



Vulnerability to Climate Change from the Kenyan Perspective

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Abstract

Vulnerability to climate change refers to the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is analyzed in three components: exposure, sensitivity and adaptive capacity. The assessment of vulnerability to climate change has often assumed biophysical and social approaches for the various economic sectors. In this study, we review the concept of social vulnerability to climate change. Social vulnerability is a measure of a social system's susceptibility to adversity due to the lack of coping capacity, adaptability or recoverability from climate change impacts. The study adopted a narrative review approach in describing the concept of social vulnerability in climate change and the various perspectives in the context of Kenya. It was established that severe droughts, floods, changing seasonal patterns, and poorly distributed rainfall negatively affect agriculture, pastoralism, water resources, health, infrastructure, and loss of lives and property. To respond to the impacts of climate change, a variety of efforts were put in place to enhance adaptive capacity. These include launch of social protection programmes, adoption of improved farming technologies and livelihood diversification, and development of a policy and legal framework to enable response to climate change impacts.

Subject Areas

Geography

Keywords

Vulnerability, Climate Change, Kenya

1. Introduction

Vulnerability is defined differently from different perspectives. It encompasses a

variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt [1]. [2] argued that vulnerability is a degree of risk and inability to resist to climate deviations. It is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. [3] pointed out that climate change will have both a direct impact on development of climate-dependent activities (such as infrastructure and agriculture) and indirect consequences for social systems (such as issues of poverty, conflict, health and education). In addition, some other most vulnerable sectors include water resources, forests and energy which are all closely interlinked with livelihood security and food systems [4].

In sub-Saharan Africa, farmers have suffered significant losses due to drought, torrential downpours and flooding [5]. One-third of global droughts occur in Sub-Saharan Africa [6]. Thus, it remains a region that is highly vulnerable to the impacts of climate change [7]. The region is already experiencing significant changes in average temperature, rainfall amount and distribution, and occurrences of extreme weather events such as drought and floods [8]. Kenya is located in the Greater Horn of Africa region, which is highly vulnerable to the impacts of climate change. More than 80% of the country's landmass is arid and semi-arid land (ASAL) with poor infrastructure and other developmental challenges. Kenya is ranked at 151 out of 181 countries for climate vulnerability [9]. Despite this vulnerability, the country is ranked as the 37th least prepared to cope with climate change crisis [10]. Kenya's climate is notably driven by the cyclical nature of ocean phenomena such as the Indian Ocean Dipole (IOD) and El Niño Southern Oscillation (ENSO). The positive IOD has been linked to increased rainfall and severe flooding, while a negative IOD leads to drier than usual conditions. La Niña years in Kenya are generally drier and can prolong drought events while El Niño years are wetter than average, bringing more flooding [11]. Poor rainfall performance during October-November-December (OND) 2020 was mainly as a result of the La Nina conditions owing to the prevailing cooler than average Sea Surface Temperatures (SSTs) in the central and eastern Equatorial Pacific Ocean and the warmer than average SSTs in the western Equatorial Pacific Ocean [12]. The extreme climate and weather conditions are also associated with anomalies in the general circulations of the seasonal northward and southward movement of the Inter-Tropical Convergence Zone (ITCZ). The El Niño Southern Oscillation, Madden Julian Oscillations (MJO) and other phenomena have been observed to exacerbate the flood situation in the country. Kenya's economy is highly dependent on climate sensitive sectors; such as, agriculture, energy, tourism, water and health [13]. Projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events and reductions in water availability may all result in reduced agricultural productivity.

The objective of this paper was to analyze recent literature on vulnerability to climate change in Kenya and provides an analysis of how social protection and other programmes are addressing the vulnerability. Specifically, the paper dis-

cusses Kenya's exposure, sensitivity and the state of adaptive capacity to climate change. It aims at generating knowledge necessary to inform the allocation of resources as well as developing policies and adaptation plans for vulnerable areas and groups so as to minimize climate change risks in the country. Understanding country's vulnerability is a crucial first step before targeting adaptation assistance [14]. This will help policy-makers and stakeholders assess the level of risk and design pertinent response strategies.

