

CLIMATE CHANGE CHALLENGES AND MITIGATION EFFECTS ON SUSTAINABLE DEVELOPMENT: A KENYAN PERSPECTIVE

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Abstract. *The terminology climate change gained popularity globally in the 1980s and has been used to refer to global warming and its effects on the Earth’s climate system such as changes in precipitation. Globally the Earth’s climate changes, continues to impact countries negatively with extreme weather patterns such as heat waves, heavy rains, severe flooding, long droughts, wild fires and hurricanes. This has adopted to address climate change in Kenya. The theories adopted for this study are The Greenhouse Theory of Climate Change and the Theory of Sustainable Development. Secondary data from literature and data from the Kenya Metrological Offices data consequently affected livelihoods and sustainable development to a large extent. Kenya lies at the equator and is characterized by pleasant tropical climate. However, there are large regional climatic variations which are influenced by several factors, such as altitude. In Kenya, the most common climate change consequences reported are prolonged drought, diseases and flooding. This study sought to address the following research objectives; to understand the history of climate change on sustainable development in Kenya; to establish the effects of current climate change patterns on sustainable development in Kenya; to examine the effects of climate change on sustainable development in Kenya; to identify the challenges associated with climate change on sustainable development in Kenya; to analyze the mitigation practices base was collected and analyzed using Statistical Package for Social Sciences. Lodwar has been selected as a region of study as it is known to be one of the driest regions in Kenya. Key findings indicate that climate change continues to bring about devastating impacts to Kenyan citizens due to mainly flooding and drought. Climate change challenges are derived when they result to harmful impacts such as lack of access to resources needed for basic needs required to cushion the affected. Despite having policy documents, mitigation plans and adaptation activities more needs to be done to address the challenges and effects of climate change in Kenya.*

Keywords: *Climate Change, Mitigation, Climate Change Patterns and Challenges, Sustainable Development*

INTRODUCTION

Climate change could be simply defined as any change in climate over time, which could be as a result of natural variability or as a consequence of human activity (United Nations, 2011, p.1). Observations in the last decade, the frequency and severity of climate extremes has become increasingly evident as global warming and climate change continue to be encountered across many countries globally (IPCC, 2021; Holden et al 2022). In the recent past climate change is now considered a threat to sustainable development as well as environmental sustainability in the 21st Century.

With reference to USAID (2023) Kenya’s economy depends heavily on rainfall for many sectors such as agriculture, tourism and natural resources, all of which are subject to climate variability as well as change and extreme weather patterns. It has further been reported that Kenya contributes less than 0.1 percent of global greenhouse gas (GHG) emissions annually. This is a low percentage in compassion to what developed countries contribute on an annual basis. However, there is a commitment to reduce emissions by 32 percent by 2030. Kenya has been a leader in championing climate change and was one of the first nations in Africa to enact a comprehensive law and policy that guides national and sub-national climate action.

It is against this background that prompted this study to be conducted. This paper elaborates on the following research questions; What is the history of climate change on sustainable development in Kenya; what are the effects of current climate change patterns on sustainable development in Kenya; what are the effects of climate change on sustainable development in Kenya; what are the challenges associated with climate change on sustainable development in Kenya; what are the mitigation practices adopted to address climate change in Kenya.

MATERIAL AND METHODS

The Greenhouse Theory of Climate Change

The Greenhouse theory of Climate change was developed based on an experiment. From the start of industrialization globally there has been evidence of atmospheric concentrations of various radio activities where active gases have been on the increase as a consequence of increased human activities. This radioactivity has resulted to a shift in the climate system moving out of equilibrium with the incoming solar energy. The theory further elaborates that the climate system will be restored to equilibrium through the warming of the surface-troposphere system as well as the cooling of the stratosphere. The Greenhouse theory of Climate Change has reached the crucial stage of compliance process to aid in restoring climate (Ramanathan, 1988). This process has begun through mitigation strategies been adopted globally to restore the damage that has been caused due to human activity. However, more strategies need to be put in place to mitigate the harmful effects of climate change.

