation in order to improve the well-being of populations worldwide.