2. Methodology

The study adopted a narrative review to discuss social vulnerability to climate change in Kenya. According to [15], a narrative review is the "traditional" way of reviewing the extant literature and is skewed towards a qualitative interpretation of prior knowledge. It is used to identify studies that describe a problem of interest. The study used journals relevant to this topic of study as well as relevant case studies, projects, programs undertaken in the country.

3. Climate Change Vulnerability

3.1. Defining Vulnerability

Vulnerability of any system is frequently considered as a function of three elements: exposure to a hazard, sensitivity to that hazard, and the capacity of the system to cope with and adapt or recover from the effects of those conditions [16]. Vulnerability is considered in six life supporting sectors: food, water, ecosystem service, health, human habitat and infrastructure [10]. It is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, potential impacts and adaptive capacity [17]. Hence,

$$V = f(E, S, AC)$$

where:

V = Vulnerability to climate change;

E = Exposure to climatic stimuli;

S = Sensitivity to climatic stimuli;

AC = Adaptive Capacity.

Figure 1 illustrates the key connections between exposure, sensitivity, and adaptive capacity that collectively determine vulnerability to climate change. Exposure and sensitivity are combined to determine the potential climate change impact which is modified by the level of adaptive capacity.

Below is a description of exposure, sensitivity and adaptive capacity in the context of Kenya.

3.2. Exposure to Climate Change Risk

Exposure is the nature and degree of a system's exposure to significant climatic variations. According to [19] exposure is the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could

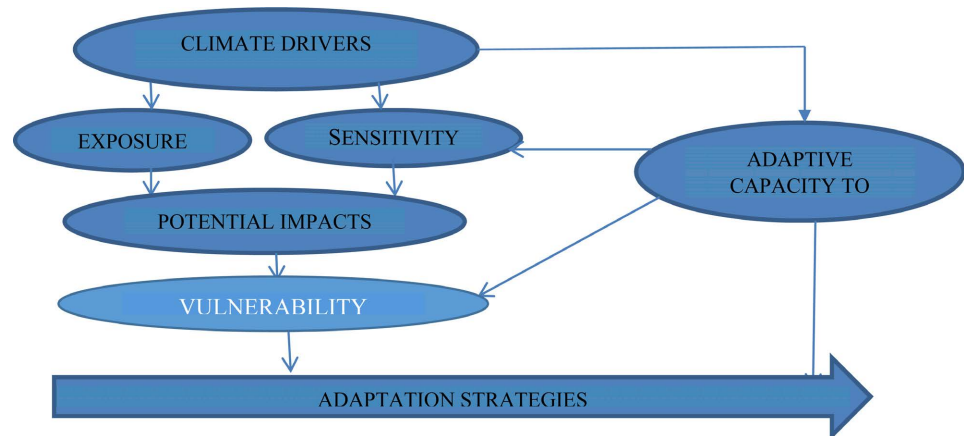


Figure 1. Schematic representation of the adaptation progress, conditioned by exposure, sensitivity, vulnerability and adaptive capacity Modified based on [18].

be adversely affected. Kenya is highly vulnerable to climate change because of its exposure to increasing temperatures and rainfall variability, its strong dependence on climate-sensitive agriculture and its moderate adaptive capacity, which suffers from the high level of corruption [20].

A study carried out by [21] found out that various elements of exposure include changes in precipitation that have been occasioned by frequent occurrence of droughts and floods, changes in both air and sea surface temperature that have been characterized by prevailing warmer conditions, increased disease, sea level rise, and increased occurrence of storms. In Kenya, the first rains of the long-wet season have become unreliable, significantly reduced on average and sometimes insufficient to support a harvest or even livestock rearing, especially in the east of the country [10]. According [22], Kenya experienced several droughts over the last half of the 20th century including in 1951, 1952-1955, 1957-1958, 1957-1958, 1974-1976, 1980-1981, 1983-1985, 1987, 1992-1993, 1995-1996, 1999-2000, and 2004-2006. Kenya also experienced drought for the better part of 2016 and 2017 which was characterized by failed rains and unusually high temperatures in twenty-three out of the forty-seven counties, prompting government to declare a national emergency [22].