Theory of Sustainable Development

Sustainable Development (SD) has become a fundamental strategy to guide the world's social and economic transformation. Nations continue to strive for increased sustainable development initiatives that do not harm the society the economy and the environment. Yang & Gao (2019) assert that the challenge of implementing sustainable development practices is what brings about misrepresentation of sustainable development.

Vivas, Sant'anna, Esquerre & Freires (2019) observe that the Theory of Sustainable Development promotes meeting the needs of the present generation without compromising the ability of future generations in meeting their own needs. In other words the Theory of Sustainable Development emphasizes the protection of life support systems by achieving a balance between economic, social, and environmental aspects of development in order to ensure the long-term viability and prosperity of a nation (Halisçelik & Soytaş, 2019). Hence a balance needs to be achieved to ensure suitability in all dimensions.

Methods

A case study of Lodwar was selected as an appropriate region of study as the region is known to be one of the driest in Kenya. Secondary data from literature was used as well as figures manually and automatically captured for rainfall and temperatures by the Metrological Officers in Kenya. Data from the Metrological Office in Nairobi was analyzed using Statistical Package of Social Sciences in order to develop graphs. Ethical considerations were observed. Researchers received consent to obtain and use data base from the Metrological Office in Nairobi, Kenya.

RESULTS AND DISCUSSIONS

Temperatures

The climate of Kenya is considered complex in terms of time and space. Kenya like many other tropics is prone to extreme climatic change; for instance, frequent floods and recurring droughts (Muhindi et al 2001). Kenya’s weather and climate is changing due to the changing in response to global warming that is consistently experienced globally (IPCC, 2013). To address this, it is essential that appropriate adaptation and mitigation measures are put into place in order to cushion populations against the harmful effects of climate change. To understand the history of climate change in Kenya Lodwar which is known to be one of the driest regions in Kenya has been used as a case study to understand change in temperature and rainfall patterns.

Year	Month	Mini	Max.Tem
1994	1	21.5	37.1
1994	2	22.3	37.9
1994	3	24.8	37.2
1994	4	25.2	36.0
1994	5	25.2	35.1
1994	6	25.3	34.8
1994	7	24.4	33.6
1994	8	24.3	34.2
1994	9	25.4	35.7
1994	10	25.0	35.9
1994	11	24.1	34.6

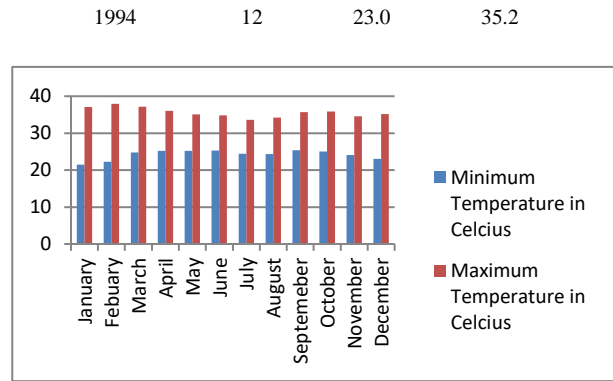


Figure 1: Monthly Temperature in Lodwar in 1994 - Minimum and Maximum

2013	1	22.6	36.4	2013	11	23.9	35.2
2013	2	23.6	37.8	2013	12	22.4	35.8
2013	3	25.1	36.6				
2013	4	24.3	34.4				
2013	5	24.8	35.0				
2013	6	25.3	34.1				
2013	7	24.3	33.4				
2013	8	24.4	34.1				
2013	9	25.5	36.1				
2013	10	26.1	36.8				

