TRANSPARENCY INTERNATIONAL KENYA

KISUMU COUNTY CLIMATE CHANGE RISK & VULNERABILITY

ASSESSMENT REPORT

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Acknowledgements

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Abbreviations

CEC	County Executive Committee Member
CHV	Community Health Volunteer
CIDP	County Integrated Development Plan
COMSA	Commonwealth Observer Mission to South Africa
GCMs	Global Climate Models
IPCC	Intergovernmental Panel on Climate Change
KIIs	Key informant surveys
KIWASCO	Kisumu Water and Sewerage
Company LVB	Lake Victoria Basin
ODK	Open Data K
SDGs	Sustainable Development Goal
SEACAP	Sustainable Energy and Climate Change Action Plan
TI-Kenya	Transparency International, Kenya
WHO	World Health Organization

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Executive Summary

Climate change is one of the most significant development challenges facing humanity. There is increasing evidence that climate change directly affects the social, economic, and human development of countries. Taking urgent action to combat climate change, therefore, has become one of the key global development priorities.

Like many countries around the world, Kenya is affected by climate change. This has led to frequent natural calamities and rising temperatures over the years. In Kisumu County, temperatures are steadily rising, and all the Intergovernmental Panel on Climate Change (IPCC) scenarios show that temperature will continue to increase significantly until the end of this century. In the Kano Plains, yearly flood-related losses are estimated at US$ 850,000 (Masese et al., 2016), while relief needs amount to US$ 600,000. Such events represent significant barriers to food security and poverty alleviation efforts in the County.

Kisumu County is, therefore, vulnerable to climate change and it is important to design an ambitious climate change adaptation strategy. Vulnerability is the degree to which a human or natural system is susceptible to, or unable to cope with adverse effects of climate change. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

The Lake Victoria Basin is known for its rich biodiversity, but environmental degradation and climate change pose a significant challenge to its existence. Environmental pollution and unsustainable and unregulated use of resources have significantly contributed to the ongoing biodegradation, with hundreds of species, both aquatic and terrestrial becoming extinct. The situation is exacerbated by the changing climate, characterized by prolonged drought and periods of intense rainfall and flooding. These changes are negatively impacting on livelihoods. Over 10% of the basin's population is gradually becoming chronically food insecure, requiring support for both short-term emergency food relief and sustainable long-term development programmes. Addressing the current challenges from recent and future climate change will be challenging.

Climate change has several effects on livelihoods, animal and plant health, the environment as well as ecosystem stability and resilience. Studies done in several countries show that many people are aware of health and environmental threats posed by climate variability. Kenya has communicated its updated Nationally Determined Contributions (NDC), and developed the National Climate Change Action Plan 2018- 2022, the national policy document for the implementation of the updated NDC.

Climate finance flows into the country is, therefore, expected to increase towards the implementation of these policy documents. The county governments can only facilitate the implementation of these national policies, which they should and must, if their planning is guided by an elaborate risk and vulnerability assessment. Beyond facilitation of the planning, risk and vulnerability assessments, it is important to prudently use climate finances and put in place key anti-corruption safeguards.

It is against this background that Kisumu County decided to develop its climate change policy, which was completed in 2018. The goal of the policy is to mainstream climate change in the economically and socially vulnerable sectors of the economy and to steer Kisumu County towards climate resilience, a blue economy, and a green development pathway. To adequately implement the policy, the County Government of Kisumu, through the support of Transparency International Kenya (TI-Kenya), commissioned the vulnerability assessment of the County. The study was conducted by Asben Eco-Consultants and Capacity Building Limited (AECB Ltd) between February 3, 2020, and February 22, 2020.

The goal of the study was to develop a comprehensive picture of current and future climate change risks as well as identify stress factors to be expected. The study will form a basis for adaptation planning for the county government and lead to a more transparent, accountable, and effective channeling of climate finances. Adaptation cannot be planned solely based on climate projections. Information on risk and vulnerabilities is also needed to determine how the climate interacts with socio- economic issues.

The study will form a basis for adaptation planning for the county government & lead to a more **transparent**, **accountable,** and **effective channeling** of climate finances.

Methodology

The study adopted a mixed-method approach where both primary and secondary data collection methods were used to gather data needed for the vulnerability assessment. Secondary data sources, such as relevant programme and sub-sector documents, county databases, and related literature were reviewed. Primary data was collected from sampled households in the county using focus group discussions (FGD), key informant interviews (KIIs), and field observation. A survey was conducted in February 2020. The survey was structured and managed in a way that ensured high data quality.

Using the standard Cochran formula for sample size calculation and considering the number of target households, a total of 427 respondents were picked, which included 5% for non-respondents' samples who were interviewed. Focus group discussions (FGDs) were conducted in 20 out of 35 wards. In addition, key county government officials were interviewed.

Key Findings

The development goals of Kisumu County are at risk from the impacts of climate change. The effects of climate change are already becoming a severe burden to the county's economy and its people. The consequences of climate change in Kisumu County are being felt in the extended and frequent drought, frequent floods, and rising temperatures. These threats have affected agricultural production, causing food insecurity and growing poverty, low per capita water availability, and a host of socio- economic impacts, such as disease outbreaks and epidemics, and access to education facilities, among others.

Current climate change is extremely rapid, which places additional stress on the capacity of ecosystems to adapt and on the lifespan of infrastructure. In health, a combination of projected changes in climate-related exposures (e.g. temperature, precipitation, lake-level rising) reported in this study will result in amplification of existing health risks and introduction of new risks with a high degree of spatial variability. Agriculture was observed to be the most vulnerable sector, mainly due to drought, rising temperature, flood, and the emergence of numerous diseases and pests. Climate change is, therefore, projected to compromise agricultural production, especially in smallholder systems with little adaptive capacity, as currently prevalent in many parts of the county.

The increasing climate changes will pose challenges for the county's development aspirations. With continued increase in greenhouse gas emissions, the atmosphere and oceans will become warmer, rainfall patterns will change, and the frequency of drought and flood incidences will increase. All these changes will add to the challenges of Kisumu's development. The loss of environmental assets due to climate change will affect many people and the economy with devastating effects on people, their culture, and their livelihoods. Based on the overall observation in different sectors:

FACTOR	FLOOD	DROUGHT	RISING TEMPT.	CHANGING RAINFALL PATTERNS	DISEASES & PESTS	LAKE LEVEL RISING	INVASIVE SPECIES	OVERALL VULNERABILITY
SECTOR								
AGRI. & LIVESTOCK	X	X	X	X	X	X	X	
WATER	X	X		X	X	X	X	
ENVIRON-MENT	X	X	X	X	X	X	X	
HEALTH	X	X	X	X	X	X	X	
ROADS & TRANS-PORT	X			X		X	X	
EDUCA-TION	X	X	X		X	X		
TECHNOL-OGY	X							
ENERGY	X	X	X	X	X			
HOUSING	X		X		X	X		
INDEX:								
LOW (1-2 FACTORS)	MEDIUM (3-4 FACTORS)				HIGH (5-7 FACTORS)			

Table 1: Overall vulnerability by sector

SUB COUNTY	FLOOD	DROUGHT	RISING TEMPT.	CLIMATE RELATED DISEASES & PESTS	LAKE LEVEL RISING	INVASIVE SPECIES	OVERALL VULNERABILITY
KISUMU CENTRAL	X		X	X	X	X	
KISUMU EAST	X	X	X	X	X	X	
KISUMU WEST	X	X	X	X			
SEME		X	X	X	X		
MUHORONI	X	X	X	X			
NYANDO	X	X	X	X	X	X	
NYAKACH	X	X	X	X	X	X	
INDEX:							
LOW (1-2 FACTORS)	MEDIUM (3-4 FACTORS)				HIGH (5-6 FACTORS)		

Table 2: Overall vulnerability by sub-county

1.0
Introduction and General Context

1.1 Background

Climate change is globally acknowledged as one of the most significant development challenges facing humanity. There is increasing evidence that climate change is directly affecting the social, economic, and human development of countries. As such, combating climate change has become one of the key global development priorities.

Likewise, corruption is acknowledged as a key hindrance to climate change response. Evidence shows that without relevant and effective anti-corruption safeguards, climate finance resources could be significantly lost to corruption. Enhanced transparency and accountability are, therefore, one of the main pillars of the Paris Agreement towards meeting the objectives of the Paris Agreement. This is further highlighted by the state of play where significant public climate finances are flowing through bilateral channels where the donor actively participates in the management of the funds as opposed to the multilateral climate change funds.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) presents strong evidence that surface temperatures across Africa have increased by 0.5-2°C over the past 100 years, and from 1950 onward climate change has changed the magnitude and frequency of extreme weather events. Africa is one of the most vulnerable continents to the impacts of climate change[1] . From the local level to the global, climate change has, therefore, become an economic, political, social, and environmental challenge, and Africa is especially vulnerable to its adverse effects. This is worsened by the fact that most of the continent's economies depend on climate-sensitive natural resources and have very low levels of adaptive capacity and extreme levels of poverty.

Kenya's climate is already changing. Average annual temperatures increased by 1°C between 1960 and 2003, with most warming taking place in the 'long rains' season of March, April, and May, which is also the primary planting season[2] . The effects of climate change and related disasters have the potential to impact the majority of Kenyans adversely, given that about 75% of the population depends directly on land and natural resources for their livelihoods. In recent years, there has been increased attention to climate change due to its impacts on the lives of Kenyans. This has been mainly due to an increase in the intensity and frequency of extreme climate events, such as severe droughts and flooding. These extreme events have had negative socio-economic impacts on almost all sectors in the Kenyan society, such as health, agriculture, livestock, environment, hydropower generation, and tourism.

1 Intergovernmental Panel on Climate Change (IPCC) (2007) Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II
2 UNCCD (2010). Climate change in Kenya: Focus on children.

The seriousness of the problem has made it imperative for policymakers to begin to mainstream climate change in development policies and strategies.

In Kenya, climate change has increased the frequency and magnitude of extreme weather events that have led to the loss of lives, diminished livelihoods, reduced crop and livestock production, and damaged infrastructure, among other adverse impacts. Climate change is likely to negatively impact Kenya's future development and achievement of the goals of Kenya's Vision 2030 – the long-term development blueprint – and the Government's Big Four agenda for 2018-2022, which focuses on ensuring food, and nutrition security, affordable and decent housing, increased manufacturing and affordable healthcare.

Among the most vulnerable regions in Kenya is the Lake Victoria Basin. Recent socio- economic impacts of severe and prolonged droughts in the Lake Victoria Basin (LVB) demonstrate the sensitivity and vulnerability of local populations[3]. Over 10% of the basin's population is gradually becoming chronically food insecure, requiring support for both short-term emergency food relief and sustainable long-term development programs. Addressing the current challenges from recent and future climate change will be challenging.

Climate change has multiple effects on livelihoods, animal and plant health. It has also affected the environment as well as the ecosystem's stability and resilience. Studies done in several countries show that many people are aware of health and environmental threats posed by climate variability. In the Lake Victoria Basin (LVB), climate change is increasingly being recognized as a significant factor contributing to poverty because of its implication to agriculture and food security, water resources, including ecosystems goods and service as well as its direct and indirect effects on human health and human settlements.

The negative impacts of climate change will increasingly be felt in the waters and on the shores of Lake Victoria. Inter-annual and inter-seasonal variability in rainfall and temperature could affect the survival of aquatic life, increasing the variability of fish catches, while uncertain agricultural yields inland may bring new entrants into the fishery each year or affect the quality of inland water resources. According to a study by Awange, et al. (2013)[4] a combined impact of both climate change and other anthropogenic factors has affected LVB water storage and led to a decline in fish and access to fresh water, environmental scarcity, loss of livelihoods, poor health and food insecurity.

1.2 Goal and Objectives of the Study

1.2.1 Goal

The study aims to determine the nature and extent of the current and future climate change risks, by analyzing potential hazards and assessing the vulnerabilities that could pose potential threats or harm to Kisumu County's population, property, livelihoods, and the environment on which they depend on.

3 Awange JL, Aluoch J, Ogallo L, Omulo M, Omondi P (2007) An assessment of frequency and severity of drought in the Lake Victoria region (Kenya) and its impact on food security. Climate Res 33:135–142.
4 Awange J. L., Anyah R. Agola N. Forootan E. and Omondi P. (2013). Potential impacts of climate and environmental change on the stored water of Lake Victoria Basin and economic implications. Water Resources Research, VOL. 49, 8160–8173, doi:10.1002/2013WR014350.

1.2.2 Objectives

- To identify present risks and vulnerabilities that Kisumu County is experiencing as a result of climate change.
- To identify priority issues for adaptation planning.
- To identify opportunities and challenges for strengthening the adaptive capacity of the communities and building resilient systems.

This risk and vulnerability assessment will, therefore, support Kisumu County to design and adopt a specific and ambitious climate change adaptation strategy. It will also mainstream climate change within each county department and policies, such as gender, youth, energy, finance, road and transport, urban planning, water and wastewater management, education, waste management, and public health.