Rain seasons have changed making it hard to predict the weather and prepare land in good time for farmers. For instance, large part Kitui County receives erratic and unreliable rainfall with most of the areas being generally hot and dry leading to high rate of evaporation [23]. The early cessation of the 2022 long rains season has worsened the drought situation in 19 of the 23 arid and semi-arid (ASAL) counties that were already bearing the brunt of poor performance of three previous consecutive failed seasons [24]. Studies, which have been carried out, indicate that early rainfall cessation over more than 30 counties in Kenya led to shortened rainy season by 10 - 20 days during MAM season [25]. On the other hand, the early onset and delayed rainfall cessation resulted in increase of length of rainy season, while late onset and early cessation reduced long rains over potential agricultural areas during JJA and SON seasons. In Yala wet-

land, majority of the respondents had observed changes in climate parameters, severe drought and irregular onset and termination of rains in the past 20 years [26]. Similarly, communities in Kitui County are vulnerable to rainfall variability in terms of onset dates, cessation, number of rainy days and rainfall amount [27].

3.3. Sensitivity to Climate Change

Agriculture:

In climate change setting, sensitivity is the degree to which a system is affected either adversely or beneficially, by climate-related stimuli [28]. It reflects a system's exposure to climate impacts and is affected both by socio-economic and environmental conditions [29]. Kenyan agriculture is 98 percent rainfed and highly sensitive to changes in temperature and rainfall [30]. Agriculture's sensitivity to climate induced stress has led to declining agricultural outputs, poverty and food insecurity with smallholder farmers mainly being affected [31]. For instance, maize which is the main staple food of Kenya accounting for about 65% of total staple food caloric intake and 36% of total food caloric intake [32] can be damaged by temperatures over 35°C, which are increasingly common in lowland regions [33]. In Kenya, the majority of the population lives in rural areas and depend on agriculture for their livelihoods. Agriculture heavily depends on rainfall, thus current trends of climate change heavily impact Kenya's agricultural sector.

The tea sub-sector in Kenya provides a source of livelihood to over 3 million people [34]. Tea is widely cultivated as a rain-fed plantation crop and is highly sensitive to climate variability. Being a rainfed plantation crop in Kenya, tea depends greatly on weather for optimal growth. For optimum production, tea requires temperature range of 18°C - 30°C and well-distributed annual rainfall of between 1400 - 2500 mm [35] with long and sunny intervals [36]. There is evidence of climate change in the tea growing areas of Kenya which is characterized by variability in rainfall trend, temperature rise, rising trend of hail and increasing incidences of frost [37]. This leads to decline in tea yields and productivity levels. For instance, tea production for the month of February 2023 dropped significantly by 8.22 Million Kilograms to 32.73 Million Kilograms from 40.95 Million Kilograms recorded in during the same period in 2022 [38]. This lowest production ever recorded during the month of February since the year 2020 was occasioned by adverse sunny and dry weather conditions in most parts of the tea growing areas with exception of a few places in the West of the Rift Valley (Nandi, Kericho, and Bomet) that experienced few rain days [38].

Forestry:

Forests are also highly sensitive to climate change. The Kenya Forest Service estimates a six percent forest cover that include indigenous, open woodland and plantation forests. The five major water towers, Mt. Kenya, Mau Forests Complex, Cherangany Hills, Mt. Elgon and the Aberdare Ranges, act as the main wa-

ter catchment areas. Forests also provide environmental goods and are a major source of biomass energy. According to [39], forest degradation and deforestation, exacerbated by climate change, have led to reduced canopy cover and altered biodiversity composition. This affects the ecosystem services that forests provide, such as reducing soil erosion, natural pest control, preserving water availability and maintaining water quality. Deforestation and forest degradation also increase Greenhouse Gas (GHG) emissions [39].

