ACADEMICIA: An International Multidisciplinary Research Journal
ISSN: 2249-7137 Vol. 12, Issue 03, March 2022 SJIF 2022 = 8.252
A peer reviewed journal

THE "FIRST CLIMATE CHANGE FAMINE" FROM 2017-2022?- AN ANALYSIS OF THE ECONOMICS AND GEOGRAPHY OF GREAT SUD DROUGHT OF MADAGASCAR (1901-2021)

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DOI: 10.5958/2249-7137.2022.00184.7

ABSTRACT

Islands of the world are facing unprecedented impacts of climate change. Rising temperatures and consequent increasing sea levels have questioned the very existence of these islands and forward a severe threat to their resources. In this regard, the island of Madagascar is not an exception. Southern Madagascar or Great Sud is facing an unprecedented drought which has exacerbated in the last four years, becoming pronounced in 2021 and 2022. It has landed the part of the country into emergency now and has converted the region into a dust bowl. The situation is turning to what has been described as the "first climate change famine" by the UN and the year 2022 is observing a similarity of conditions. The current examination attempts to examine the question whether the catastrophe is human or climate induced or both? This has been attempted through a detailed examination of rainfall patterns and trends and an inspection of economic and political scenario of the country. Our analysis indicates that rainfall does exhibit a fluctuating trend in the region, but there definitely exist other factors than geography in creating this precarious situation for the country.

KEYWORDS: *Climate Change, Drought, Economics, Madagascar, Rainfall*

INTRODUCTION

Madagascar is the fourth largest island in the world (Dresch, n.d.) **[1]** and Africa's largest island located in the Indian Ocean separated from Africa through the Mozambique Channel (Online, n.d.) **[2].** It has area slightly larger than France and has a distinct and peculiar flora and fauna (Online, n.d.) **[2]** and majority of them are not found anywhere in the world (Fund, 2022) **[3].** This makes the island country unique and special and making it an 'island continent' (Goodman & Jungers, 2014) **[4].** The country has been reeling under political instability, declining incomes and an increasing poverty levels and recently, pest infections and COVID-19 has augmented the already existing concerns (Programme , 2022) **[5].**

A high population growth rate (Kouame, n.d.) **[6],** extremely high poverty levels, biodiversity loss, natural hazards- most exposed African country to cyclones (Mongabay, 2020) **[7]**, climate

change, rising sea levels, unsustainable land use leading to land degradation have all landed the country into the ten top most vulnerable nations in the world on a constant basis (USAID, 2022) **[8]** and in 2020 it ranked at the fourth place in Global Climate Risk Index (Ravi, 2021) **[9].** It was at 164 out of 189 in the Human Development Index of 2020 (Programme , 2022) **[5].**

Southern Madagascar or Great Sud region has faced the longest and worst drought in 40 years and the last four to five years have been notably disastrous (Administration, n.d.; Tandon, 2021) **[10,11]** with people dying due to hunger (Taylor, 2021) **[12].** With agriculture as the main occupation (Tandon, 2021) **[11]**; deforestation, drought, population growth and many other kinds of environmental issues have been facing the country constantly along with climate change and rising temperatures (Schlein, 2022) **[13].** It has also been highlighted that this will be the first ever human generated famine due to climate change (Harding, 2021) **[14].**

However, studies are also indicating that the current drought situation is not induced by human generated climate change but due to poverty, rainfed agriculture, mismanagement, land degradation, and general natural climatic variations; and that the concerns of climate change only have a small role to play (Sen, 1983; Leeuwen & Dijkman, 2019; ACAPS, 2022; France 24, 2021; Janovsky, 2022; Zocherman, 2022) **[15-20]** as famines are considered as benchmarks of economic retardation (Grada, 2009) **[21].** Current day famines are contributed to politics (Rubin, 2011) **[22].**

In 2022, three cyclones and a tropical storm have devastated the southern and eastern part of the already troubled region; with a recent most storm in February 2022 impacting thousands (IFRC, 2022;Yang, 2022) **[23,24].** Unpredictability of rainfall is not new to the region but currently deforestation at a vast scale has further augmented the problem of dust storms to the extent that South Madagascar has turned into a dust bowl (Team, 2022) **[25].**

'Tiomena' or 'red wind' is observed to cause severe destruction to the extent that people 'prefer' drought over these winds. The more of these winds means more dryness, crop loss and storms that obstruct sunlight during the months of May-October (Foundation W. A., 2021) **[26].** The cyclic nature of cyclones and droughts have made the nation further poor with the recent cyclones of Batsirai and Emnati destroying about 85% of the prosperous town of Marolambo in eastern Madagascar (Service, 2022) **[27].**

Currently, around 1.5 million people are in urgent need of food in South Madagascar (Programme , 2022) **[5].** In this regard, social security components are a dire need but are missing for the region (Yang, 2022) **[24].** In all the above contexts, the study proceeds to observe the geographical context of rainfall and attempts to find whether there has been such a drastic shift in rainfall that such a situation is plausible. Although a limitation in this regard is to check the 'appropriateness' of this quantity but at least a broad idea can be gathered and observed with the ground realities to check the probabilities of such incidence just due to rain failure. For this purpose, historical data for trends are observed along with current satellite data to check the geographical variations that have taken place in rainfall in the country from the period 1901-2021.