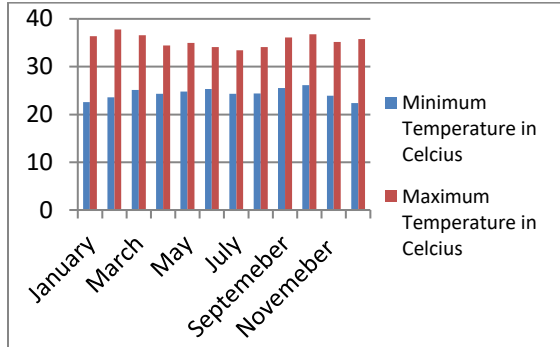


Figure 2: Monthly Temperature in Lewder in 2013 Minimum and Maximum

2022	1	20.6	35.0
2022	2	22.7	37.7
2022	3	24.6	38.4
2022	4	25.2	36.8
2022	5	25.8	36.4
2022	6	25.2	35.1
2022	7	25.0	33.8
2022	8	25.1	33.5
2022	9	25.8	35.2
2022	10	26.6	36.5
2022	11	25.8	35.8
2022	12	22.6	36.0

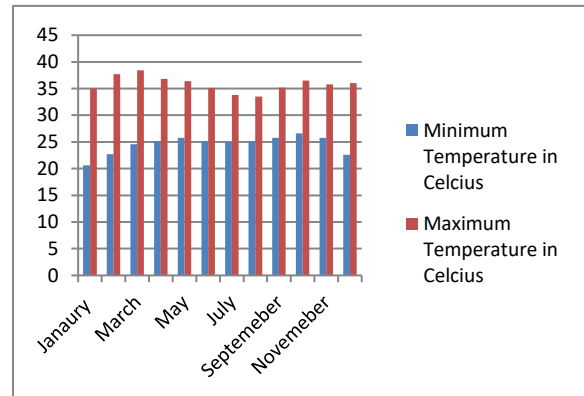


Figure 3: Monthly Temperature in Lewder in 2022 Minimum and Maximum

Source: (Figure 1, 2, 3) Metrological Department Republic of Kenya (2024)

Findings reveal that at the minimum and maximum temperatures of Lodwar one of the driest region in Kenya, in the year 1994, 2013 and 2022 in the month of February, it is evident that maximum temperatures are relatively high (37.9 Celsius, 37.8 Celsius, 37.7 Celsius). Hence temperatures trends are characterized by fluctuations.

Rainfall

The table that follows illustrates rainfall patterns in Lodwar.

1994	1	0.0	2013	1	7.7	2022	1	47.0
1994	2	1.0	2013	2	0.0	2022	2	1.3
1994	3	18.9	2013	3	54.0	2022	3	0.0
1994	4	50.8	2013	4	117.9	2022	4	15.0
1994	5	7.5	2013	5	33.1	2022	5	282.0
1994	6	1.4	2013	6	0.0	2022	6	0.8
1994	7	4.5	2013	7	8.1	2022	7	0.0
1994	8	10.7	2013	8	29.6	2022	8	6.0
1994	9	0.0	2013	9	0.0	2022	9	19.2
1994	10	8.5	2013	10	0.0	2022	10	19.0
1994	11	27.6	2013	11	22.6	2022	11	0.0
1994	12	0.4	2013	12	1.2	2022	12	10.6

Figure 4: Rainfall in MM for 1994, 2013 and 2022 For Lodwar in Kenya

Source: Metrological Department Republic of Kenya (2024)

Findings further reveal that there is reduction of rainfall in Lodwar. Based on the figure 4 above, April which is the month that rainfall should be heaviest in Kenya in Lodwar. In 1994 rainfall was 50.8 mm and in 2013 rainfall increased to 117.9mm and drastically reduced in 2022 to 15.0 mm. This could imply that changes in climate is not a new occurrence but has been ongoing based on historical figures. The figures for both temperature and rainfall for Lodwar are an indication that temperatures were relatively high and decline in rainfall was experienced in 2022 in Lodwar. Hence evidence of drought due to change in climate that is observed.