Pastoralism:

Arid and semi-arid counties are frequently exposed to climate change and vulnerability. Livelihoods in Kenya's ASALs are dominated by pastoralism and livestock nutrition and productivity are reliant on the availability of pasture, which is highly sensitive to erratic and uncertain rainfall and to drought [40]. In northern Turkana County, increased competition over grazing lands and water has heightened the likelihood of conflict and insecurity [41]. According to [42], livestock mortalities were reported across the pastoral and marginal mixed farming zones from the beginning of October 2022. The mortalities reported were 203,198 cattle, 584,250 goats, 615,407 sheep and 83,456 camels across Marsabit, Turkana and Samburu counties. Equally, the counties of Kajiado, Laikipia and Nyeri recorded a total of 475,363 livestock deaths due to the ongoing drought (270,354 cattle, 141,620 sheep and 63,983 goats).

Infrastructure:

Events of floods in Kenya disrupt provision of infrastructure services by damaging road networks, energy facilities, buildings, and social facilities [43]. [44] conducted a rapid needs assessment in Marsabit County in November 2023 and established that the ongoing El Nino rains caused severe road damage in areas not connected with tarmac in the county. In addition, the main livestock markets in Moyale, North Horr and Laisamis Sub Counties were disrupted due to impassable roads that had affected the transportation of goats to the main market as many areas were currently cut-off. This in turn affected household purchasing power as this inhibited exchange of livestock for other food stuffs.

According to the [12], strong gusts of wind of 28 knots (14.4 m/s) were experienced over Nairobi for five consecutive hours on 1st of October 2019. This resulted in electric power disruption, damage to infrastructure in the form of billboards and drastically reduced visibility in the region for hours. Another case of strong winds (30 knots or 15.4 m/s) was reported during the month of July 2020 as a result of strong pressure gradients [12]. The areas affected were in the North-eastern parts of Kenya and the strongest winds in knots were 30 knots (15.4 m/s). This resulted in damage to infrastructure in the form of billboards, electric power disruption and drastically reduced visibility in the region for hours [12].

Water Resources:

Climate risks associated with weather variability, extremes and changes in intra-seasonal characteristics, have been experienced in the Water Towers. This manifests in frequent drought occurrences, late onset of rainfall, dry spells, early

rainfall withdrawal, and increasing temperatures [33]. For instance, access to water around Lake Turkana is difficult for households due to long dry season and frequent periods of drought [41]. Similarly, [45] argued that the climate change drivers such as rainfall patterns, increasing temperatures and seasonal variations of Lake Victoria water level affected drinking water in the Nzoia River Basin in the last ten years. According to [46] climate change impacts in the water sector in Kenya is manifested in severe flooding, droughts, rising water levels in lakes, water scarcity, invasion of alien species in water bodies such as water hyacinth in Lake Victoria and other water bodies. These affect people's health, livelihoods and access to clean water for domestic and livestock use. For instance, hot weather conditions in Narok County during the day have led to serious decline in the amount of water available for livestock, wildlife, and domestic use [47]. Water levels in rivers like Mara which is vital for wildlife survival in Maasai Mara Game Reserve, has often declined drastically.