Study Area- The current study focusses on the island nation of Madagascar shown in Figure 1. It is located in the Indian Ocean off the western coast of Africa and is Africa's biggest island. Covering nearly 6000,000 sq.km. of area, it has a population of 28 million as of 2022 (Worldometer, 2022) **[28]** of which about 90% live in poverty and subsistence is the main occupation (Fund, 2022) **[3].**

It is the fourth largest island in the world after Greenland, New Guinea and Borneo. The geography is highly distinct with the central part marked by a plateau which has 40 % of the country's area, a coastal stretch in the east and plains in the west. In both the eastern and western parts, a number of streams and rivers are found with the majority of the drainage in the western part towards the Mozambique Channel. Vast coral reef and mangrove systems are integral to the landscape. The diversity in geography also affects the climate along with other specific factors which have generated gradients for weather in the country in which rainfall stands as the most differential parameter (Goodman & Jungers, 2014) **[4].**

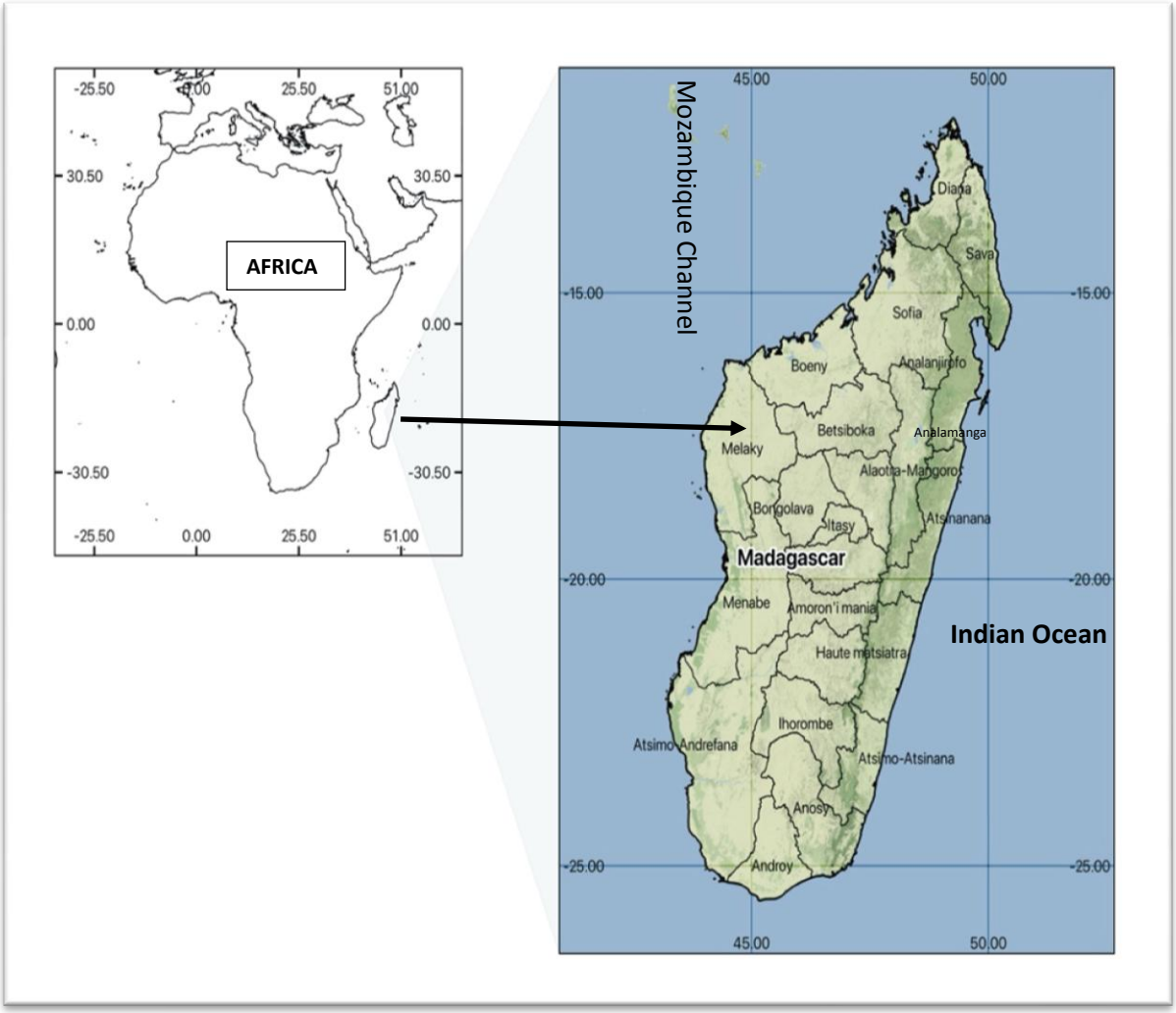
It makes the eastern most part of the island windward with high rainfall and the western part of this eastern side as leeward with drier conditions and making the south west a desert (Dresch, n.d.) **[1].** The conditions of dryness are augmented by a cold ocean current (Dresch, n.d.; Goodman & Jungers, 2014) **[1,4].** This makes the south west arid and sets in the geography of drought. The climate is mainly tropical in nature along the coast, with the impact of altitude operating across the country (Adventures, 2022) **[29].**

