# **Using R to analysis World Development Indicators**

# - Globalization, climate change and malnutrition: Income-Temperature-Stunting relationship in a cross-nation study

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## **ASSERT model ------ A visualisation theoretical framework to tell an insightful story**

### **A -- Ask a question**

Here we want answers for the question:

1. During the globalization process, did economic benefits it brought cover its damage to the environment and to health?

To answer this question, we make following hypotheses:

# The damage to the environment

* Global warming and the emergence of climate extremes are related;

# The comparison of benefit and damage

* People in wealthy countries who benefit from trade boost could also be strongly influenced by global warming;
* The growth in the economic area alone is not able to solve the malnutrition problem in all low-income countries.

### **S -- Search for information**

### In need of testing hypotheses and to address the related question, we applied the ASSERT framework. We gathered data from the Word Bank data time series (2019) catalogue. Here we will use World Development Indicators (WDI) dataset, which contains the most up-to-date official data available on global development for the years 1960-2019 (World Bank, 2017). Specifically, following visualizations come from Droughts, floods, extreme temperatures (% of the population, average 1990-2009); CO2 emissions (kt); the population of female and male; Prevalence of stunting, height for age (percentage of children under 5); population ages 00-04.

### **S -- Structuring the data**

WDI dataset seems to be a relatively large dataset. So the first step is to select subsets and filter out irrelevant indicators. Also, we need to clean it as the time series consists of loads of missing value. Here we simply remove missing values due to two reasons. One is that we will conduct time series analysis, and there are too many nations. The other is that there are too many changes across time and not enough background information. We need to avoid misleading results by using mean values to represent.

The globalization progress is represented by income as it shows capital assets and its distribution is highly sensitive to changes in globalization (Milanovic, 2005).

Climate change is evaluated by the average percentage of the population in one area who suffered from droughts, floods and extreme temperature from 1990 to 2009. The index of CO2 emission is chosen to identify the leading cause of warming deterioration.

### **E -- Envision the answer & R – Represent the visualisation**

“Droughts, floods, extreme temperatures (% of the population) average 1990-2009” is the main indicator, considering that there is only one column left, which is the year of 2009, the method of time series analysis turned into a scatterplot that took categorical variable (Country Code) as y-value. Because text shown in y-axis could easily overlap each other, it has been set to blank. At the same time, readers should be aware that data points which locate on the top of the plot result only from the alphabetical order of their country code.

A screenshot of a cell phone

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From the first scatter plot, the first pattern comes the distribution of droughts, floods, and extreme temperatures scaled by population across different income groups. The World Bank dividend income into four groups which was calculated by gross national income per capita using dollars. Fig.1 clearly shows that almost all of the high-income countries located near the y-axis except for one outlier which is Australia.

Unsurprisingly, relative to lower-income countries, upper middle-income countries are less likely to suffer from extreme anomalies. However, the difference between lower middle-income countries and low-income countries is scarce. Countries from these two income groups are dispersed in the plot. But the highest value of the extreme climate has occurred in the lower middle-income countries.

After roughly getting familiar with the association between income and extreme weather, the world map was drawn. As for the geographic mapping, on account of strict license requirement, the access to geospatial datasets on the World Bank was denied. Instead, to spatial geo-visualization, we obtained shapefile of country polygons directly from the ggplot2 (the boundaries between states do not represent any individual’s opinion on the political territory). To feel the threat of natural hazard intuitively, it filled with the Zissou1 colour palettes which use blue and red as the starting and ending. Typically, there are missing data provided by WDI. For unavailable information, it was removed, and we choose a light grey colour to fill in the areas. The reason to map the anomalies geographically is to find out if there is any pattern embedded in the regional distribution or any region which clearly differs from others.

A close up of a map

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In Fig.2, the colour visualizes the regional distribution of anomalies around the world. It indicates that the extreme weather condition concentrated in Asia and Central Africa. Among these countries, in East Asia, the weather ranking in China is hard to neglect with its darker colour. Also, a country named Guyana on South America’s North Atlantic coast acts differently compared to its surroundings. There is one place in this world map which is coloured in dark red. It is Malawi. Overall, about 8.82% of the whole population in Malawi had the experience of drought, floods or extreme temperatures. Also, the situation in Australia needs to be taken seriously as its average extreme climate ratio is higher than 3%.

Based on the spatial data, six countries (Australia, China, Guyana, Malawi, United Kingdom and United States) were taken out for further comparison of greenhouse gas emission. In this study we investigate CO2 emissions only, as it is the most critical contributing greenhouse gas for global warming from burning coal. Instead of analyzing sources of CO2 specifically, here we focus on the total CO2 emission (kt) per year in need to compare it between six countries through 54 years. Since the population is remarkably different in these states, to provide a better insight, both line charts are given, with one scaled by the country’s total population at that time.

A close up of a map

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The line chart in Fig.3 shows that almost all six countries share a growing trend in exhausting CO2 through nearly 50 years. Across these countries, it should be noted that two developing countries, the United Kingdom and America, remain stable. On the contrary, China has become the top one in terms of CO2 emissions (kt) ever since 2005. As its slope says, the increase in CO2 emissions stays at the highest rate from 1970 to 2014.

However, while looking at the total emissions, the result should be considered carefully. Seeing that Malawi and Guyana are way lower in the plot, the possible reason might be the size of nations and their population difference. Fig.4 gives a second insight by using scaled data. The United States has always been on the top, but from 2005 on, it declined gradually. Whereas emissions in the UK keep decreasing, the goal to reduce carbon dioxide emissions is still not achieved in China and Australia. Noticing that Australian emissions peaked in around 2009, it could be related to the large bushfire. On the contrary, two low-income countries did not contribute much to CO2 emissions.

In the next stage, we are about to discuss health problems, the report digs into the field concerning “undernutrition”. It can be quantified as the physical condition of anthropometric markers. According to the report written by the World Health Organization (2006), stunting (children-low- height-for-age) indices often represents undernutrition well. The coordinate of the bar chart is shared and flipped to compare the stunted population in 2000 and 2017. Given that the data for European and Central Asian area was unavailable, the chart only covers six aggregates.

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Fig.5 shows changes in numbers of stunted children under five. Children living in North America have barely been affected by stunting, but there are huge gaps between regions. It should be pointed out that Sub-Saharan Africa is the only region where the number of stunted children has increased. Even though undernutrition conditions have improved in most countries, the total number is still significant.

### **T – Tell a story**

In the first part, it illustrates that high-income countries are less vulnerable to high temperature and some other natural disasters, but there are also exceptions. For the developed nations, the risk of being affected by extreme anomalies directly or indirectly is still high (e.g., the bushfire in Australia and the consequence for the goods supply chain). For lower-income countries, the efforts to gain profits requires a more massive amount of burning fossil fuels. Although the emission of CO2 per person in developing countries might be lower than that in high-income nations, the sum of it can still be destructive to the environment. Additionally, the evidence of stunting prevalence reinforces the dilemma in the high-speed-development stage. First, the growing population challenges food supplies maintenance. A better quality of life encourages the increase in populations, but the lack of food supplies maintenance is related to undernourished illness. Second, the worse environment might reduce food production. The global climate change, which can be accelerated by globalization, may cause more frequent natural disaster and make it harder for food growth.

# **Reference list**

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