Changing mindsets is certainly the biggest challenge. It is important to share knowledge on climate change with all stakeholders, particularly the residents of Kisumu County. Raising awareness and showcasing best practices will encourage them to adopt practices that protect them, infrastructures, and activities on the territories of Kisumu.

1.3 Boundaries of the Assessment

The study was undertaken within the jurisdiction of Kisumu County. The county is administratively divided into seven sub-counties and further into thirty-five wards.

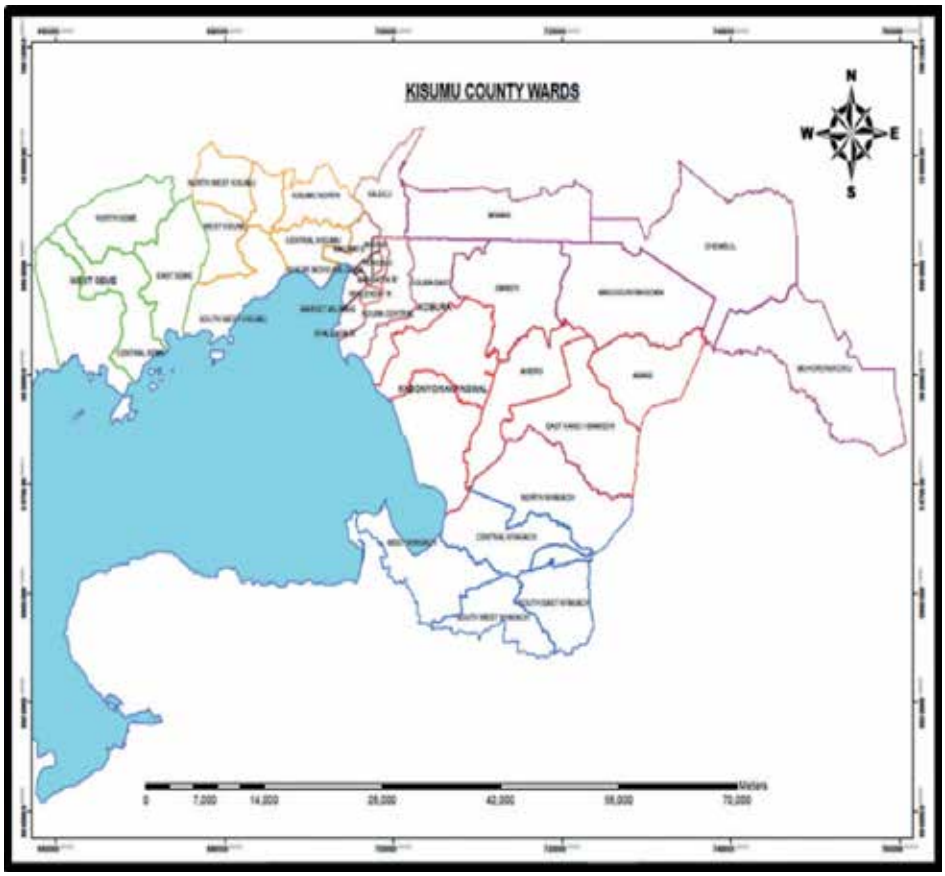


Figure 1: Kisumu County Wards map
Source: www.researchgate.net

1.4 Methodology

1.4.1 General Approach

The survey was commissioned by the County Government of Kisumu, Department of Water, Environment, Climate Change and Natural Resources in collaboration with Transparency International Kenya. The study adopted a mixed-method approach where both primary and secondary data collection methods were used to gather data needed for the vulnerability assessment. Secondary data sources, such as relevant Programme and sub-sector documents, county databases, and related literature were assessed. Primary data was collected from sampled households in the county using focus group discussions (FGDs) and field observation. The survey was conducted in February 2020. It was structured and managed in a way that ensured that high-quality data was collected.

1.4.2 Survey Instrument Design

The survey instruments were designed to meet the objectives of the study and obtain the information listed under the indicators. The design of the survey instruments ensured that there was little variability between interviewers, thus enhancing the collection of credible data/ information from the interviewees. The draft survey instruments were shared with Kisumu County and TI-Kenya for their concurrence before the finalization and roll-out of the study. The survey tool was then loaded in an Open Data Kit (ODK).

1.4.3 Sampling Techniques

Using the above standard sample size calculation and considering the number of target households, a total of 427 (Fig. 4), including 5% for non-respondent samples were interviewed. The consultant team employed a multi-stage cluster sampling technique in which the sub-counties were first-level clusters and second and third level clusters were the wards and sub-locations. A random sampling technique was used to select the houses for household interviews at the sub-location level.

Focus group discussions (FGD) were conducted in 20 out of 35 wards. Each FGD consisted of 6-8 people and inclusivity was considered when choosing participants. This includes ensuring gender representations among participants in FGDs.

The study adopted a mixed-method approach where both primary and secondary data collection methods were used to gather data needed for the vulnerability assessment. Secondary data sources, such as ***relevant Programme*** *and* ***sub-sector documents, county databases****, &* ***related literature*** *were assessed.*

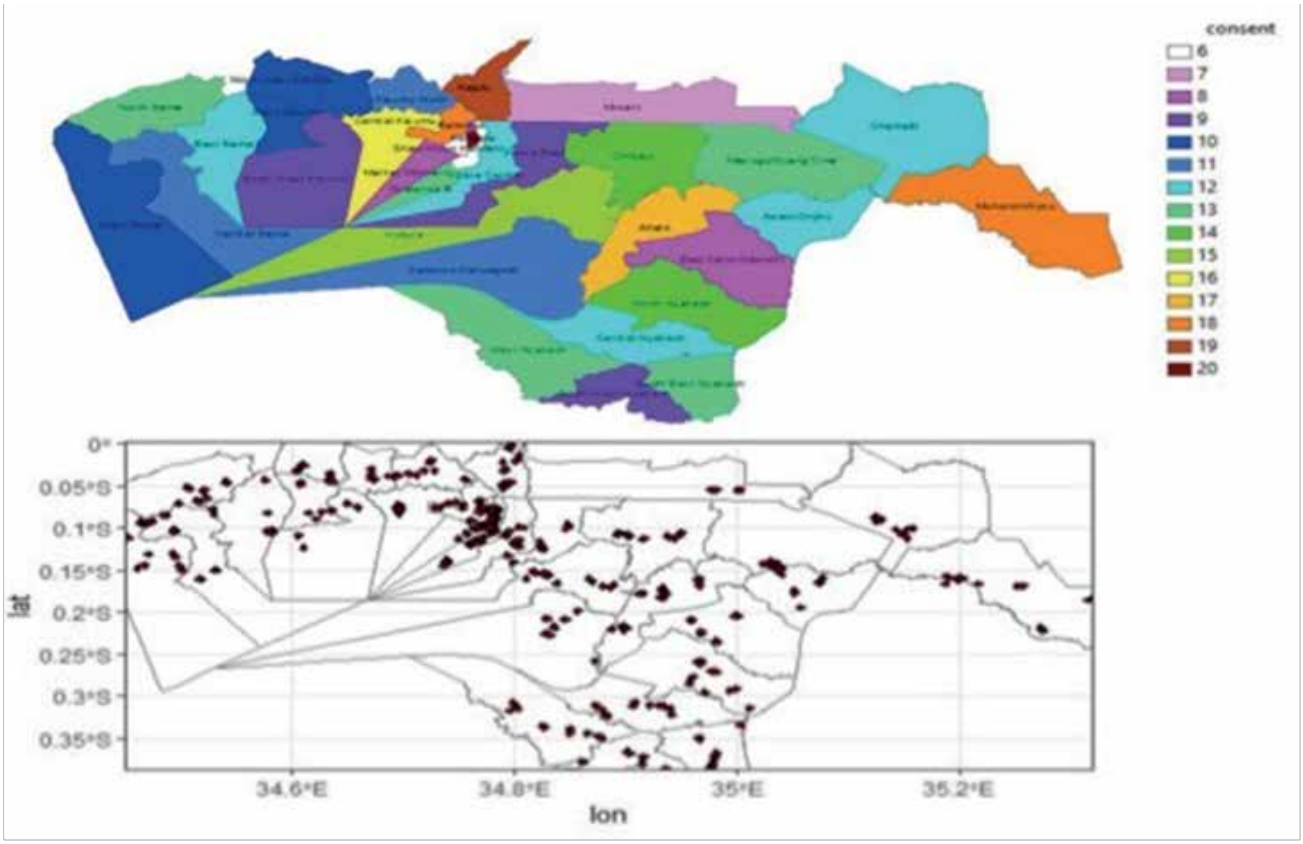


Figure 2: Map of Kisumu County showing households sampled for the interview per ward

The researchers also conducted key informant interviews (KIIs) with relevant county and national government sectorial officials, such as those in the Departments of Water, Health, Agriculture, Livestock, Fisheries, Environment, Climate Change, Renewable Energy Health, and County Director of Meteorological Services.

1.4.4 Data Analysis

The data collected using different instruments was analysed, interpreted, and used to prepare the assessment report. The survey data was encoded, entered into the appropriate Programme, cleaned, and analysed. Qualitative data gathered through interviews was analysed using SPSS software with a 95% confidence level and 5% margin of error. The quantitative data was used as the primary input for describing the results. It was also used to enrich, complement qualitative data, and illustrate the evaluation findings.

The findings from document reviews and field observations were organised and incorporated into relevant sections of the report. The level of analysis included descriptive statistics based on measures of central tendency (including percentages, comparisons, and averages) and inferential statistical analyses. Qualitative information from the focus group discussions complemented the quantitative information in the process of writing the report.

1.4.5 Ethical Considerations and Quality Control

In this assignment, different data quality assurance mechanisms were employed at all stages of the evaluation process. Accordingly, the evaluation employed a participatory and voluntary approach to ensure that the data collected reflected the reality of the project support.

2.0
Context, Past Climatic Events, & Trends

2.1 Demographic and Socio-Economic Context

2.1.1 Demographic context

According to the 2019 census[5] , Kisumu County has a total population of 1,144,777 people with an average population density of 554 persons per square kilometre. The county has approximately 300,745 households and an average household size of about 3.8 members (Table 1). The average national population density of Kenya is 82 persons per square kilometre, which shows that the Kisumu population is high above the average national population. Roughly 70% of the people live in rural areas, most of whom are women; rural-to-urban migration is particularly high among men, who move to urban centres, such as Kisumu, Ahero, Maseno, Chemelil, Muhoroni, and Awasi, in search of off-farm jobs.

	POPULATION	AVERAGE HOUSEHOLD SIZE	LAND AREA (Sq. Km)	POPULATION DENSITY (No. per Sq. Km)
Kisumu East	220,997	3.6	141.6	1,560
Kisumu Central	174,145	3.3	36.8	4,737
Kisumu west	172,821	3.7	Sub - County	827
Seme	121,667	4.1	267.7	455
Muhoroni	154,116	4.1	657.5	234
Nyando	161,508	4.2	446.1	362
Nyakach	150,320	4.2	326.7	460
Total	1,155,574	3.8	2,085.4	554

Table 3: Population of Kisumu County per sub-county
Source: (2019 population census)