Human Health:

Human health has been affected adversely by climate change impacts in Kenya. High temperatures and intense rainfall, are known to be critical factors in initiating malaria epidemics in Kenya [39]. The impacts of climate change on health are characterized by compromised air quality; floods and droughts; increased vector borne diseases and water related illnesses; mental illness consequences; food insecurity and poor nutrition with varying degree of exposure to climate related extremes [48]. Floods in Kenya cause disease outbreaks, such as malaria, typhoid, Rift Valley fever, dysentery, and cholera; increase demand for health services; and disrupt access for both staff and patients to health facilities by damaging transport and medical infrastructure [49]. Malaria which is the most sensitive to climate and causes the death of more than 627,000 people every year is the number-one killer of children under five in sub-Saharan Africa [33]. Changes in temperature, humidity and rainfall can influence the behaviour and survival of the malaria-carrying *Anopheles* mosquito. [50] noted that the annual disease frequency per household was the highest in Budalang'i, Kenya, and lowest in Bomet, a region with relatively good weather. Malaria, respiratory tract infection, typhoid, pneumonia and diarrhoea were the major diseases among the Lake Victoria basin residents.

3.4. Adaptive Capacity of Households to Climate Change

Adaptive capacity refers to a system's ability to respond successfully to the adverse effects of climate change [51]. It is the latent ability to implement effective responses to changes by minimizing, coping with, or recovering from the potential impacts of a stressor [52]. Adaptive capacity encompasses two dimensions: recovery from shocks and response to changes [53]. The two dimensions play an essential role, as they ensure a system's progress towards adaptation. The efforts put in place to enhance adaptive capacity of households to climate change in Kenya include;

Social Protection

The impacts of climate change differ between people and groups because of the interaction of socioeconomic conditions based on income; assets; and discrimination related to minority status, race or ethnicity, sex and gender, age, poor health and impaired mobility [54]. According to [55], the indicators of adaptive capacity among rural households of semi-arid Kenya include diversity of livelihoods, two growing season and cultivation of drought tolerant crops such as millet, green grams, sorghum and cowpeas. However, households' adaptive capacity is often undermined by high cost of farm inputs, limited access to credit, market uncertainties, poor road networks, limited livelihood streams, and disjointed agricultural- and climate-related information systems, as well as farm sizes, land tenure issues and inter-ethnic conflicts in the area [56]. Thus, households' adaptive capacity needs to be supplemented by social protection programmes. Social protection programmes are proven as effective in breaking the vicious cycle of poverty and hunger.

Various policy strategies have been put in place to guide the implementation of social protection interventions. These include: the Constitution of Kenya (2010), the Kenya Vision 2030 (2007) and the National Social Protection Policy (2011). The Kenya National Safety Net Programme (NSNP) is a flagship government Social Protection programme established in September 2013 and is implemented by the National Drought Management Authority. Its objective is to cushion Kenya's poorest and most vulnerable households from the worst effects of crises such as drought, malnutrition and unemployment [57]. Social cash transfers initiatives are delivered under the umbrella of social protection as provided by the Kenya National Social Protection Policy (NSPP) 2012. Currently, there are four ongoing national social cash transfer interventions under NSNP, namely: Hunger Safety Net Programme (2009), Orphans and Vulnerable Children (2006), Persons with Severe Disability (2010) and Inua Jamii 70 years and above (2018) cash transfer programmes [57]. According to [24], Inua Jamii cash transfer payments amounting to Ksh 8.58 billion were effected to 1,071,856 beneficiaries in the period November 2021-February 2022 payment cycle. On the other hand, the Government has disbursed a total of Ksh 667 million under the Hunger Safety Net Programme (HSNP) to cushion poor and vulnerable households affected by drought in four arid counties of Marsabit, Wajir, Mandera and Turkana in the 2022 March-April routine cash transfer payment cycle. Social protection programmes contribute to resilient livelihoods by enhancing the nutritional, health and educational levels of household members, which in turn increases their capacity to engage in productive activities [53].

Improvement of farming techniques and livelihood diversification

In Yatta sub-County, climate change resulted in the introduction of drought tolerant crops, change in planting time, change in cropping systems from mono cropping to mixed and intercropping, introduction of pest and disease resistant crops [58]. Green grams and Sorghum production was very good especially in Kitui county during the March to May season [12]. However in River Tana Ba-

sin, it was established that the communities preferred livelihood diversification (business, cropping, and livestock) as an alternative livelihood option, sustainable use of the land including conservation agriculture, mulching, building trenches and ditches around the homesteads and watering crops using cans during dry spell [59]. They have also adopted drought-tolerant and early maturing crop species, changing eating behaviors and afforestation.