There is a diversity in the landscape and weather conditions (Goodman & Jungers, 2014) **[4].** The months of November to April mark the rainy season in the country and the southwestern part of the country is desert (Fund, 2022) **[3].** The economy of the country has been turbulent with economic displacement caused by military regime in the 1970s and since then, the French supported economy has suffered numerous shocks and notable declines (Dresch, n.d.) **[1]** and is now in an unregulated state (Theodora, 2020) **[30].**

The country produces 80% of world's vanilla crop (Foundation T. H., 2022) **[31].** COVID-19 disrupted the last four years of growth experienced by the country (Group, 2022) **[32].** At the economic front, things have been observed to be showing improvement although (Commission, n.d.) **[33].**

The administrative divisions of the country have been depicted below for conducting the analysis. These are divided as provinces, regions and communes (Dresch, n.d.) **[1].** These divisions shown in the Figure are analysed below at the 22 'regions' level. These are- Alaotra Mangoro, Amoroni Mania, Analamanga, Analanjirofo, Androy, Anoso, Atsimo- Andrefana, Atsimo-Atsinanana, Atsinanana, Betsiboka, Boeny, Bongolava, Diana, Haute- Matsiatra, Ihorombe, Itasi, Melaky, Menabe, Sava, Sofia, Vakinankaratra, Vatovavy- Fitovinany (Population, n.d.) **[34].**

Figure 1. Study Area- Location and Administrative Divisions



Source- Authors, 2022

Database and Methodology- The analysis has been conducted to observe the variations in rainfall in the country on a space- time scale. For this purpose, the following method has been attempted:

a. Outlining the trend in rainfall in the country from 1901-2020. The database is available on the Climate Knowledge Portal website of the World Bank (Bank, 2022) **[35].** The results are supplemented with trends from 1960-2020 from the Terra Climate information derived from Climate Engine. Terra Climate Climatology Lab provides high spatial resolution data for a monthly climate at a temporal resolution of$1/24^{th}$ of a degree.

b. To get a detailed regional picture, a sample of three southern regions of the country is analysed for trend in rainfall from 1901-2021 to compare the findings. These are Atsimo-Andrefana, Androy and Ihorombe. Atsimo- Andrefana is the one of the largest, southwestern most region with location on the leeward side of the Central Massif. Ihorombe lies in the

middle of the region experiencing drought these days and Androy is the southern-most region of the country. The three belong to the Great Sud or Southern Madagascar region .

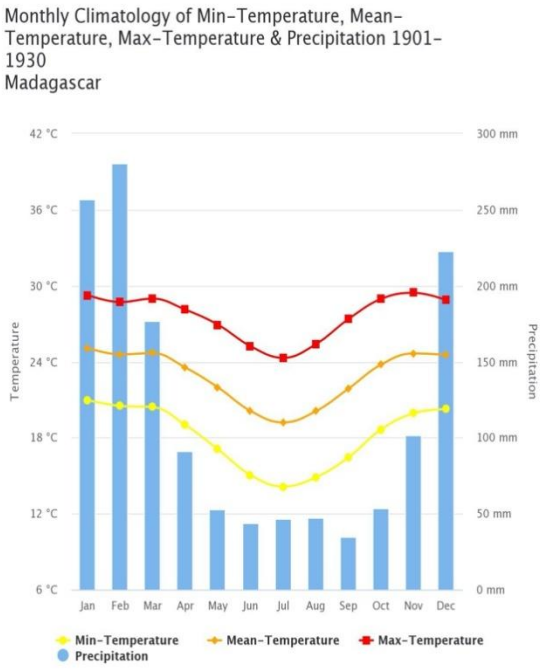
c. The last four-year time period from 2017-2021is examined specifically from November to April for patterns in rainfall for the country through the Global Precipitation Measurement (GPM) v6 database which provides state of art data on precipitation of rain and snow every three hours. Provided by the NASA GEC DISC, with a resolution of 11132 metres, its precipitation band provides 'merged satellite-gauge precipitation estimate' (Engine C. , 2022) **[36].** The information has been derived from Google Earth Engine Code Editor (Engine G. E., 2022) **[37].** This analysis is done to detail out the specificity of geographical patterns of rainfall in the country.

d. Required processing is done in QGIS 3.16 software.

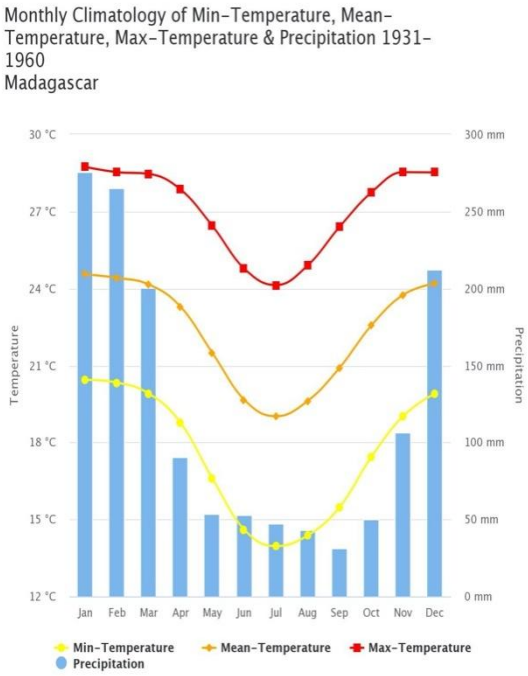
Analysis- The basic trend of information for rainfall for the country can be observed in the following figures which provide a combination of its spatial and temporal analysis from 1901-2020.