5 2019 Kenya Population and Housing Census: Volume II

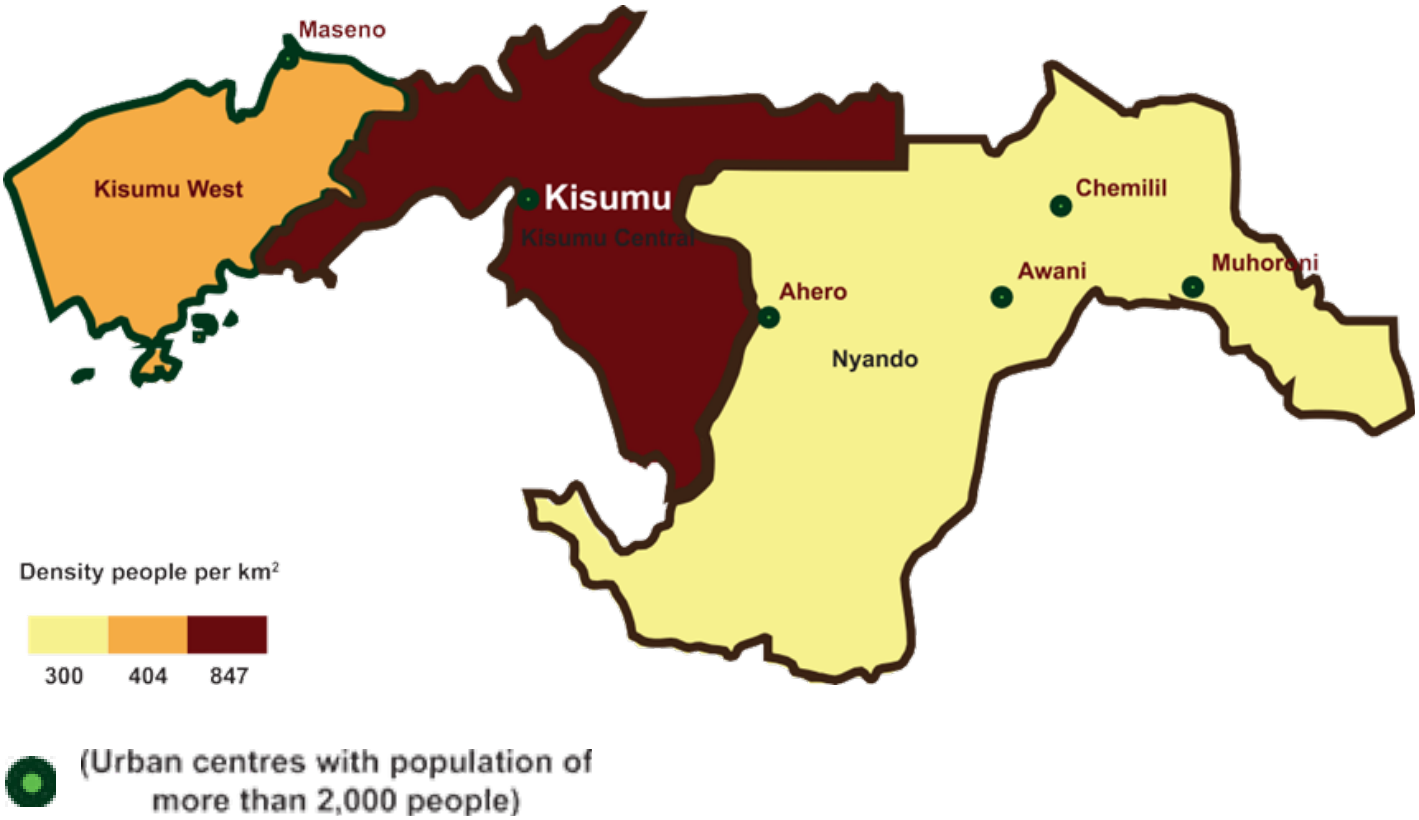


Figure 3: Population map of Kisumu County

2.1.2 Socio-economic Context

2.1.2.1 Education

The education level of the head of household, to some extent, usually influences decisions, such as the adoption of new technologies and investment levels, including the ability to take risks in making decisions. Literacy levels are relatively high in Kisumu County, where 82% of the population can read and write. However, there is a significant difference in the level of education between the sub-counties at a 95% confidence level (p-value = 0.04929) with the highest number of respondents with higher education coming from Kisumu Central and East.

The level of education is an important factor in resilience to climate change. In a society where employment opportunities are based on education, it is assumed that individuals with a higher level of education have better opportunities for better-paid employment, which comes with higher levels of income. People with higher income are more resilient to climate-induced shocks[6] . For example, in the current study, it was demonstrated that respondents with upper primary school education and above had more household assets than their counterparts with lower education levels, as demonstrated below.

6 Asmamaw, M., Mereta, S. T., & Ambelu, A. (2019). Exploring households' resilience to climate change-induced shocks using Climate Resilience Index in Dinki watershed, central highlands of Ethiopia. PLOS ONE, 14(7), e0219393. doi: 10.1371/journal.pone.0219393.

Level of Education and household resource in Kisumu County

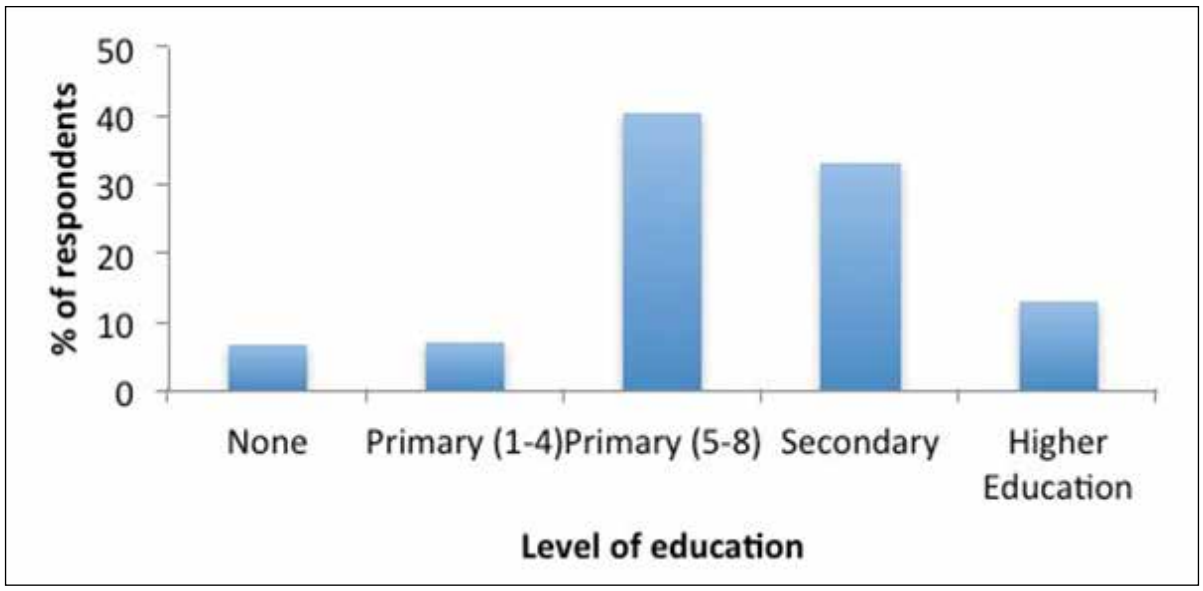


Figure 4: Level of education in Kisumu County

SUB - COUNTY	NONE	PRIMARY (1-4)	PRIMARY (5-8)	SECONDARY	HIGHER EDUCATION
Kisumu East	3	4	19	18	15
Kisumu Central	6	5	25	27	15
Kisumu west	4	7	27	16	3
Muhoroni	5	2	28	20	9
Nyakach	2	4	22	26	9
Nyando	6	3	26	23	2
Seme	3	5	25	11	2
Total	29	30	172	141	55

Table 4: Level of Education (%), per sub-county and household resource

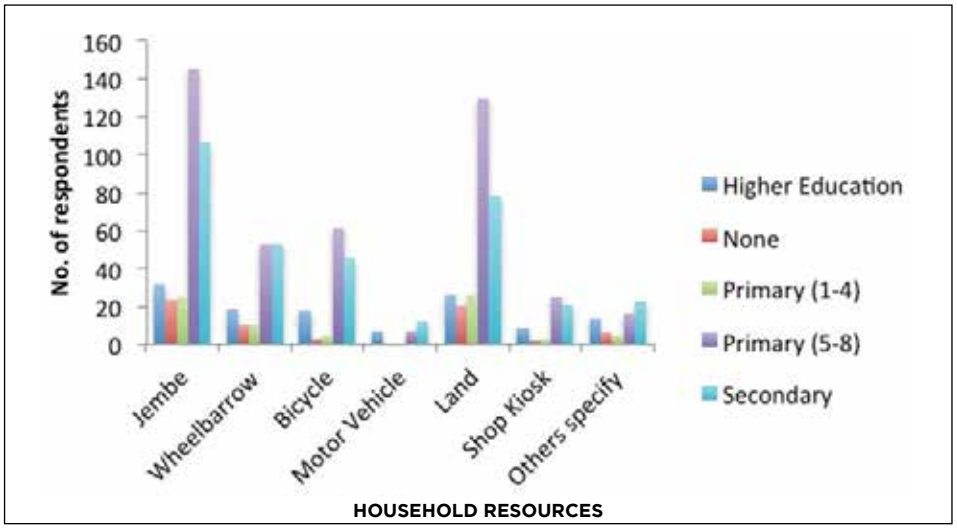


Table 5: Level of household resource

2.1.2.2 Household heads

The study revealed that about 71% of the households are headed by males, while 22% and 7% are headed by females and youth, respectively. This observation could have a bearing on households' vulnerability to climate change. For example, in a patriarchal society where resource allocation is biased towards males, female-headed households could be disadvantaged in resource allocation and therefore are more vulnerable to climate change. Previous studies also conclude that the impacts of climate change, extreme weather events, and slow-onset disasters are acutely felt along gender lines. Gender-based inequalities and social exclusion are vital factors undermining people's and communities' capacities to cope.

2.1.2.3 Household income

At least 55% of the respondents reported that they did not have a salary, regular source of income, or estimate of how much money they made per day or month. This is likely because they describe themselves as casual workers or farmers and do not make a steady income. Casual workers are those who work on farms, drive motorbikes, or work other odd jobs, which does not allow them to estimate their regular income. A few other participants did not list income because they are retired (with no pension), students, or they were women whose husbands would not share financial matters with. Most of the respondents are either self-employed (31.4%) or farming (24.8%). Fishing is one of the key economic activities in Kisumu County, accounting for 22.4% of the respondents. Most of the fish harvesting takes place in Lake Victoria. With the advent of fishponds, households are investing in the ponds, and there are over 1,330 fish farms. Adult male-headed households had a relatively higher level of participation across all types of occupations in the County.

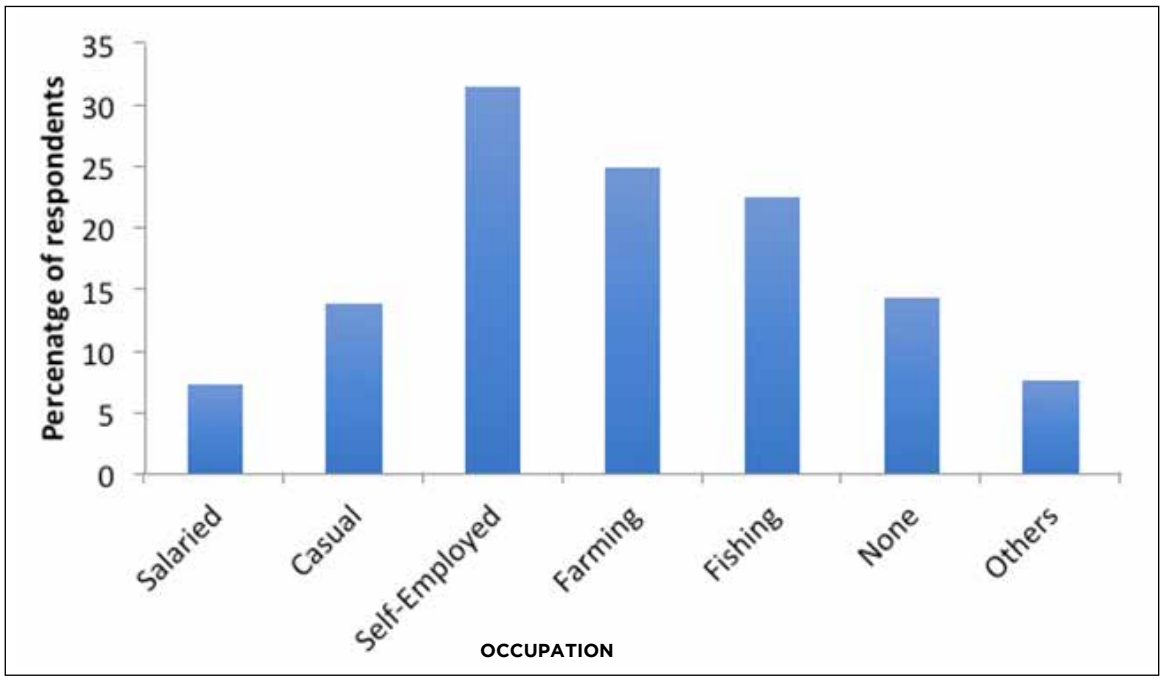


Table 6: Household income levels

2.1.2.4 Land ownership

The average farm size was 3.5 acres. Disaggregated by gender, male-headed households owned 4.5 acres, female-headed owned 3.2 acres, and youth-headed owned 3.0 acres. The holdings are highly fragmented, which discourages economies of scale and long-term investments. There was a significant difference (at 95% confidence level) between sub-counties on the average land size per household. Kisumu Central and East have the smallest sizes, while Muhoroni has the highest number of respondents with more than five acres of land compared to other sub- counties on average. Most of the land (79%) is owned by individuals, 5% is clan/ family-owned, 0.4% is communally owned, and the rest is owned by various local authorities. Land is a critical factor for production. Therefore, the smaller the land- holding size per family, the higher the vulnerability. About 40% of households hold title deeds to their land, 53% owned land but did not have title deeds or any formal document, and 7% leased land. This indicates that only about 40% of households have incentives to borrow or undertake investments using their land as collateral. The challenge of conducting climate investments on government-owned land could also be affected since few or no parcels had been set aside for community projects except schools and water projects already congested due to lack of space for expansion.

2.1.2.5 Poverty

The high poverty level is one of the significant developmental challenges in Kisumu County. The impact of climate change has further exacerbated the poverty situation in the county. While climate change is a global phenomenon, its negative impacts are more severely felt by vulnerable poor in rural and peri-urban areas. In Kisumu, high dependencies on natural resources as well as climate-sensitive agricultural practices are a major cause of vulnerability to climate change. The situation is worsened by the low technical capacity of the communities and insufficient financial resources to cope with climatic extremes.