[60] found out that adoption of stress-tolerant varieties of several crops (such as bean, pigeon pea, cowpea, maize and sorghum) improved household dietary diversity score by 40% and reduced food insufficiency by 75% of Kenyans. Adoption of improved and resilient livestock breeds (including Red Maasai sheep and Galla goats) improved household dietary diversity by 38% while reducing household food insufficiency by 90%. The study resonates with a study done by [61] [62] who found out that uptake of multiple stress-tolerant crops improves household income by 83%, which in turn improves household asset accumulation. In Uasin Gishu County, small-scale maize farmers opted for change of crop varieties and planting dates as adaptation strategies [62].

East African Breweries Limited (EABL) developed a low-cost beer made from sorghum, a drought tolerant crop. This was to create new market opportunities for EABL while providing a cash crop for smallholder farmers that helped to improve livelihoods, enhance food security, and increase climate resilience [63]. The *jilische kisha uuze* (feed yourself then sell) programme encourages that sorghum first be used as a household food, with the remainder being sold to EABL. The development of a value chain for a sorghum-based beer has increased the climate resilience of local communities [63]. In addition, sorghum is a drought-tolerant crop and production can be maintained in a changing climate. The improvements in household food security, incomes and jobs help reduce vulnerability to the impacts of climate change.

Adoption of appropriate technologies and knowledge management

[64] identified and ranked in order of priority strategies and technologies for adapting water supply management to climate change in Nzoia River Basin. These include water storage, water efficiency and demand management, water augmentation, alternative water sources, water allocation, urban storm water management, riverine flood protection, hazard and risk assessment, vulnerability assessment, disaster response, and early warning. Additional water storage infrastructure, such as reservoirs or storage tanks, can be built to offer buffers against rising seasonal and annual fluctuation in precipitation and runoff. [65] noted that communities, supported by community-based organizations, have and use the knowledge, skills, attitudes and tools to adapt to changes brought about by climate change. For instance, NASARU women Community Based Organization (CBO) in Kajiado County had key projects such as water harvesting; promotion of drought tolerant crops and irrigation of agriculture around dams; awareness creation and capacity building on climate change.

Expansion of renewable energy sources

Efficient and reliable energy supply is fundamental for development of all sectors of the economy [66]. Energy reliability is low in Kenya due to the dependence on hydropower sources which are prone to climate risks [67]. In the past there has been heavy reliance on hydro power plants for energy production, which in recent years has been highly vulnerable to droughts and floods. Geothermal energy plays a vital role in the context of climate change as a mitigation and adaptation technology [68]. Kenya has made significant strides in developing renewable energy sources, particularly geothermal, solar, and wind and ranks 8th in the world in geothermal energy installed capacity and first in Africa to [67]. Kenya's geothermal resource potential is estimated to be between 8000 to 12,000 MW spread over 14 sites mainly located within the Rift Valley region. At present, geothermal power is being harnessed in the Olkaria, Menengai and Eburru fields on the floor of the Rift Valley. In the medium and long term, new geothermal reservoirs are being explored in Baringo-Silali, Suswa and Longonot [67]. Other ongoing projects/initiatives include coal development in Lamu, Dongo-Kundu, Kilifi, Kwale, Meru/Isiolo; Lake Turkana Wind Power Project; installation of wind energy storage facility in Marsabit [39]. Besides geothermal energy, the country has established other renewable energy projects such as the Lake Turkana Wind Power [69].