Figure 2. Madagascar- Trend in Rainfall

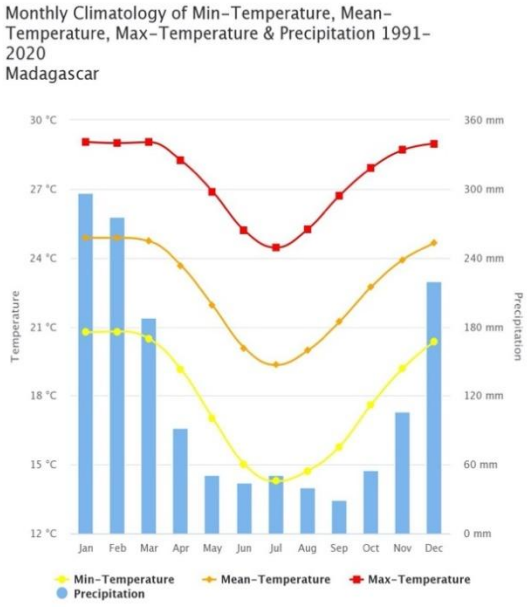
a. 1901-1930



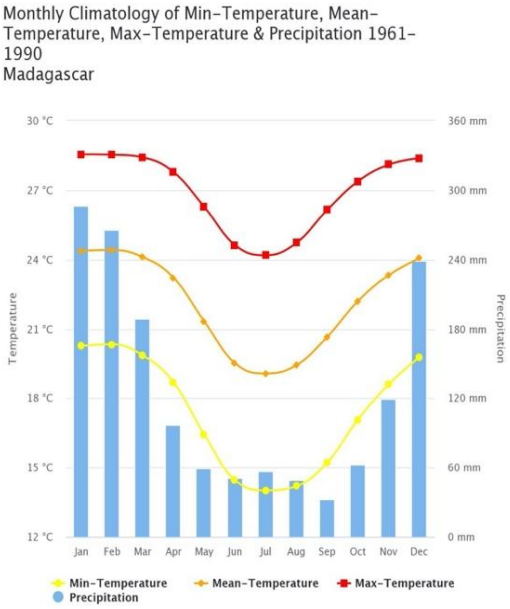
b. 1931-1960



c. 1961-1990



d. 1991-2020

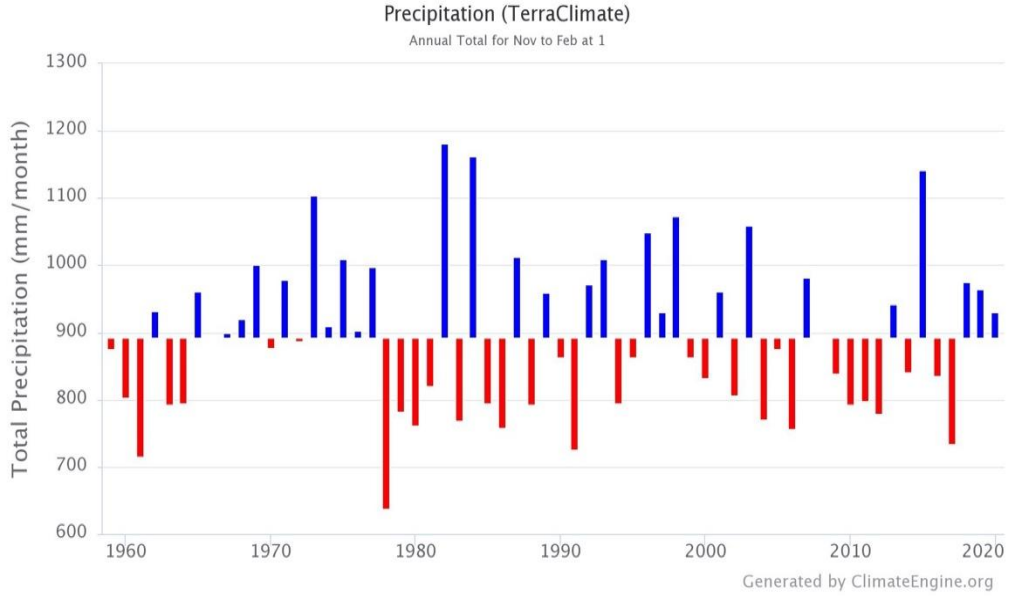


Source- Bank, 2022

The climatological profile of the country is depicted in the above diagrams for the parameters of minimum temperature, maximum temperature, mean temperature and precipitation from 1901-2020. In this regard, minimum, maximum and mean temperatures have not shown any significant change for the country. Observations on precipitation which is mainly in the form of rainfall for the country indicates that, again, there has been no significant change in rainfall for the country. This is very pertinent as an analysis as rainfall fluctuations have been cited as the main reason behind the ongoing drought in the country. The last 50 years of data are analysed specifically for further detailed observations. Data from Terra Climate has been observed for the months November to February for the years 1960-2020.