The leading causes of poverty include the HIV and AIDS pandemic; the collapse of local agro-based industries; unemployment; and low agricultural and fish production. Food insecurity; inaccessibility to affordable healthcare; lack of proper storage facilities; erratic and unreliable rainfall; and inadequate and inaccessible road network have also increased the poverty levels. So have floods; the collapse of agro industries, such as problems with the sugar, rice, cotton, and fish industries; lack of title deeds; poor water and sanitation systems; malaria, and waterborne diseases.

*The situation is worsened by the **low technical capacity** of the communities and insufficient financial resources to cope with climatic extremes.*

2.2 Environmental Context

2.2.1 Climatic Conditions

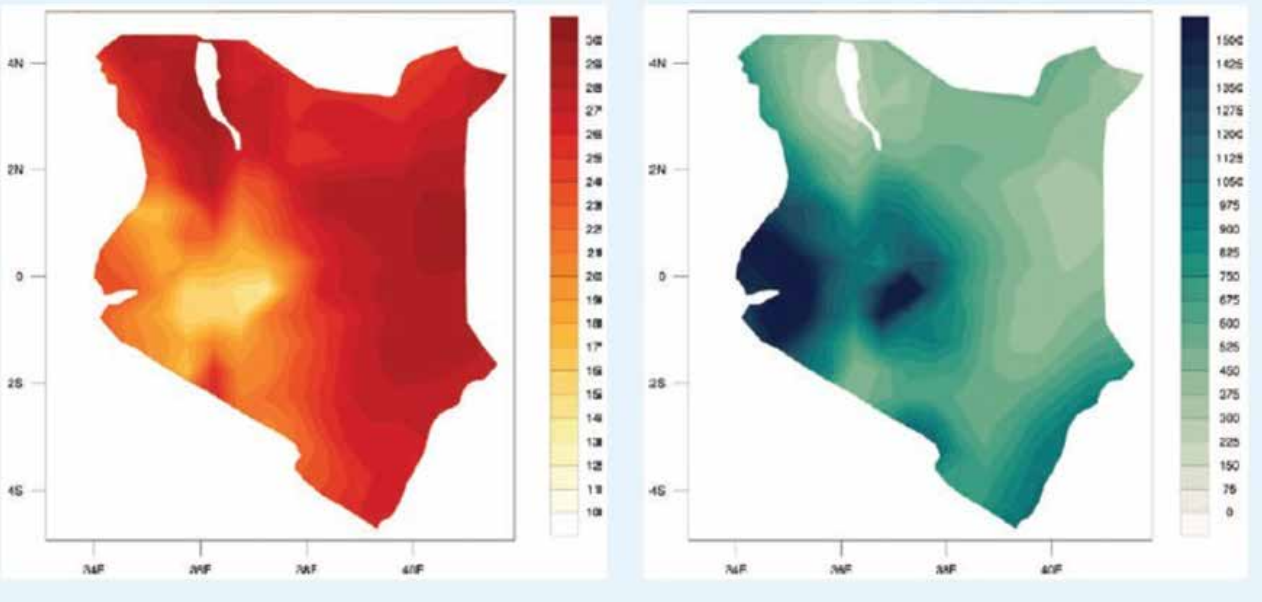


Figure 5: Map of average temperature and annual precipitation in Kenya for the period, 1991-2020

(Left: Average temperature and right: annual precipitation in Kenya for the period

1991-2020. Source: World Bank, Kenya Country profile 2021[7])

The maps above show the temperature and precipitation means for the last thirty years. Regarding temperature, researchers have observed that Kisumu is preserved with the combined influence of Lake Victoria and the forests and mountains (Kakamega and Mau forests, Mt. Elgon) surrounding it. Looking at precipitation, the Lake region around Kisumu also benefits from specific rain patterns with higher precipitation as a consequence of the same reasons.

The climate of the county is generally warm with minimal monthly variation in temperatures between 230C and 330C throughout the year. The rainfall is determined by a modified equatorial climate characterized by long rains (March to May) and short rains (September to November). The average annual rainfall varies from 1000- 1800mm during the long rains and 450-600 mm during the short rains.

The altitude in the county varies from 1,144 meters above the sea level on the plains to 1,525 meters above sea level in the Maseno and Lower Nyakach areas. This greatly influences temperatures and rainfall in the County[8].

Figure 6 demonstrates the average monthly temperature and rainfall for Kenya for the period 1991-2020.

7 WBG Climate Change Knowledge Portal (CCKP, 2020). Kenya, Historical Climate. URL: https://climateknowledgeportal.worldbank. org/country/Kenya/climate-data-historical

8 National Environment Management Authority (2015). Kenya- Second National Communication to the United National Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/Kennc2.pdf

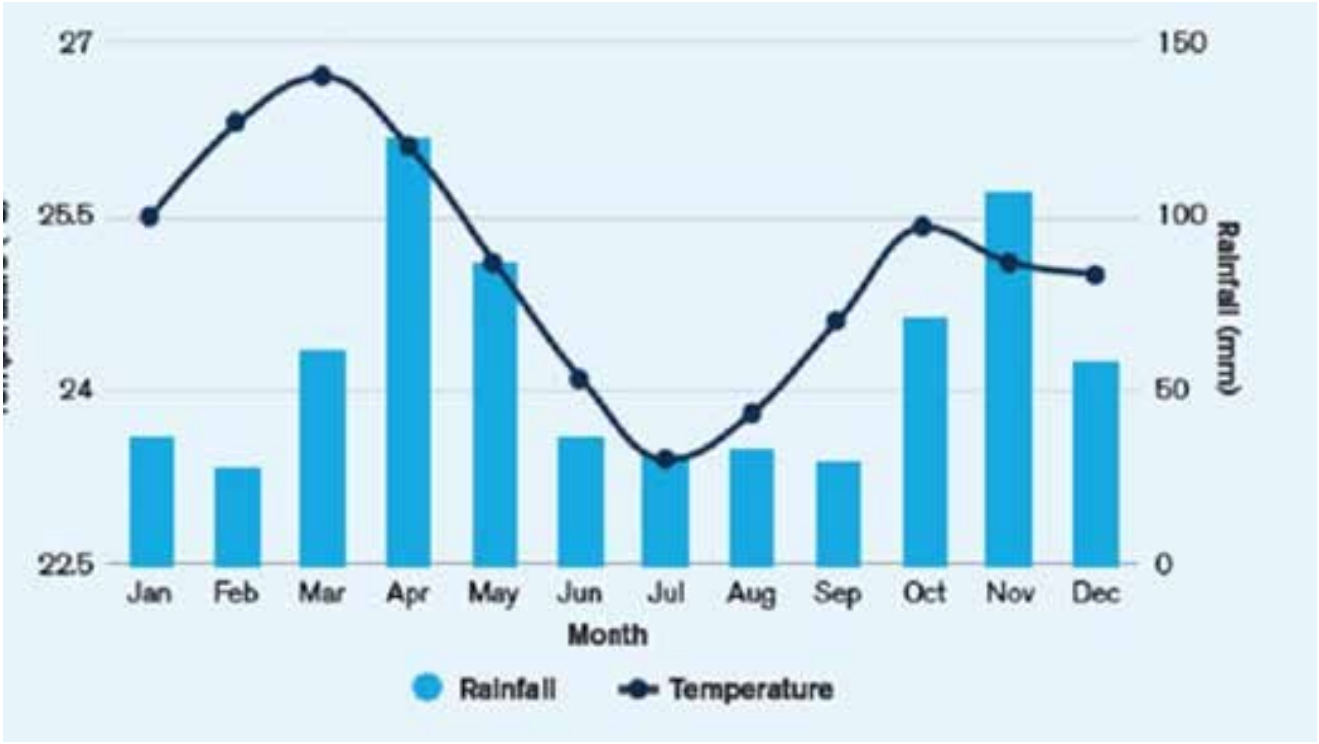


Figure 6: Average monthly temperature and rainfall for Kenya, 1991-2020
Source: World Bank, Kenya Country profile 2021

Climate and weather observations are significantly different because climate observation is based on the long-term duration of observation of a minimum of 33 years to millions of years, while the weather is observing periods of hours or days. The graph below perfectly demonstrates this trend for Kenya: The annual average varies every year but the five-year smoothing shows a slow but continuous increase in temperature. This is the same scenario for the region of Kisumu. For sustainability, the county needs to develop its system of temperature & rain patterns follow-up (with fixed meteorological centres, for example).

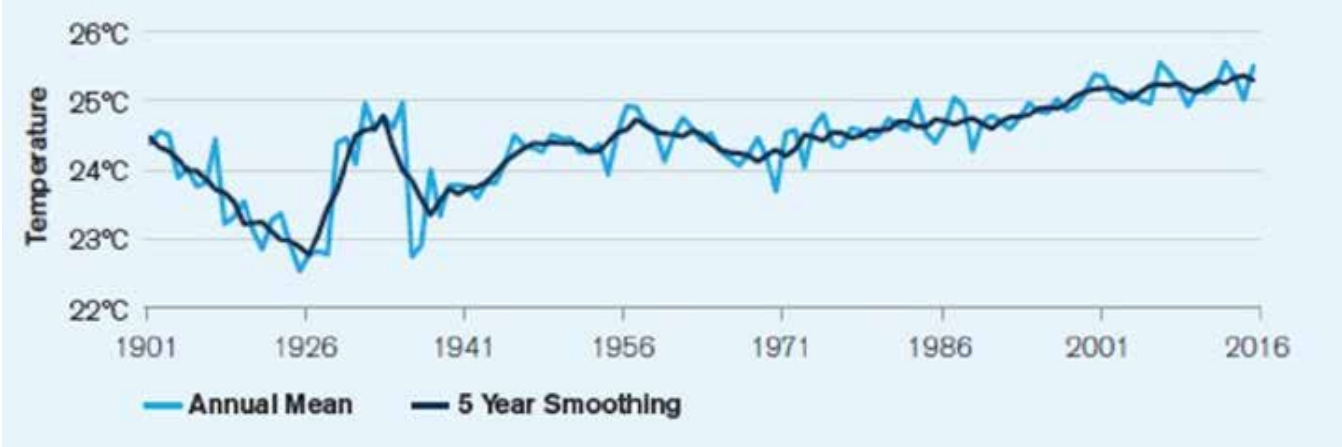


Figure 7: Observed temperature for Kenya, 1901 - 2020
Source: World Bank Kenya Country profile 2021

The observation of climate is based on the collection and analysis of data, such as temperatures, from several decades. Natural and anthropologic facts, such as human activities which emit high levels of greenhouses gases, explain these variations.

These long-term data observations from the past can be extended to try to anticipate the future – still on a long-term period. That is the role of the IPCC, which elaborates the different scenarios under the United Nations Framework Convention on Climate Change (UNFCC). These worldwide scenarios are downscaled at the national and local levels to measure the evolution and the impacts of climate change.

The Kenya Country Climate Risk Profile released in 2021 summarized has summarized this work:

"The main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP) is the CMIP5 (Coupled Inter-comparison Project No.5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e., RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (a cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes a business-as-usual scenario. For more information, please refer to the RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5), and a high (RCP8.5) emission scenario in this profile. (Figure 8) provides CMIP5 projections for essential climate variables under high emission scenarios (RCP8.5) over four different time horizons.

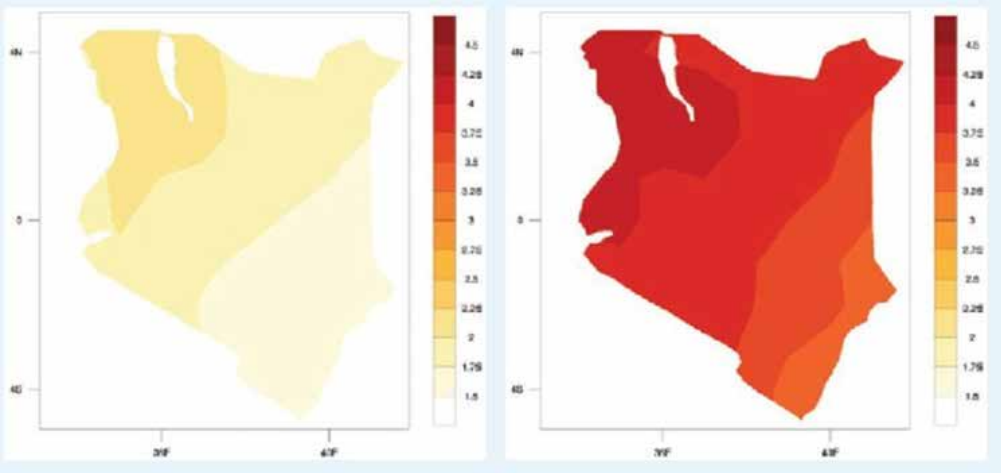
CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Annual Temperature Anomaly (°C)	**+0.5 to +1.4** (+1.0°C)	**+1.2 to +2.4** (+1.7°C)	**+2.0 to +3.7** (+2.5°C)	**+2.7 to +5.1** (+3.5°C)
Annual Precipitation Anomaly (mm)	**–13.7 to +21.6** (2.6 mm)	**–17.1 to +25.2** (3.5 mm)	**–17.0 to +34.0** (6.7 mm)	**–17.8 to +44.0** (10.5 mm)

Note: The table shows CMIP5 ensemble projection under RCP8.5. Bold value is the range (10th–90th Percentile) and values in parentheses show the median (or 50th Percentile).