The Policy and legislative framework strategy for climate change

Kenya has been in the forefront of advocating for climate change. According to [70], the relevant policy and legislative framework has been put in place to guide the country's response to the challenges of climate change in Kenya. Kenya initiated the development of the National Climate Change Response Strategy (NCCRS) in 2010 [71] and the first action plan National Climate Change Action Plan (NCCAP 2013-2017) in 2013 [66]. The objective of NCCAP 2013-2017 was to encourage low carbon climate resilient development throughout the country. The second action plan, NCCAP 2018-2022, is a five-year plan that helps Kenya adapt to climate change and reduce greenhouse gas emissions [72].

In 2016, Kenya adopted the National Adaptation Plan (NAP 2015-2030). The objective of NAP 2015-2030 was to integrate climate change adaptation into national and county level development planning and budgeting processes [39]. According to [71], the Climate Change Act (CCA), adopted in 2016, is the main legislation guiding the country's CCA governance and actions. Its objective is to "enhance climate change resilience and low carbon development for sustainable development in Kenya". The Act establishes institutional structures, including the National Climate Change Council (the Council), headed by the President of Kenya, as well as the Climate Change Directorate.

The country has also adopted the National Climate Change Framework Policy (2018) which provides a framework to guide the development and implementation of detailed climate change interventions listed in the Climate Change Action Plans [72]. Kenya Climate Smart Agriculture Strategy 2017-2026 another key strategy whose aim was to adapt to climate change, build resilience of agri-

cultural systems [73] while minimizing emissions for enhanced food and nutritional security and improved livelihoods [30]. Climate Risk Management Framework (2017) outlines how the government intends to harmonise its climate change and disaster risk policies while National Climate Finance Policy (2018) was adopted to sets out a guiding framework to enhance national financial systems and institutional capacity to effectively access, disburse, absorb, manage, monitor, and report on climate finance in a transparent and accountable manner [72].

Drought management is increasingly integrated into the national disaster management framework [74] coordinated by the National Drought Management Agency (NDMA) [75]. The mandate of the NDMA is to coordinate disaster risk reduction programmes, operation of the drought Early Warning Systems, structures for drought management and drought-related policy formation [75]. The Government established the National Drought Emergency fund (NDEF) through the Public Finance Management Regulations, 2021, 10-year fund worth Kshs. 2 billion annually whose administration is bestowed upon the NDMA. National Drought Emergency Fund (NDEF) is a common basket emergency whose purpose of the Fund is to ensure drought early action to protect lives, livelihoods and reduce high cost of emergency response in drought affected areas [76]. For climate justice to be effectively done, action is needed on a global scale [54].

Suggested ways of reducing the impacts of the extreme climate change to the Kenyan

Adapting to climate change involves reducing exposure and sensitivity and increasing adaptive capacity. The following are suggested ways of reducing the impacts of extreme climate change to Kenya communities:

- 1) Strengthen climate change institutions such as KMD so that they become effective in providing adequate and appropriate climate change information and knowledge to researchers, planners, policy-makers and the general public. This can enhance public participation and awareness of climate change.
- 2) Government should promote and document application of traditional indigenous knowledge and practices on climate change. This can help communities to respond to the immediate effects of climate change and also help them to prepare long-term adaptation strategies and programmes that can reduce impacts of climate change.
- 3) The Government should invest more in renewable green energy such as Geothermal, Solar and Wind, Biogas, Bio-ethanol and diesel value chains energy. This could help reduce the over reliance on the use of water for hydropower.

4. Conclusion

Kenya is highly vulnerable to climate change because of its exposure to extremes events such as frequent droughts, floods and rise in temperatures and a highly variable rainfall. The country's dependence on climate-sensitive sectors such agriculture, pastoralism, health, water resources and energy has affected the envi-

ronment, economy and livelihoods of its citizens. This has triggered adaptive capacity initiatives such as social protection programmes, development of renewable energy sources, introduction of drought tolerant crops use of early warnings and establishment legal and institutional framework. These initiatives aim at reducing vulnerability to climate change and increasing resilience.

Conflicts of Interest

The authors declare no conflicts of interest.

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