The results as depicted in Figure 3. indicate that post 1980, fluctuations in rainfall have become more pronounced as compared to 1960-1980 period. More importantly, the years which have experienced a decline in total rainfall are slightly higher than the years which have experienced higher total rainfall than the average and, in this regard, few years from 2010 onwards have a more pronounced trend of decline. But on the whole, it is clearly visible that the decline in total rainfall is becoming lesser and lesser in terms of absolute quantity for the period of study from 1960-2020. So, it can be clearly said that other factors do operate in determining drought conditions for the country.

Figure 3. Rainfall Trend in Madagascar (1901-2021)

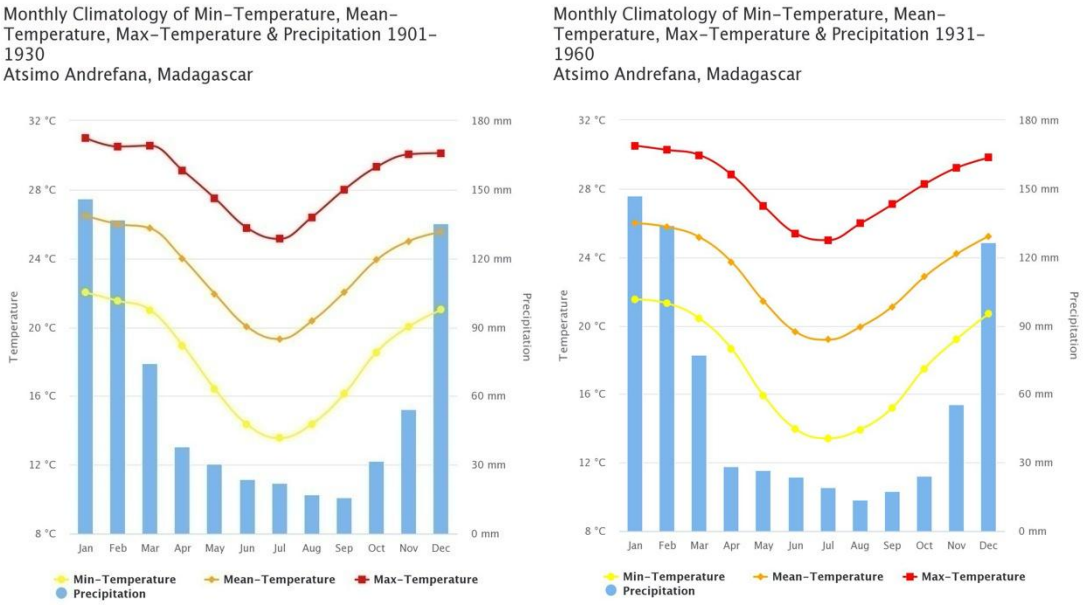


Source- Authors, 2022 from Climate Engine (Engine, 2022)

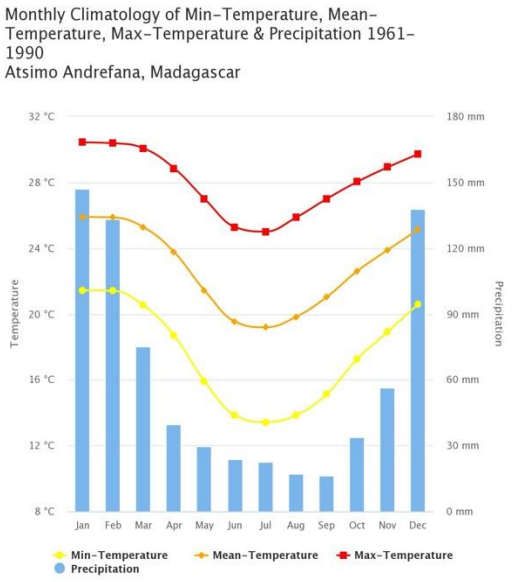
However, this analysis is requiring a supplement. In this context, a regional analysis on the basis of random sampling is done. The southern regions of Atsimo-Andrefana, Androy and Ihorombe are taken for analysis and the observations are depicted in Figure 4.,5. and, 6 respectively.