Figure 8: Data snapshot: CMIP5 ensemble projections

Source: World Bank 2021

Figure 9 below presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099."



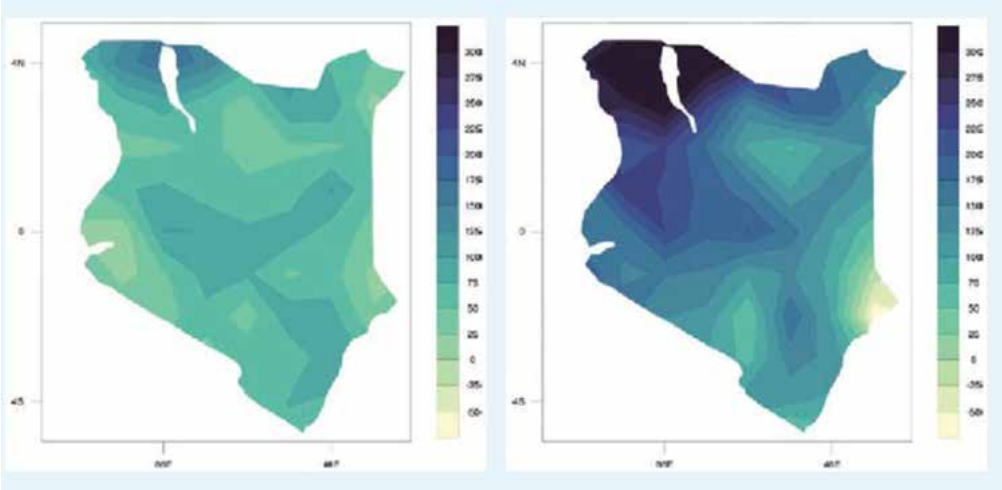
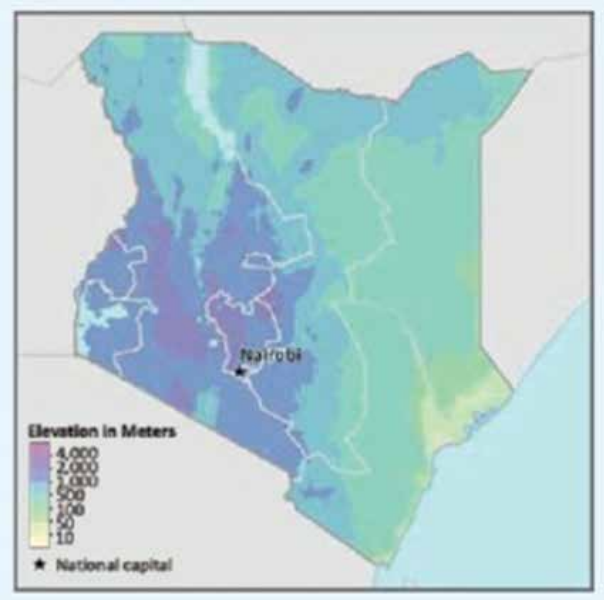


Figure 9: Projected change in annual temperature and precipitation

Figure 9 above shows ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), relative to 1986–2005 baseline under RCP8.5.

Regarding temperature, it is evident from these scenarios that in all cases, the temperature will rise with acceleration by mid-century. An average temperature per day of 1.7°C during the mid-century which is expected to reach 3.5°C by the end of the century is a strong increase. This means that the peak of heat during the day will be quite high. In terms of having a population affected by natural disasters, Kenya is ranked first in East Africa. In general, droughts affect more people and have a higher economic impact in Kenya. Floods, however, have more localized effects, especially in the Lake Victoria basin, and have caused more loss of life than droughts[9].

2.2.2 Physiographic and Natural Conditions



The county's topography is undulating and characterized by Kano Plains, which is a flat stretch lying on the floor of the Rift Valley; the Nyabondo Plateau; and the over-hanging huge granite rocks at Riat hills, Maseno and Seme areas. Due to flash flooding, the Kano-Plains have rich alluvial soils which favour agricultural production of horticulture and rice. The county also has granite which is used in building and road construction. Kisumu is endowed with the second largest freshwater lake in the world, L. Victoria, and two major rivers, Nyando and Sondu-Miriu. Its catchment has seven permanent rivers, including Awach-Kano, Oroba/Ombeyi, Kibos, Awach-Seme, Kisian, and Mugru. These resources have huge potential for the development of the blue economy. Impala sanctuary, Ndere Island, the legendary Luanda Magere and Kit-Mikayi sites are among the unique topographical features.

9 Ministry of Foreign Affairs of the Netherlands (2018). Climate Change Profile, Kenya. URL: https://reliefweb.int/sites/reliefweb.int/ files/resources/ Kenya_2.pdf

2.2.3 Ecological Conditions

Kano Plains is predominantly made of black cotton soil that is unstable and drains poorly. The cotton soil is, however, suitable for the production of rice, horticulture, and sugarcane. Seme and the lower parts of Nyakach sub-counties are dominated by lake sediments that are mainly comprised of sand and clay soils, while Kisumu West Sub- County and Upper-Nyakach are predominantly red-loamy soils suitable for agricultural production. The lake shores are swampy and offer fertile ground for horticulture and fish breeding

2.3 Past and Current Climatic Events and Trends

This section attempts to capture the climate-related risks and shocks facing different sectors in Kisumu County. "Risk" refers to the potential of shocks and stresses to affect the state of systems, communities, households, or individuals. Individuals, families, and communities are constantly exposed to risks that can threaten their well-being. Ill health, unemployment, violent crime, or a sudden change in market conditions can, in principle, affect anyone. Climate risks are not equally distributed, but they are widely disbursed. Many factors influence how a community or individual households react to such risks. These factors include their socioeconomic situation and environment, which affect their capacity to adapt to climate shocks which are referred to as sensitivity and adaptive capacity.

2.3.1 Agriculture, Livestock and Food Security

Agriculture is the mainstay of the population in the county. Mixed farming systems predominate in the county; only a few farmers cultivate sugarcane and rice for commercial purposes under mono-cropping systems. Approximately 34% of the land in the county is dedicated to subsistence crops, 34% to natural pastures, and 18% to commercial crop production; homesteads extend over 7% of the land. Small-scale production represents 90% of total agricultural production in the county; it accounts for 75% of the total agricultural output and 70% of the marketed agricultural produce. Some nucleus estates are established around sugarcane factories in Muhoroni and parts of Nyando Constituency.

The vast majority (62%) of the population in Kisumu County rears local poultry. Of those practicing local poultry production, free-range (traditional) accounts for 85%, semi-intensive (backyard) for 10%, and only 5% practice commercial-intensive production systems. About 44% of the households keep local cattle while local sheep and goats accounted for 24% each.

About 68% of the interviewed households did not produce enough food to cover their household consumption for a whole year. Of the households facing a deficit, the households experienced food deficit for a varied period in a year with the majority of respondents (54%) indicating that they experience deficit for well over four months a year, and only 46% indicated that they experience shorter deficit periods of three months or less.

Kisumu County's agricultural sector is vulnerable to climate variability and extreme weather events, such as droughts and floods. These events have led to food shortages, rising food prices, and damage to the county's economy. This sector's vulnerability stems in part from the annual variability in rainfall and dependency on rain-fed agricultural production.

The sector's vulnerability to climate risks could be reduced by investing in water storage, rainwater harvesting, and irrigation infrastructure, as well as more efficient water use in light of current and projected water shortages. Intensification of irrigation could lead to an estimated fourfold increase in crop production, not accounting for the implications of climate change.

The historical economic impact of drought on Kenya's agricultural sector has been significant. Drought encourages deforestation as people increasingly clear forests for agricultural lands, use forested lands for grazing, and produce charcoal for their energy and economic needs. Floods are also a concern for both crop and livestock production, leading to loss of lives and result in damages to the agricultural sector[10].

2.3.1.2 Current Climate Risks on the Agricultural Sector

Floods, drought, rising temperature, pests, and diseases were identified as the key risks facing agriculture. This situation worsens during the rainy season when flooding is experienced in several sub-counties (especially in Nyando, Nyakach, and Muhoroni areas). The flooding damages crops and properties and increases the risk of waterborne diseases. The risk of flood, drought and rising temperature is expected worsen with time due to the changing climate.

Land tenure and management is another challenge to agricultural production in the county. In the absence of clear title deeds and land delimitations, open grazing is a common practice, causing damage and even losses of crops due to animal interference. Moreover, population growth and cultural inheritance norms have caused more pressure on natural resources, leading to high land fragmentation that threatens the economic efficiency of agricultural production systems of most farmers.

It becomes difficult for farmers to access markets during the rainy season because of poor road infrastructure. Moreover, farmers who are not part of cooperatives and group structures are unable to fetch reasonable prices for their products, access credit, and pool resources for value addition. They lose their bargaining power to intermediaries and brokers. Despite the existence of a wide range of financial institutions (banks, insurance companies, and corporations), most of the credit facilities and insurance services available to farmers require them to use their title deeds as collateral and incur high interest rates, discouraging the use of such financial products and even farmers' engagement in agri-business.

Crop production is affected by a wide range of pests and diseases like stalk borers, smut, and aphids in sorghum. During the time of data collection, there was an outbreak of desert locusts, which was observed in the Muhoroni and Koru areas.

Livestock production is affected by a wide range of pests and diseases, such as the East Coast Fever in cattle, Newcastle disease, and Gumboro disease. Others are fowl typhoid and coccidiosis in the chicken value chain, tsetse flies, lung infections (pneumonia), worm load, and parasitic infections of worms in livestock. During the dry spells, there are cases of hand-foot-mouth diseases (HFMD) or even anthrax (in Nyakach Sub County in particular) which led to severe livestock and economic losses. Other challenges identified include low productivity, water scarcity, access to the livestock market, pasture especially during the drought season, and inadequate animal health services.

2.3.2 Water Sector

10 MoALF. 2017. Climate Risk Profile for Kisumu County. Kenya County Climate Risk Profile Series. The Ministry of Agriculture, Livestock and Fisheries (MoALF), Nairobi, Kenya.

Kisumu County boasts abundant water resources due to its proximity to Lake Victoria. Rivers such as Nyando, Sondu-Miriu,Ombeyi, Awach, Nyaidho, Ang'wecha, Kibos, Magada, Mugru, Kisian, Saka, Auji, Kisat serve the county.

The study sought to determine the water access situation in the county. Access to clean water is a crucial pillar under the United Nation's Sustainable Development Goals (SDGs). Exposure to climate change risks, such as drought and floods, affect water availability and quality. In this study, the respondents were asked to estimate the distance to the nearest water point. The study found that the majority of the respondents (79%) could access water within a kilometre from their homes. Nearly half of the households (47%) spend less than five minutes (one way) to fetch drinking water. Around 55% of the households have access to potable water, while only 8% have access to piped water. The study probed further to determine water access- related problems the residents were facing.

2.3.2.1 Historical Impacts of Climate Risk on Water Sector

Kisumu County's water resources are periodically affected by extreme weather events, such as droughts and heavy rains. Between such events, we may observe some changes in the length of the rainy and dry seasons. The extreme weather events and season length changes may affect the water resources that provide water to the consumers located in the Kisumu County Region.

During periods of drought, water springs and rivers dry up, lake levels drop and they experience increased siltation. The consequences are that water needs to be collected from more distant locations and that water quality declines as pollutants become increasingly concentrated in smaller water bodies. Conflicts on the accessibility of water supplied by scarce resources can increase between the different kinds of consumers (agriculture, inhabitants...)[11]. During the period of heavy rains, floods also adversely affect water quality by bringing more chemical products and other pollutants, fertilizer, pesticide residues into the water bodies, potentially leading to eutrophication[12].

Moreover, floods damage infrastructure, such as roads, railway lines, bridges, water intakes, houses, tourism and other leisure infrastructures on the lakeshores. This damage can in turn create food shortages, power rationing, and infrastructure damage, all a heavy burden on society and the economy.

2.3.2.2 Current Climate Risk on Water Sector

Rivers break their banks and cause severe flooding and destruction of property such as crops, livestock, and buildings. This may lead to human displacement and sometimes death. Other consequences of flooding include the spread of waterborne diseases, and soil erosion which causes siltation of rivers and the lake.

Further, there is pollution of water resources through waste and raw sewage disposal, chang'aa (local liquor) brewing, car-washing and overexploitation of natural resources like papyrus reeds, fish stocks and trees around the water resources.