Current climate change patterns

In the recent past, Kenya continues to face the impact of recurrent climate change disasters most commonly drought, flooding and disease outbreaks, which consequently result to displacement and humanitarian needs. In the months of October to December 2023 during short rains, floods across Kenya resulted to the untimely death of at least 174 people and the displacement of about 546,000 people in Kenya. In contrast, prior to the October to December rains in 2023, Kenya experienced five consecutive seasons of below average rainfall between 2020 and 2022 hence resulting to severe drought and insufficient access to food and water, hence limiting agricultural outputs and livelihood opportunities.

A more recent occurrence of flooding associated with the March to May 2024 long rains and El Niño weather patterns is currently causing displacement. At least 150,000 people have been displaced as communities desperately seek emergency relief

commodities such as food, shelter, clean water, sanitation, and hygiene (WASH) assistance (United Nations, 2024; Government of Kenya Relief Web 2024).

Muhindi et al (2001) reports that the main driver of weather and climate conditions in Kenya consist of the ‘bi-annual northward and southward movement of the overhead sun across the equator. The movement of the overhead sun influences the position of the Inter-Tropical Convergence Zone (ITCZ).’

Rainfall

The figure that follows illustrates rainfall distribution in Kenya in the year 2022.

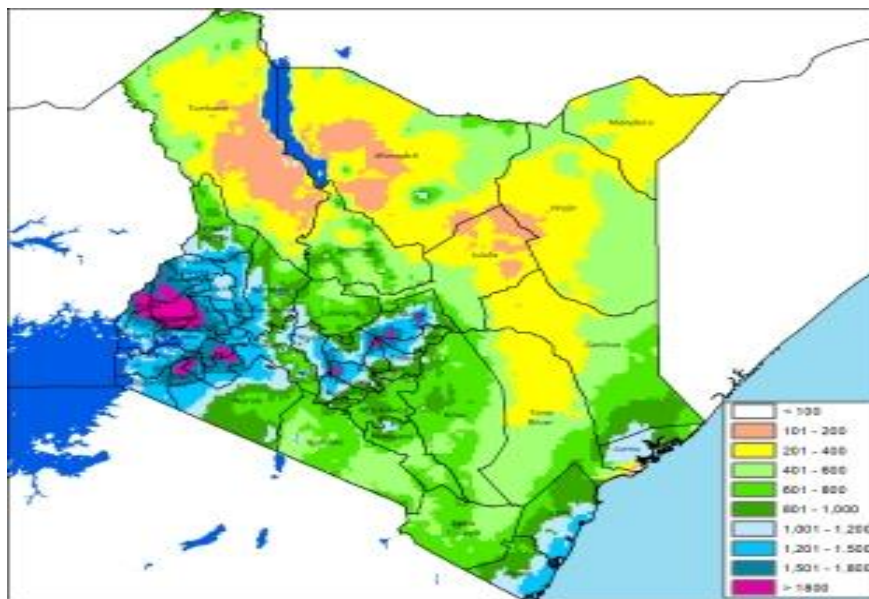


Figure 5: Rainfall climatologically zones of Kenya based on annual total rainfall

Source: State of the Climate 2022 -Metrological Department Republic of Kenya

The counties in the highlands west of the Rift Valley receive the highest rainfall of more than 1800mm yearly. Some few other counties in the central highlands east of the Rift Valley also receive high annual amounts of rainfall. Counties that receive the lowest annual rainfall amounts are those in semi-arid areas such as Northwest and Northeast of Kenya.