Figure 4. Atsimo-Andrefana Region- Rainfall

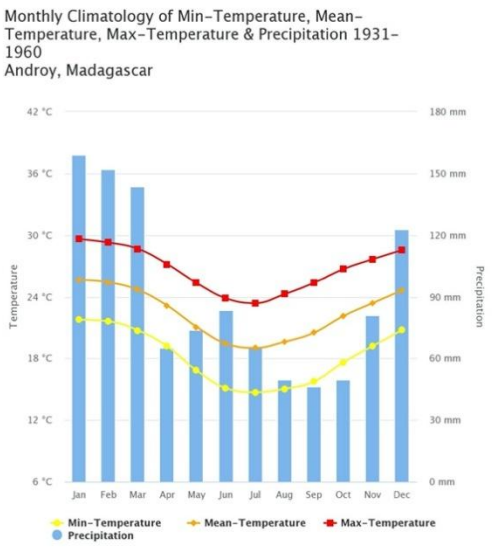
a. 1901-1930 **b. 1931-1960**



c. 1961-1990



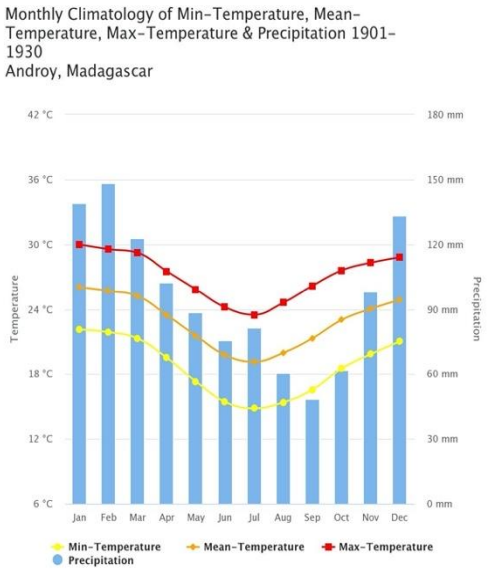
d. 1991-2020



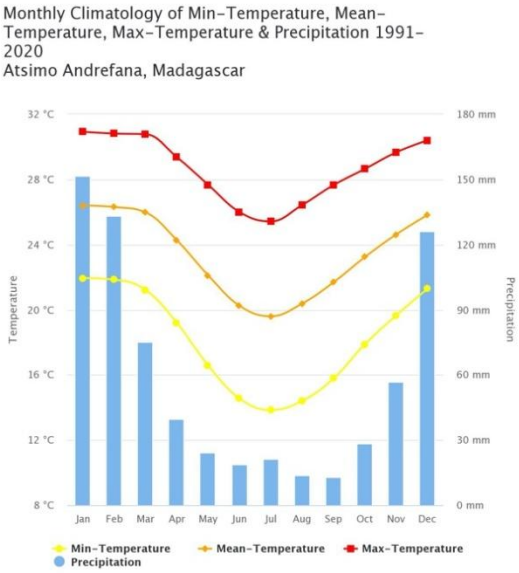
It is visible for Atsimo-Andrefana that here is only a slight variation in rainfall and that too only for a few months in the whole time period of observation. Except for the period from 1990-2020 and that also for the month of December, there is no significantly observable change in rainfall pattern in the region.