Sand harvesting is another major challenge in the county. Sand harvesting has led to the destruction of underground aquifers; loss of safe water by affecting surface water quality and quantity; and damage

11 Awange J. L., Anyah R. Agola N. Forootan E. and Omondi P. (2013). Potential impacts of climate and environmental change on the stored water of Lake Victoria Basin and economic implications. Water Resources Research, VOL. 49, 8160–8173, doi:10.1002/2013WR014350.
12 Climate Risks, Vulnerability and Governance in Kenya: A review Authors: Jo-Ellen Parry, Daniella Echeverria, Julie Dekens and Joseph Maitima

to the aquatic ecosystem. Haulage of sand by heavy trucks causes environmental degradation. With the changing rainfall pattern, rising temperature, and prolonged drought, the water problem is bound to worsen.

2.3.3 Health Sector

2.3.3.1 Historical and Current Climatic Risks on health

Climatic factors, such as temperature and precipitation patterns, directly and indirectly, affect the health and well-being of people today. These impacts are caused by extreme weather-related events and changes in average climate conditions. Many health–climate links are also influenced by forms of environmental degradation, such as rapid deforestation, loss of biodiversity, and degradation of water resources. While these processes can lead to the emergence of diseases, they can also reduce the capacity to treat health ailments. Vector- and water-borne diseases, in particular, are directly influenced by climatic patterns. Of these diseases, malaria and cholera are of particular concern.

Outbreaks have been found to occur when high-temperature anomalies are followed by substantial rainfall after a month. Historically, malaria has been more prevalent in lowland areas of Kenya (Yanda et al., 2006). However, research conducted in Kenya and the Lake Victoria basin has found that malaria has become more widespread in the highlands in recent decades. This is as a result of greater climatic variability coupled with environmental changes (such as deforestation) and changes in cropping patterns, and their influence on mosquito breeding and survival. Cholera also poses a heavy health burden in Kisumu. Along the Lake Victoria Basin, cholera outbreaks have emerged through the consumption of contaminated water and food and poor hygiene practices. Apart from climatic variability, socioeconomic factors also influence the vulnerability of poor households to malaria and cholera. Income- generation capacity is correlated with the ability of households to invest in healthy coping mechanisms, such as food and medicines (Olago et al., 2007; Wandiga, 2006; Wandiga et al., 2010; Yanda et al., 2006). Moreover, poverty coupled with an inadequate health care system handicaps the capacity of poor households to cope with health-related risks.

Due to the challenges, Kisumu's capacity to respond to climate-inflicted diseases is low, and most times the response is too late.

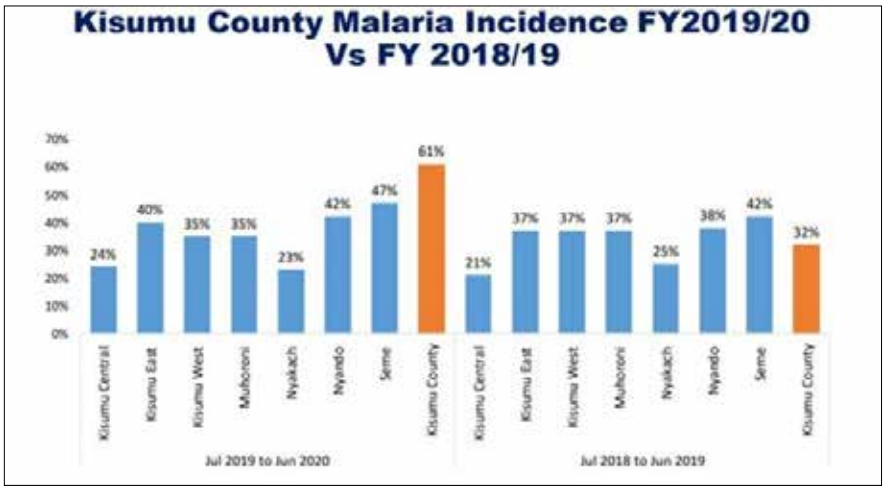


Figure 10 Kisumu County Malaria incidence survey

(Source: Kisumu County Health Information Systems Directorate)

2.3.4 Infrastructure Sector

Infrastructure is important for the development of the society and economy. In recent years, climate change has been identified as a growing threat to important infrastructure, and many studies have been conducted to assess the vulnerability of critical infrastructures to climate change. Impacts of climate change, such as flooding, drought, heatwaves, wildfires, landslides, rising lake level, etc. could have a severe impact on the infrastructural system, causing changes in air quality, property damage, service disruptions, water quality, and habitat changes among others. Understanding the impacts of climate change on infrastructure is key in designing adaptation measures necessary to climate-proof the infrastructural system.

2.3.4.1 Historical and Current Climatic Risks on Infrastructure

Vital infrastructure for energy supply, water supply, and transportation systems are likely to be affected by climate change. Extreme weather and lake level rise pose new risks to the infrastructure. Extreme weather leads to negative impacts on transportation infrastructure, including on its physical condition and the cost for operation and maintenance. Furthermore, the increase in temperature will increase heat, which reduces the life of asphalt and increase the stress to bridges expansion joints. A transportation system is essential to ensure the efficient distribution of food, energy, and trade, as well as to facilitate workers and consumers in accessing jobs and markets.

In addition, to ensure that there is electricity in a region, energy production and distribution facilities must function appropriately. Climate change causes damage to these infrastructure systems and disrupts these services, which will cause significant economic and human losses. Extreme weather that leads to flooding will weaken the structural support of bridges, increase sedimentation rate in water infrastructure, and increase the risk of landslides or avalanches. Flooding also causes damage to significant freight routes, deteriorates energy infrastructure, and cuts the electricity off. Further, flooding can lead to the destruction of the water supply network and wastewater system. Public facilities, such as hospitals, schools, shopping malls, and offices, can also be damaged by floods.

In addition, to ensure that there is electricity in a region, energy production and distribution facilities must function appropriately. Climate change causes damage to these infrastructure systems and disrupts these services, which will cause significant economic and human losses.

3.0 Projected Climate Change Hazards and Impacts

3.1 Projected Climate Change Impacts On Agriculture

The sector, and particularly smallholder farmers, are vulnerable to the impacts of climate change due to its high dependence on rain-fed production. Generally speaking, climate change is expected to affect the availability, accessibility, utilization, and system stability of food production in Kisumu County. Crop yields are expected to decline due to excessive or insufficient availability of water, more losses to pests and diseases, and more competition with weeds.

In the livestock sector, production might decline due to lack of pasture, restricted access to water, and heat stress. Changes in the prevalence of livestock diseases (such as Rift Valley fever) are also possible. Current studies conclude that the impacts of climate change will vary among agro-ecological zones. In terms of how specific crops may be affected by climate change, research indicates that a long- term decrease in the production of key crops such as maize may occur and the total value of agricultural land would be reduced by one-third.

Changing behaviour in land use management and agricultural practices are strategic for climate change adaptation and environmental pollution reduction.

3.1.1 Adaptation Strategies and Prospects

Respondents suggested adaptation issues, such as conservation of floodwater; irrigation of land during drought; provision of farm inputs by the government; reduction of post-harvest losses; control of pests and diseases; and use of better and improved crop varieties. Others are diversification of livelihoods, on-farm adaptation measures to increase the resilience of production systems and livelihoods to a changing, unpredictable climate including soil management and conservation practices such as (staggered cropping, green manure, composting, plowing back of the organic material); promotion of drought-tolerant varieties of traditional crops (sorghum, cassava, green grams, sweet potatoes); intercropping with legumes (maize and sorghum in Stopamba, Nyakach), and also water conversation practices (rainwater harvesting and storage to enable use during the dry spell, water pans, and irrigation infrastructure). Smallholder irrigation schemes are currently extended over a total of 6,000 ha of land.

Based on the Transparency International 2021 study, “Measures that improve productivity while also building resilience to future climate change are generally referred to as ‘no-regret’ measures—that is, actions that make sense even in the absence of climate change.”

The study recommends:

- Promote/provide farmers with climate-resilient crop varieties and animal breeds;
- Build the capacity of farmers to adopt sustainable soil management;
- Support renewable energy-based efficient irrigation technologies;
- Promote/support improved climate-resilient fishery technology;
- Develop and implement agriculture insurance programmes to manage the financial cost of disasters to farmers and government;
- Provision of farm inputs by the county Government;
- Employment of Agricultural extension officers to advise farmers on correct farming methods;
- Construction and provision of water reservoirs for irrigation;
- Provision of a market for farm produce;
- Cold and storage facility for fish;
- Promote integrated pest management;
- Promote sustainable agricultural systems such as agro forestry; and
- Domesticate and implement the Kenya Climate-Smart Agriculture Strategy.

3.2 Projected Climate Change Impacts on Water

Kisumu County's water resources are vulnerable to climate change which will alter rainfall patterns. Both the quality and quantity of water resources will be affected. Natural waterbodies may be destroyed, as well as the human encroachments that amplify the impacts.

Floods, water pollution, lake-level rise, destruction of natural waterbodies, and human settlements may occur more frequently and with more intensity. The duration of seasons may vary. While uncertainty remains regarding how precipitation patterns will change, it may be anticipated that soil moisture, river runoff, and groundwater recharge patterns will be affected both positively and negatively.

Where rainfall increases, opportunities to harvest rainwater and store clean water could expand, which in turn may reduce the occurrence of water-borne diseases. These impacts will also influence reservoir systems, water quality, and water supply infrastructure.

Higher temperatures will also lead to more rapid evaporation, which could affect access to surface water for irrigation, household use, and livestock production. This effect could also lead to the persistence of moisture deficits for longer periods.

Reducing vulnerability to these and other water-related hazards would reduce risks to investments and production, and hence would contribute to poverty reduction.

3.2.1 Adaptation Strategies and Prospects

The adaption strategy needed to address water problems must consider issues such as landscape restoration, integrated water resource management, Integrated wastewater management, groundwater

management including managed aquifers recharge systems.

From a larger environmental perspective, environment and ecosystem protection are crucial. The combined effect of a growing population and the impacts of climate change puts significant pressure on the environment resulting in environmental degradation. Serious challenges include: poor land use planning, lack of proper liquid and solid waste management, unregulated point and non-point source pollution, dropping water levels, increase in silt loads entering the lake, catchment degradation (land and forests); lack of protection of wetlands; and loss of biodiversity and ecosystem services.

Kisumu's economy is resource-based relying heavily on farming, fisheries as well as related livelihoods. Disruption of this system, therefore, has led to severe problems. For example, land degradation results in low food production and increased poverty. Strengthening and enforcement of environmental governance is, therefore, key to long-term resilience building. The study recommends to:

- Build on the existing Kisumu Environment Policy. The county needs to develop and implement strong environmental legislation, which is essential to minimize further degradation of the ecosystems and ensure their continued protection;
- Develop and implement a clear action plan to preserve soil and soil fertility, including through training and capacity building of communities, to maintain agriculture production for food security and livelihoods;
- Invest in community-led protection of the forest, wetland, lakeshore, and riverbank areas;
- Develop and implement a comprehensive waste management policy and strategy to reduce pressure on the environment and ecosystems;
- Conserve protected areas to withstand increasing pressures and effects of changing climate;
- Invest in eco-tourism.

3.3 Projected Climate Change Impacts on Public Health and Security

Within the constraints of current knowledge, the government has identified malaria and water-borne diseases (such as cholera and typhoid), as some of the health impacts that are likely to grow due to climate change (WHO, 2010). Of these concerns, the vast majority of completed research concentrates on the Lake Victoria basin and focuses specifically on malaria and, to a lesser extent, cholera. Based upon this research, temperature and precipitation increases in higher elevations are projected to result in malaria spreading to new locations.

3.3.1 Adaptation Strategies and Prospects

Improvement of access to safe water and improved sanitation, enhancement of public health functions such as surveillance, vulnerability mapping, and early warning systems, and coordination across sectors.

According to the Transparency International 2021 study for vulnerable and low- resilience populations, it is critical to provide the tools and support they need to manage and recover from the natural shocks that cannot be avoided. Indeed, appropriate land- use planning and building norms, as well as better

infrastructure, can help minimize the risk that natural hazards like heavy precipitation will translate into natural disasters, but they cannot prevent all shocks. Some shocks are unavoidable, especially in highly exposed areas. Moreover, the County will continue to have a share of its population at high risk and with limited capacity to cope with and recover from shocks. This population will remain dependent on government and community support after disasters.

Similarly, people stuck in low-income activities will need support to benefit from economic growth. Growing sectors can provide new and higher-productivity jobs, but vulnerable populations may struggle to capture those opportunities and risk being locked into low productivity or decreasing productivity jobs and activities. For those, dedicated policies are needed to improve their wellbeing, help them capture opportunities and accumulate assets, and ensure that their children do not inherit poverty and vulnerability from their parents.

The study recommends to:

- Establish an effective early warning system and preparedness to save lives and protect assets;
- Establish a social protection mechanism including Insurance-based solutions to make the population better able to cope with shocks;
- Improve the health care system to improve resilience and build capacity to prepare for climate change-induced health emergencies;
- Ensure equity by providing targeted gender interventions and specific measures to protect vulnerable populations in all sectors, including the prevention of gender- based violence (GBV);
- Ensure a conducive policy environment that will facilitate the creation of green jobs.