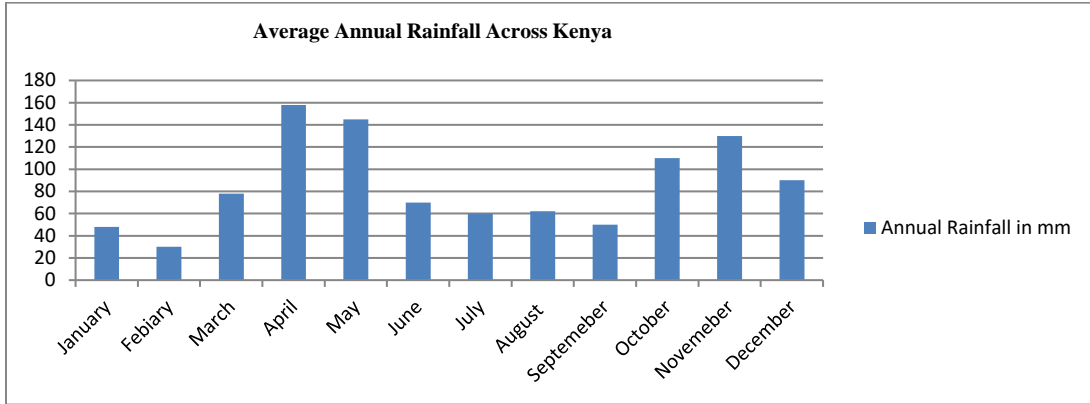


Figure 6: Rainfall average is summarized in the graph below. *Source: State of the Climate 2022, p. 3 2022 - Metrological Department Republic of Kenya*

During the month of January-February, it is sunny and dry, long-rains season is in the months of March, April and May. Cold season for high altitude areas is experienced during the months of June, July, August, and September. Short-rains season are experienced between October, November and December. The highest rainfall period is April with an average of 158mm of rainfall while February experiences the lowest rainfall of an average of 30mm.

On the other hand, the coastal region, the highlands west of the Rift Valley and the Lake Victoria Basin do encounter a third rainfall season between June and August. In Kenya the long-rains season is observed to be the most important for agricultural production in Kenya which contributes to 26% of the Gross Domestic Product (GDP). In Kenya the agriculture sector employs more than 40% of the total population and more than 70% of the rural population (ASTGS, 2019). This is an indication that indeed climate patterns would influence the economy and livelihoods hence the concept of sustainable development is of importance and should be considered when dealing with climate change to ensure sustainability. More recent rainfall patterns in 2024 where by floods were experienced in Kenya follows.

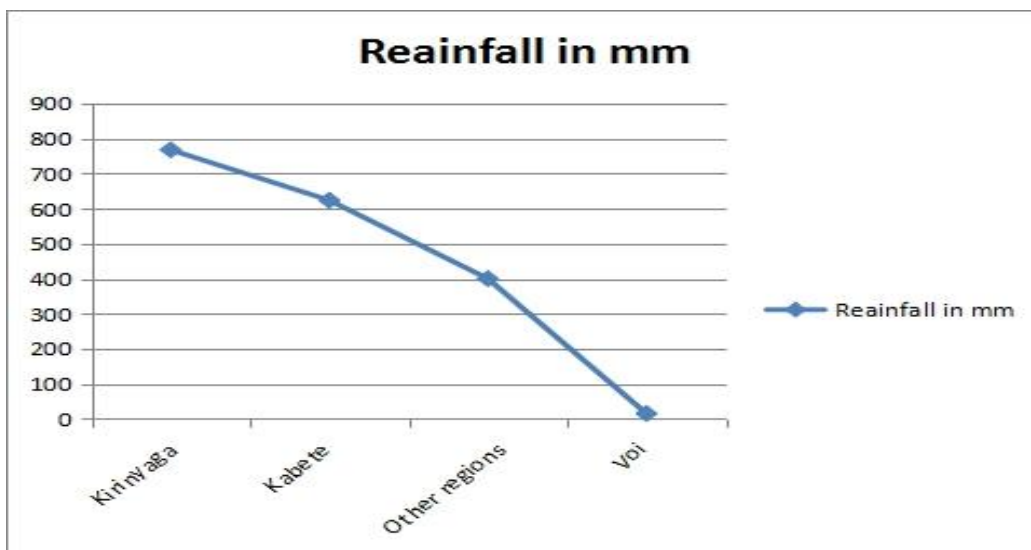


Figure 7: Current rainfall patterns in Kenya March – 26th April, 2024

Regions in Kenya

Source: Republic of Kenya- Kenya Metrological department. (2024).