Figure 5.Androy Region- Rainfall

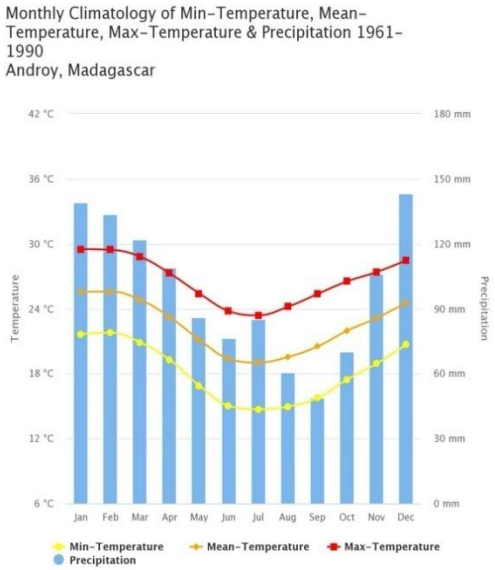
a. 1901-1930



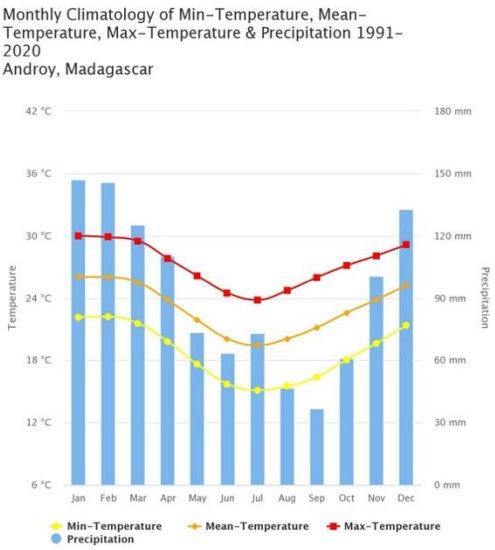
b. 1931-1960



c. 1961-1990



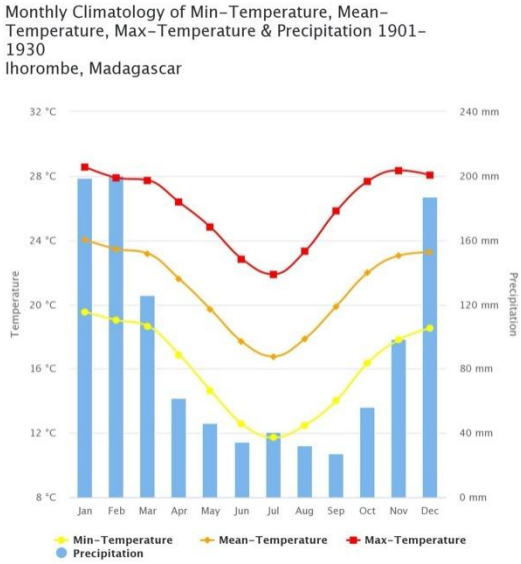
d. 1991-2020



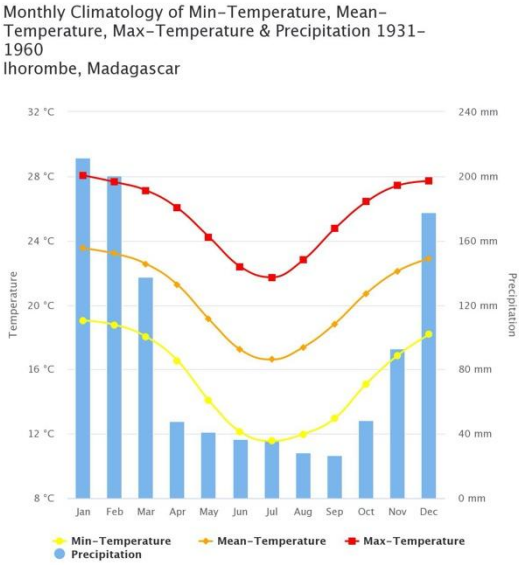
For Androy, again no visible shift in the pattern of rainfall is observed except for a few months in the whole time period of study. Significant declines and rises in rainfall are scattered across the time period form 1901-2020. So, it can be clearly mentioned here also that rainfall decline or shift alone cannot be counted as the reason of drought for the region.