3.4 Projected Climate Change Impacts on Infrastructure

Climate change will affect infrastructure provision and operation, with the severity of these effects depending on the overall emissions pathway and decisions resulting in increased exposure of assets and maladaptation.

Demand for infrastructure services is projected to go up, for example, changing patterns of demand driven by climate change, such as increased energy; demand for air-conditioning during drought seasons; or increased water demand for irrigation.

It is expected that there will be increased demand for protective infrastructure, such as buffer zones to address rising lake levels.

There will be a need for the provision of infrastructure services, for example, increased cost of supply, as climate change may increase the costs of providing the same level of service (e.g., larger reservoirs needed to address more variable precipitation).

3.4.1 Adaptation Strategies and Prospects

Infrastructure specifically designed to reduce vulnerability to climate variability (e.g., flood control structures and decentralized energy systems) and general public health infrastructure (e.g., sanitation

facilities, wastewater treatment systems, laboratory buildings) enhance adaptive capacity. However, infrastructure (mainly if immovable) can be adversely affected by climate, especially in extreme events such as floods.

Invest in climate-proofed flood risk management such as dykes, riverbank draining and drenching; desilting of rivers and streams; drilling of more boreholes; digging of canals to direct water to the lake; extending piped water provision to households; shoreline protection measures through legislative means and protection walls where necessary; invest in the resilient road network to critical installations and services such as schools, health facilities, market; improve water transport by addressing safety issues, the impact of water hyacinth and necessary by-laws; build/strengthen energy systems for climate resilience and enhance access to clean energy by the poor; improve water and sanitation services primarily in the informal settlement, peri-urban and rural areas; improve health infrastructure by reducing the average distance to the health facility, number of health service providers and relevant supplies. Community health volunteers play a critical role in providing health services in rural areas; improve access to technology such as smart mobile phones to support early warning and climate information services, agriculture, water resources, and healthcare systems; invest in education infrastructure (classrooms and toilets); construction of footpaths along rivers that connect wards; and introduction of lunch programmes for primary schools especially during drought.

Current settlement trends in the county lead to unplanned development, including in areas with significant and increased levels of natural risks such as flood-prone areas, wetlands, and lakeshores. To address the problem, the study recommends the following measures:

- Develop a comprehensive digitalized spatial plan for the whole county to control and prevent development in unsafe areas and reduce the vulnerability of settlement areas.
- Partner with the private sector to provide safe and affordable housing solutions in the county
- Work with the private sector to strengthen the quality and availability of affordable local construction and building materials industry.
- Assess the efficiency of the rental market and work to ensure that it meets the needs of the extremely poor.
- Upgrade informal settlements for current and future risks by adopting a passive planning approach for in situ upgrading of the settlements.

4.0 Conclusion

The development goals of Kisumu County are at risk from the impacts of climate change which are exacerbated by inadequate climate governance frameworks. These impacts are already becoming a severe burden to the county's economy and its people. The county is actively addressing some of these risks—for example, through the construction of dykes, dams, and roads. The county has also supported communities in highly exposed areas to evacuate to safer areas. This assessment report will help the county prepare a framework for short, medium, and long-term interventions.

The increasing climate change will pose challenges for the county's development aspirations. The continued increase in greenhouse gas emissions will cause warming of the atmosphere and oceans, change in rainfall patterns, and increased frequency of drought and flooding. Compounded, these changes will greatly hinder the development of Kisumu County. It is also anticipated that the loss of environmental assets due to climate change will affect many people and the economy with devastating effects on people, their culture, and their livelihoods.

Current climate change is extremely rapid, which places additional stress both on the capacity of ecosystems to adapt and on the lifespan of infrastructure. Kisumu County needs to urgently invest in building resilient systems to address the impact of climate change. This will require policy intervention and financial investment to effect. It is also important to involve all stakeholders, including the government and private sectors as well as community buy-in.

The interventions for climate change impacts should be multifaceted to provide sustainable development direction. These should include the political will to implement the County Climate Change policy, County Climate Change Act and the County Climate Change Action Plan. Other proposed interventions are synergy from the County Disaster management policy, mainstreaming climate change in the County Integrated Development Plan, and having a County Climate Change Adaptation Plan for ten years. The adaptation plan should be monitored and tracked throughout its implementation.

The implementation and actualization of the Sustainable Energy and Climate Change Action Plan (SEACAP) supported by COMSA and through technical assistance by Expertise France is an added advantage to the city as well as the County Government of Kisumu. The implementation will enhance professional and technical direction and will incorporate the County Adaptation, Energy and Climate Change Action Plans developed and implemented in the county. The need to provide strategic direction from the County Government through the Climate Change Directorate will be critical. The Climate Change Vulnerability Assessment Report is a critical document in the

preparation of a collectively driven process in the development of a County Climate Change Action Plan for 2020-2022. These policy, legal, and institutional frameworks also act as anti-corruption safeguards and shall facilitate transparency and accountability in climate change response at the county level.

APPENDIX
Climate vulnerability at ward level

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
Kisumu East	Kajulu	Unpredictable rainfall patterns; Hot temperatures; Increase in sun intensity; High rainfall intensity; Waterborne diseases	Increase in soil erosion; Crops are destroyed; Water quality is affected; Drying of springs; Reduction of water table level; Water scarcity	Drilling of boreholes; Water treatment; Diversification of livelihood; Use of fertilizers. Construction of gabions; Drilling of boreholes; Water treatment; Use of mosquito nets; Draining stagnant water
	Kolwa East	Unpredictable rainfall patterns; High temperatures; Sand harvesting; Poor waste disposal and Poultry farmers; Waterborne diseases (Malaria, Cholera, Bilharzia, Typhoid); Bird's invasion;	Drying riverbeds; water scarcity; Poor water quality; Soil erosion in the farms; Siltation of rivers; Loss of livelihoods; Raw materials loss; Famine; Insecurity; School dropouts; Social disorders; Increased level of poverty	Digging of terraces; Use of fertilizers; Digging of ponds and water pans; Training CHVs; Indoor spraying; Clearing bushes and compounds; Draining stagnant water
	Manyatta A and B	Heavy floods and bad smell along Auji River; Prevalence of mosquitos	Relocation and destruction of settlements in Manyatta B along Auji River (Kuoyo estate); High living standards; Insecurity issues; Sewage backflow in Manyatta Peace Market; Disconnection of piped water by Kiwasco due to accumulation of bills Poor drainage systems	Construct a sewage system; Livelihood diversification; Improve security; Reduce pollution.
	Kolwa Central	Flood Drought	Destruction of road infrastructure; Increased spread of malaria; Poor crop production; Spread of animal diseases; Water scarcity; Increased crop pests and diseases	Water pans; Tree planting; Planting of better crop variety

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
Kisumu West	South West Kisumu	Flood; Drought Rains with hailstones; Floods; Changes in farming seasons; Unpredictable rainfall patterns; Changes in rainy seasons	Poor road accessibility; Increased spread of diseases such as malaria; Reduced crop production; Poor water accessibility during rainy season due to scarcity of clean water; Poor road infrastructure Poor roads affect the transportation of produce to market; Livestock diseases; Crop pest and diseases; Malnutrition; Famine; High food prices; Loss of livelihood; Food insecurity; Insecurity; Low water quality; Waterborne diseases; Increase in poverty	Diversification of livelihood, e.g., quarry and sand harvesting; Treatment of water; Buying water from water vendors
	Central Kisumu	Unusual cold temperatures and hot temperatures; Floods; Unpredictable rainfall patterns; Waterborne diseases; Crop/livestock pests and diseases	Low crop productivity; High food prices; Loss of livelihoods; Rising poverty; insecurity; Water scarcity; Destruction of infrastructure; Increased prevalence of malaria	Diversification of livelihoods; Buying of food; Use of certified seeds; Treating water; Clearing bushes and compounds; Draining stagnant water
	West Kisumu	Massive floods during the rainy season; Deforestation; Unpredictable rainfall patterns; Increased pest and diseases; Change in planting seasons; Increase in pest and diseases; Increased temperatures; Extreme cold periods; Invasion of pest & diseases; Floods	Stress to animals due to rising temperatures; Extreme weather patterns have brought poultry disease; Food insecurity and famine; Disruption of movement and communication; High school dropouts; Insecurity; Burning of waste (plastics); Poor drainage; Poor infrastructure systems (bridges) in Kapuonja	Use of mosquito nets; Draining stagnant water; Treating water before drinking; Tree planting; Improve sewage system
	North West Kisumu	Prolonged drought seasons; Deforestation (Karateng sub-locations); Charcoal burning and tree felling	Soil erosion; High rate of poverty; Drainage systems are not well	Tree planting, use of improved cooking stoves; Use of briquettes instead of charcoal; Soil conservation

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
Kisumu Central	Railways	Pollutionfrom quarry; Unpredictable rainfall patterns and distribution, Mosquito infestation; Increased waterborne diseases; Other diseases (Malaria, HIV/AIDS, Cholera, Bilharzia, Amoebic dysentery)	Spending a lot of time and money seeking treatment; Loss of life; Increase in food prices; Increased levels of poverty; Food insecurity; Malnourishment and other food-related diseases; Insecurity	Planting of cover crops; Planting of resistant crops; Opening canals; Clearing bushes and compounds; Draining stagnant water; Treating water by using Water Guard and PUR water filters; Boiling drinking water
	Migosi	Change in rain seasons; Hotter temperatures are being experienced; Unpredictable rain patterns, Floods; Children getting waterborne diseases	Overwhelmed sewer system; Increased erosion; Pollution; Clearing of vegetation for construction; Reclamation of wetlands for the construction of houses; Displacement by floods; Injuries; Loss of lives (there is one incident where a child was drawn by current in River Auji); Loss of property; Flash floods affect accessibility to schools;	Proper sewer lines and drainages; Irrigation; Planting of alternative crops; Use of certified seeds; Clearing bushes and compounds; Draining stagnant water; Treating water by using Water Guard and PUR water filters
	Kondele	Floods; Increased disease frequency; Increase in temperature; Malaria and HIV/ AIDS, Invasion of pest & Diseases; Drought and famine; Flooding; Clearing of vegetation and cutting of trees for the construction of houses; Solid waste disposal is poorly done; Disposal of untreated wastewater.	Poor sanitation; Poor roads; Insecurity; Poor waste management; Poor drainage Poor performance in schools; School dropouts; Food insecurity; Rising poverty levels	Construction of proper drainage system; Water treatment; use of improved crops varieties; Clearing bushes; Draining stagnant water;

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
	Nyalenda A and B	Floods; Change in planting seasons; Unpredictable rainfall patterns; High temperatures; High rainfall intensity; Long sunny periods; Extreme hot seasons; Increased waterborne diseases	Increased diseases spread in the area such as malaria, typhoid; Poor road infrastructure and accessibility in some households; Reduction in crop production thereby enhancing food insecurity; Lack of access to clean water mostly during rainy seasons; Hippo invasion is also a problem in some areas and has also led to the destruction of the crop in the farmland; Increase in pests and diseases; Low yield; Loss of livelihoods; Food insecurity; Insecurity; Destruction of infrastructure	Diversification of livelihood; Digging of terraces; Use of fertilizers; Distillation; Use of organic manure; Clearing of drainages; Use of hybrid seeds with early maturity, drought resistance and high yield; Digging of water pans; Crop rotation; Early spraying and continuous spraying; Tree planting in most of the households; Use of biogas as a source of fuel; Use of charcoal briquettes
Muhoroni	Miwani	Runoff from the hills; Landlessness	Poor soil fertility: Low crop production/ Productivity: Rising poverty;	Building of gabions; Tree planting, Terracing
	Ombeyi	Floods during heavy rainy seasons Drought	Poor roads due to flooding; Increased prevalence of malaria and waterborne diseases such as typhoid; Difficulty in accessing health facilities and schools; Reduced crop production due to drought and enhanced flooding; Displacements of communities by flood; Destruction of property such as houses and farmlands.	Development of water pans for conservation of floodwaters; Growth of drought-tolerant crops and better crop varieties such as cassava, yams, and sweet potatoes; Enhancement of proper drainage; Use of treated mosquito nets
	Masogo/ Nyang'oma	Unpredictable rainfall patterns; Floods; High temperatures; Increased rainfall intensity; Floods; Waterborne diseases	Floods destroy houses; loss of soil fertility; High rate of school absenteeism due to floods; Increased rate of illiteracy; Loss of livelihood; Insecurity; High hospital bills; Rising poverty	Digging terraces; Use of fertilizers; Digging of ponds and water pans; Treatment of water; Indoor spraying; Clearing bushes and compounds; Draining stagnant water;