Key

Region in Kenya	Rainfall in mm
Kirinyaga	767.9
Kabete	623.9
Other regions	400
Voi	14.8

Figure 7 illustrates that from March 2024 to 26th April, the highest monthly rainfall total (767.9mm) was recorded in Miad Kandongu rainfall station in Kirinyaga County, followed by Kabete Meteorological station with 623.9mm. All the other stations recorded less than 400mm of rainfall, with Voi Meteorological station recording the least amount of rainfall at 14.8mm. The above figures indicated high rainfall which consequently has resulted to the flooding situation currently being experienced in Kenya.

Temperature

An analysis of the monthly distribution of temperatures shows that March is the hottest month with an average of 23.3 Celsius. On the other hand, August was deemed to be the coolest with an average temperature of 19.7 Celsius and July 19.8 Celsius. This is illustrated in the figure that follows.

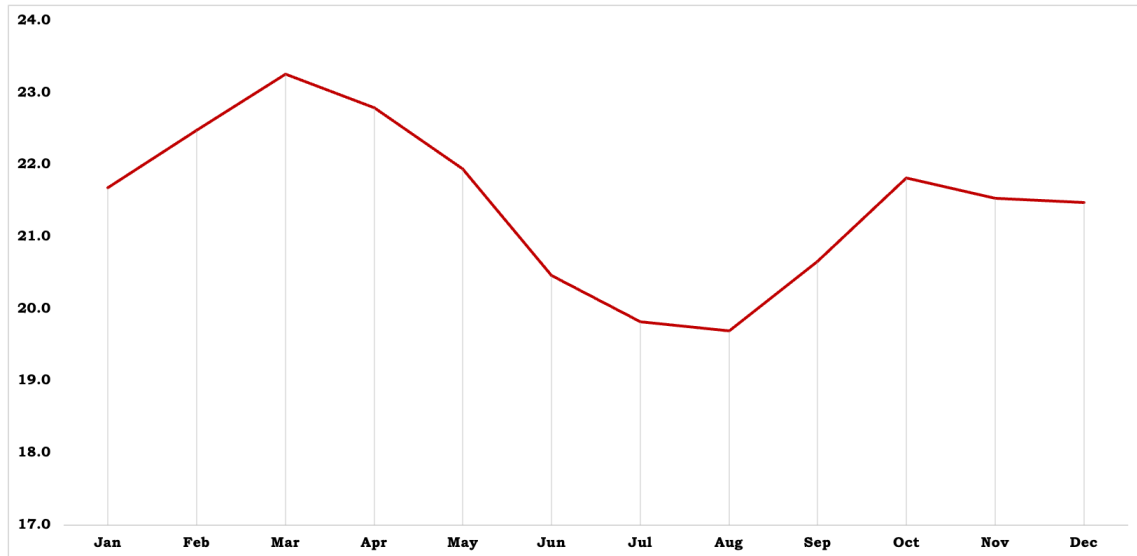


Figure 8: Temperature distributions across Kenya

Source: *State of the Climate 2022 -Metrological Department Nairobi*

The figure illustrates that there are fluctuations in temperature just like rainfall patterns.

Effects of Climate change

Climate change brings a serious risk to increased poverty and threatens to undo decades of development efforts.

Drought - Deaths of domestic animals and displacements

In the case of pastoralists in Kenya, climate change affects their livelihoods. It was estimated in 2003 that 2.6m livestock deaths were reported due to prolonged drought (Saya, 2023).

Flooding- Death of Kenyan citizens

It has been further reported why flooding in Kenya has been so devastating. It has been stated; '*Government criticized over poor infrastructure as 210 people killed, thousands displaced.....*' (Shamim, 2024). This is an indication that inadequate measures have been put in place to help mitigate the harmful effects of flooding in Kenya. Hence there are gaps that need to be addressed.