Figure 6. Ihorombe region – Rainfall

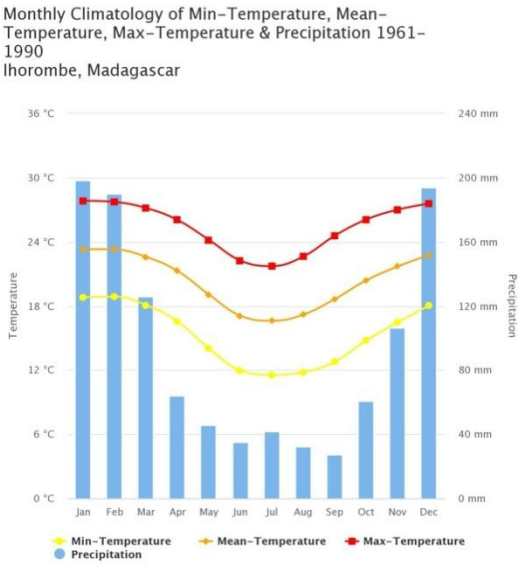
a. 1901-1930



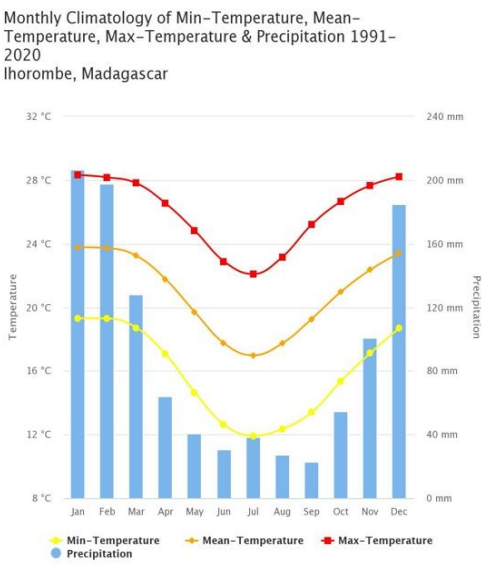
b. 1931-1960



c. 1961-1990



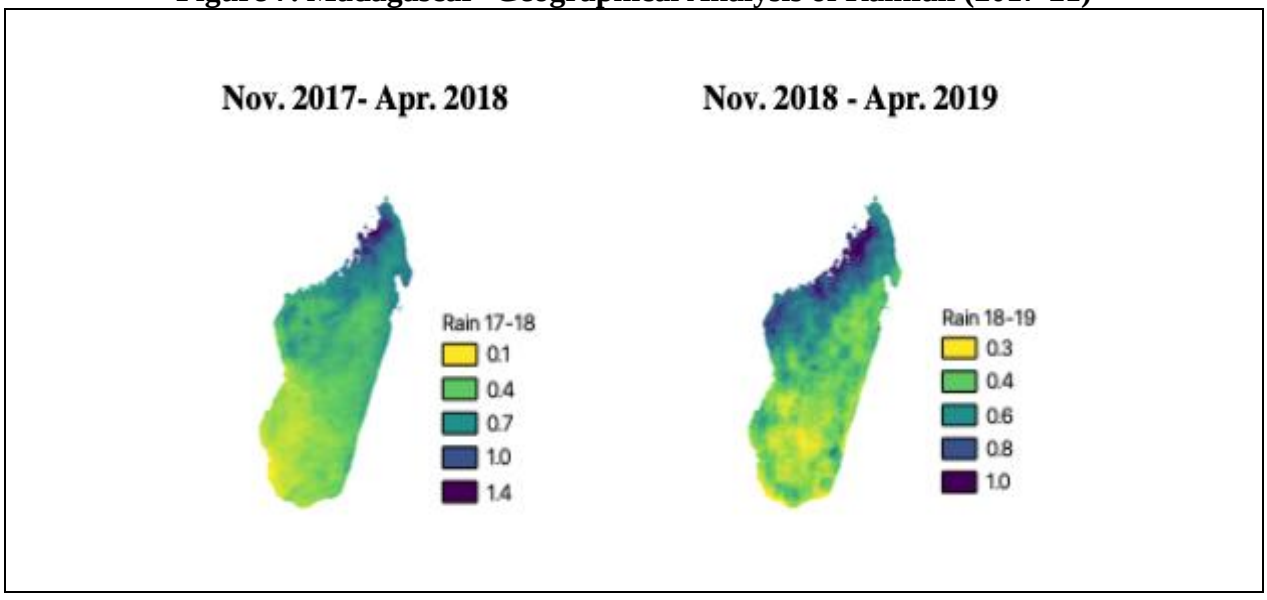
d. 1991-2020

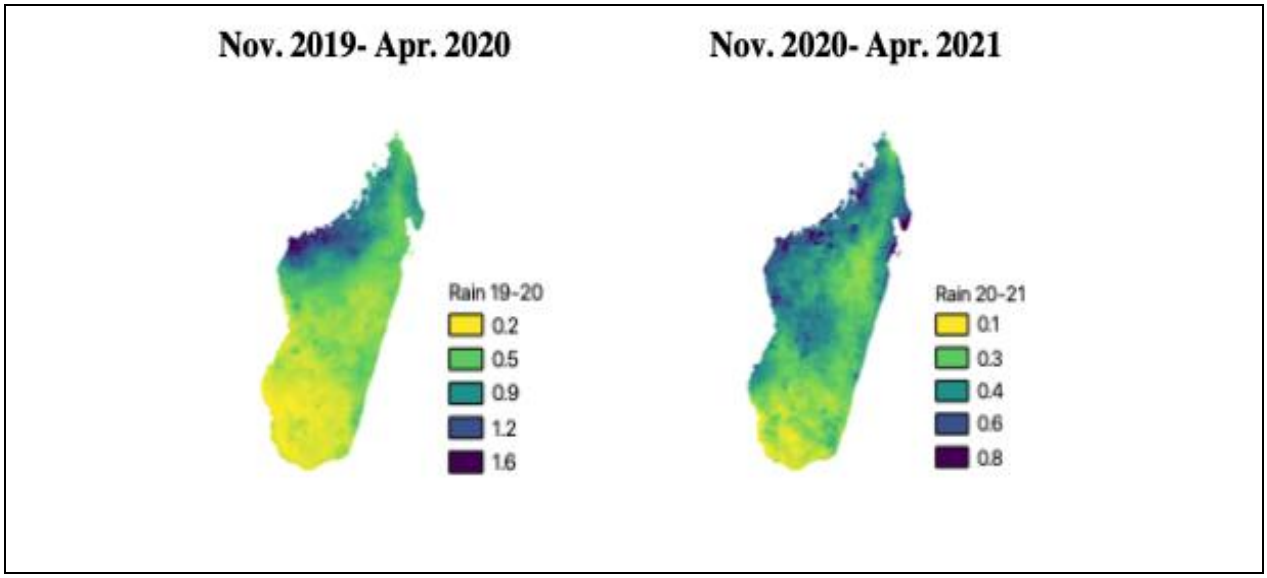


Source- Bank, 2022

The figures above indicate that the region has not experienced a drastic shift in rainfall. There are slight fluctuations which are observed but this is natural for a phenomenon like rainfall. The fact is very significant as a finding as this is a part of the Great Sud or Great South region of Madagascar which is, of recent, facing an unprecedented drought and hunger situation. Thus, it can be strongly said that other factors also exist in 'creating' drought in the region. To sum up the analysis, a yearly examination from 2017- 2022 is conducted for the months of November to April; which is the rainy season for the country from NASA GPM database.

Figure 7. Madagascar- Geographical Analysis of Rainfall (2017-21)





- **Data is for daily precipitation in mm/hr**

Source- Authors, 2022

It is observable from Figure 7. that the geographic factor of location and topography have a direct effect on rainfall patterns in the country. This is bound to create variations in it as well. The northern part naturally receives more rainfall and this is evident as well. But it is not that it is constantly facing a fall in rainfall which is a very important parameter to study. Further, the rainy season period form 2020-2021 has observed an increase in rainfall which is a surprising funding. Fluctuations do exist in rainfall but this is not unnatural in itself as a trend. The north western part of the country is the geographic region with the maximum rainfall. The year 2020-2021 has experienced the least rainfall in the time period of analysis but 2019-2020 had more daily precipitation in the same.

Similarly, the southern region naturally receives less rainfall but in 2019-2020 it experienced the maximum one amongst the time period of study. The lower rainfall regions are also observed in the northern parts of the country. So, to attribute the drought like condition only to rain failure seems to be a stretched statement. There definitely exist other factors which have a strong influence on the problems that the region is facing.

CONCLUSIONS

It can be emphatically mentioned form the observations that the “First Climate Change Famine” is not clearly attributed to just rain failure over the last few years. It also appears that the already existing concerns for the country related particularly to its economy and resource management have a strong overbearing on this scenario. So, it is not just geography which is augmenting the changes but a combination of other factors as well.

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