Flooding -Food insecurity

Due to the current ongoing heavy rains in Kenya, farmers are staring at losses which are consequently affecting trade and livelihoods. Hence little or no income is been generated by farmers (Njoroge, 2024). Climate

change is happening and will increasingly affect the poor in Kenya at a large scale. Adaptation is necessary and there is a need to integrate responses to climate change and adaptation measures into strategies for poverty reduction to ensure sustainable development and sustainable livelihoods.

Kibe (2018) further highlights the following as additional impacts of climate change;

- I. Human health for instance malaria.
- II. Tourism in the case of flooding or drought could lead to either death or migration of world life
- III. Reduction of economic activities which impacts trade.
- IV. Businesses are closed due to flooding and this results to lack of economic activity as people flee to safer ground.

Challenges associated with Climate Change

Key challenges that are a consequence of climate change include the following;

- I. Draining of water which would involve improved infrastructure to correct the problem.
- II. Migration of wildlife which results to reducing animals available for the tourist sector.
- III. Battles for scarce resources such as pasture and water drinking points for domestic use and domestic animals such as cows and goats by pastoralist communities not only in Kenya but Africa at large (Relief web, 2024).

The above challenges can only be managed through creating long term solutions.

Mitigation and adaptation practices currently adopted

According to USAID (2023) Kenya plans to reduce emissions by prioritizing the following mitigation activities:

- I. Firstly, increasing the proportion of renewables in the electricity generation mix of the national grid to 100 percent by 2030.
- II. Promoting energy and resources efficiency across all sectors.
- III. Climate smart agriculture and sustainable waste management systems.
- IV. The country's priority adaptation actions include enhancing adaptive capacity and climate resilience across sectors and National and County governments, financing locally led climate action for climate resilient livelihoods, and enhancing the generation and use of climate information.

The reality today is with all the policy documents prepared and mitigation and adaptation activities engaged in, the impact of climate change continues to bring devastating outcomes in Kenya.

Kibe (2018) conducted a study on 'Effectiveness of Kenya's climate change mitigation strategies after the ratification of united nations framework convention on climate change (UNFCCC) protocols.' The study revealed that Kenya has been committed to the global fight against climate change however, more needs to be done.

Strides to mitigate the effects of climate change in Kenya continues to be addressed for instance, 10 May 2024 was declared a public holiday by the President of Kenya to commemorate those who lost their loved ones through death during floods experience recently in Kenya. In addition, a tree planting initiative was conducted the same day to illustrate to citizens the importance of trees in facilitating to reduce the harmful impact of climate change.

Limitation of the Study

One key limitation of this study is that the Kenya Metro logical Department in Nairobi did not have rainfall and temperature data for 2023 and 2024. Hence data has not been put into a usable format for analysis. This data would have been useful to give an accurate picture of rainfall and temperatures trends.

Acknowledgement

Gratitude is expressed to the Metrological Department Head Office in Nairobi for sharing rainfall and temperature data for Kenya from 1994-2022. This data was useful for analysis for historical and more current climate trends. Also appreciate the support from the personnel in the Kenya Metrological Department.

CONCLUSIONS

Climate change is a real threat that continuously needs to be addressed in order to avoid the devastating impact that comes along with it. Climate change influences sustainable development and livelihoods and therefore should be taken with the seriousness it deserves.

Mitigation is of paramount importance as it aims to avoid extensive human interference while considering the climate system and stabilize GHG levels in a time span appropriate to allow ecosystems to adapt naturally to climate change, in order to ensure food production is not compromised, and thus enables economic growth to take place in a sustainable manner.

In conclusion climate change is not a new occurrence. Climate change has been happening for decades now, the only challenge that needs to be addressed is creating an equilibrium as it is suggested in the Greenhouse Theory as well as a balance in human activity that will not compromise the environment.

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