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
	Muhoroni/Koru	Unpredictable rainfall patterns; Change in planting season; High-intensity rainfall; Flash floods in the swampy areas; Waterborne diseases	Low crop yields; Soil erosion; Reduced soil fertility; Floods destroys crops; Food insecurity; Malnourishment and other food-related diseases; High cost of production	Planting high yielding varieties; keeping improved livestock breeds; Treatment of water using water guard; Boiling of water; Rainwater harvesting; Use of mosquito nets; Clearing bushes and compounds; Draining stagnant water; Building more toilets
Nyakach	North Nyakach	Unpredictable rainfall; Biodiversity loss; Flooding has destroyed crops and homes; Flooding; Invasion of pest & Diseases; Waterborne diseases (Malaria, Cholera, Bilharzia, Typhoid)	Low crop production; Increased levels of poverty; Food insecurity; Malnourishment and nutritional disorders;	Opening of canals; Planting of pest/drought resistant crops; Use of fertilizers; Use of pesticides and herbicides; Drilling of more boreholes; Treatment of water using Water Guard; Boiling of water; Rainwater harvesting
	Central Nyakach	Heavy flooding; Drought; Salty water wells	Poor road accessibility; Poor road infrastructure during the rainy season; Poor crop production in both wards; Increased spread of malaria and typhoid; Hippos are also and hindrance to crop production; Increased crop pests and diseases in both wards; Scarcity of water in both wards; Reduced crop production in both wards	Most households in Central Nyakach have constructed water pans to conserve flood waters; Tree planting

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
	West Nyakach	Unpredictable weather patterns; Flooding; Change in planting season; Extreme hot temperatures; Increase in livestock diseases; Invasion of pest and diseases; Drought and famine; Waterborne diseases (malaria, Typhoid, Amoebic dysentery)	Drying of some seasonal rivers; Destruction of school structures; Destruction of access routes to school Low crop produce; Drying of pasture; Drying of rivers; poor water quality; Siltation of rivers and dams; Destruction of habitats; Loss of biodiversity; Soil erosion	Clearing bushes and compounds; Draining stagnant water; Using the smoking method and pesticides to deal with mosquitoes; Treating water by using water guard; Boiling drinking water; Tree planting
	South East Nyakach	Flood Drought	Poor road accessibility; Poor road infrastructure during the rainy season; Poor crop production in both wards; Increased spread of malaria and typhoid; Increased crop pests and diseases in both wards; Scarcity of water in both wards; Reduced crop production in both wards; No livestock because of cattle rustling by neighbouring tribe	Most households in Central Nyakach have constructed water pans to conserve flood waters; Tree planting; Crop farming instead of livestock to avoid cattle rustling
Nyando	East Kano Wawidhi	Unpredictable rainfall patterns; Change in planting season; Outbreak of stroke affecting many people of all ages; Waterborne diseases (malaria, Typhoid, Amoebic dysentery)	High health expenditure, growing poverty; Food insecurity; Malnourishment and nutritional disorders; Insecurity; Migrations	

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
	Ahero	Floods; Unpredictable rainfall patterns; High rainfall intensity; High temperatures; Change in planting season; Increase in pests and diseases; Wastewater from the market is channeled to the river; Drought	Destruction of crops and farmlands due to waterlogging in farmlands; Increased waterborne diseases such as typhoid and malaria; Displacement of people; Destruction of property such as houses and croplands; Increased waterborne diseases; Destruction of infrastructure; Shortage of water; Livestock diseases; Food insecurity	Opening of canals; Planting of drought resistant crops; Use of chemicals; Digging of water pans; digging of more borehole; Use of technology to construct narrow boreholes that don't collapse; Treatment of water using Water Guard; Rainwater harvesting
	Kabonyo Kanyagwal	Rising lake water levels; Unpredictable rainfall patterns; Lake level rising; Temperature rising; Unpredictable rainfall and distribution (changing seasons); Flooding; Pollution of water sources due to flooding	Low crop productivity; destruction of houses and infrastructure; Drying rivers and ponds; Salty water; Poor quality water; Increased waterborne diseases; Destruction of infrastructure; Shortage of water; Increased levels of poverty; Food insecurity; Malnutrition and nutritional disorders; Insecurity; Migration; Damage of infrastructure; Drying of rivers; Pollution of water sources due to flooding; Inter-community conflicts over water	Opening of canals; Planting of resistant crops; Use of fertilizer; Opening canals; Elevation and piping of boreholes; Treatment of water using water guard; Boiling of water; Rainwater harvesting; Merging schools; Construction of floodwater drainage; Building bridges
	Kobura	Flood Drought	Displacement of people; Increased crop pests and diseases; Drying of water sources such as rivers and wells; Poor crop growth leading food insecurity; Destruction of crops lands leading to food insecurity; Increased spread of diseases such as malaria; Apida dam which has led to high flooding in parts of Kochogo sub-location and accidents leading to deaths in the area; Poor Road infrastructure due to heavy rainfall that has led to muddy roads; Poor accessibility to schools and health centres during the rainy season	No adaptive measures?

SUB - COUNTY	WARD	VULNERABILITY	IMPACT	ADAPTATION STRATEGY
Seme	West Seme	Unpredictable rainfall patterns; Increase in temperature; Increase in drought frequency	Human-wildlife conflict; Soil erosion; Poor sanitation (inadequate construction of toilets); Low productions; Lack of pastures; Diminishing fish production; Water scarcity; Waterborne diseases; Increase in respiratory diseases; Increase in malaria disease; Waterborne diseases	Tree planting; Planting of drought-resistant crops; Zero grazing; Irrigation; Water pans; Construction of footbridges; Construction of small gabions;
	Central Seme	Temperature fluctuation; Unpredictable rainfall patterns; Waterborne diseases	Low yield; Waterlogging destroys crops; Displacement from farms; Crop pest and diseases; Water scarcity; Destruction of infrastructure; Shortage of water	Diversification of livelihood; Digging terraces; Use of modern agriculture; Early warning system; Control of soil erosion
	East Seme		Prevalence of malaria; Human-wildlife conflict (monkeys which destroy crops in the farms; Poor waste disposal mechanisms (open air garbage burning); Low productivity during drought periods; Fuelwood crisis during rainy seasons	Use of clean cooking solutions (improved stoves and clean fuel); Clearing stagnant water
	North Seme	Unpredictable rainfall; Emergence of pests and diseases; Extreme temperatures; Increase in rain intensity;	Low crop yields; Livestock diseases and pest Food insecurity; Decrease in water quality; Reduction in water levels of rivers; Drying of springs	Planting of resistant crops; Use of fertilizers; Use of pesticides and herbicides; Drilling of more boreholes; Treatment of water using water guard; Boiling of water; Rainwater harvesting

RISK & VULNERABILITY ASSESSMENT

Climate Change Risk and Vulnerability Assessment(s)

TITLE	AUTHOR(S)	YEAR	DESCRIPTION	BOUNDARY	METHOD & SOURCE(S)	UPDATE OR REVISION PROCESS
Kisumu County - Climate RVA Report	County Government of Kisumu (CGK) Transparency International Kenya Expertise France	2020	The table is built from the RVA undertaken by Transparency International, KE and information from the Cliamte Change Directorate of the County Government of Kisumu	Kisumu county, Kenya	Primary data was collected from sampled households in the County, focused group discussion (FGD), key informant interviews (KIIs), and field observation + litterature reviews + GIS mapping Interviewes of stakeholders and inhabitants of Kisumu (from the 7 sub-counties) CGK Departments feedbacks SEACAP/ JRC guidelines	Reporting/updating is planned as follow : a) every year - CGK shall monitor the climate hazards it is exposed to, vulnerable population groups, as well as its adaptive capacity. b) Every two years - The assessment results and information reported previously must be confirmed or updated according to more recent assessments performed. >> The process should be aligned with the National reporting expectations.
		[Drop - Down]				

Climate Change Risks

Climate hazard	Current risks		Future Hazards				Vulnerable sectors				Vulnerable Population Groups	Adaptive Capacity				
	probability of hazard	impact of hazard	Expected Change in intensity	Expected change in frequeny	Timeframe	Descriptioon of expected Impacts	Most Vulnerable sector(s)	VulnerabilitY Level	Indicators	Indicator Value	Most Vulnerable population group(s)	Adaptive Capacity Factor		Adaptive capacity Level	Indicators	Indicator Value
Rise of Temperature	High	High	Increase	Increase	Long-term	**Food shortages, rising food prices, and damage to the County's economy.** The agriculture sector is already very fragile with fluctuent weather conditions and the collaps of the agro-industries. Climate change may increase the weaknesses of the sector with reductions of agriculture productivity, feedstocks, fisheries and change in soil quality and water resources... ("About 68% of the interviewed households did not produce enough food to cover their household consumption for a whole year. TI Survey, 2020)	Agriculture & Forestry	High	RV_S15		Other	Governmental & Institutional	Specific programmes to develop smart and sustainable agriculture + Change mindset and practices in farming + Rules of physical planning and land use management regulation	Moderate	RV-A1	
Rise of Temperature	High	High	Increase	Increase	Long-term		Education	High	RV_S28		Children	Governmental & Institutional	Building classes with enough ventilation+big windows and high roofing with ceilings Use of climate sensitive materi-als and designs for buildings	Low	RV_A6	

Rise of Temperature	High	High	Increase	Increase	Long-term	**Public health at risk for the weakest** Higher temperatures will affect the good health of a lot of people, especially the sensitive people like the older ones, people with a sickness and youths. Water scarcity will make worse this situation	Health	High	RV_S6		Persons with Chron-ic diseases	Governmental & Institutional	Develop green spaces and refreshing spots in the urban areas of Kisumu County + Reduce the distance between public health facilities and intense built areas + Work on the construction regulation and permits allowance process to set rules for climate resilient building starting at first with public buildings and facilities	High	RV_A8	
Rise of Temperature	High	High	Increase	Increase		**Urban heat waves** At building level : At home, at work, at school or out-side, heat will bring uncon-fortable situations leading less efficiency, productivity, health problems. At neighborhood level : hot spot in the constructed/ mineral areas	Buildings	High	RV_S1		Persons living in sub-stand-ard housing	Physical & Environmental		Moderate	RV_A10	
Droughts & Water Scarcity	High	High	Increase	Increase	Mid -term	**Loss of productivity for agriculture and farming sectors** Reduce agriculture productivity; Livestock diseases; Low water quality; Waterborne diseases	Agriculture & Forestry	High	RV_S15		Low - income households	Governmental & Institutional		Moderate		
Droughts & Water Scarcity	High	High	Increase	Increase	Mid -term	**Food insecurity and raise of health issues** Crop pest and diseases; Malnutrition; Famine; High food prices; Loss of livelihood; Increase uncomfort at home/ work/urban places, Affect sensitive people, Reduce water resources access and water infiltration in soil, Increase risk of fire. Lead to biodiversity extinction…	Health	High	RV_S25		Elderly		The adaption strategy needed to address water problems must consider issues such as landscape restoration, integrated water resource management, Integrated waste water management, groundwater management including managed aquifers recharge systems Agriculture focus : Vulnerability of the sector to climate risks could be reduced through investments in water storage, rainwater harvesting, and irrigation infrastructure, as well as more efficient water use in light of current and projected water shortages. Intensification of irrigation could lead to an estimated fourfold increase in crop production, not accounting for the implications of climate change.	Moderate	RV_A1	
Droughts & Water Scarcity	High	High	Increase			**Water** resources are reduced as most reservoirs dry up.	water	High	RV_S4		Low - income households	Governmental & Institutional	Water harvesting and storage to shield against the impacts, construction of larger reser-voirs,construction of protective infrastructure, such as buffer zones	Moderate	RV_A5	

Droughts & Water Scarcity	High	High	Increase	Increase	Mid -term	**Wild fires** may occur at some places either because of human misconduct or naturally.	Environment & Biodiver-sity	Not Known			Low - income households		Public prevention policy with sensitization campaigns Risk and disaster strategy			
Droughts & Water Scarcity	High	High	Increase	Increase	Mid -term	**Increase in energy demand and reliability of electricity supply** Increase of energy demand for air conditionning Increase the risk of electricity supply shortage	Energy	Not Known	RV_S4			Governmental & Institutional	Short term : environmental specifications to make new building more resilient to climate change (code of constructions, mandatory spec-ifications prior to the permit allocations Mid term : audit of the current resilience of energy distribution networks to climate change extreme events + forecast of the electricity demand for AC in the future			
Changing rainfall patterns/ heavy precipitation	High	High	Increase	Increase	Mid -term	**Food shortages, rising food prices, and damage to the County's economy.** Approximately 34% of the land in the County is dedicated to subsistence crops, 34% to natural pastures, and 18% to commercial crop production; homesteads extend over 7% of the land. Until recently, seasons in Kisumu were steady and rainfall patterns almost at the same periods. Climate change is affecting it and will seriously continue. Rainy seasons may be shorter but with more water at a go. Impacts on agriculture will be importants as water may miss sometimes but could also be too much with crops destructions or animal deaths for instance, and unsufficient infiltration in the ground to renew the underground water stocks	Agriculture & Forestry	High	RV_S2		Other	Governmental & Institutional	Weather forecast and early warning systems may help for the agriculture sector to plan its activities and to prevent any damages for the crops, cattle, equipments, etc	High	RV_A5	
Floods & Lake level rise	High	High	Increase	Increase	Short -term		Health	High	RV_S6		Persons living in sub standard conditions	Governmental & Institutional	Physical planning to avoid new constructions and settlements in risky areas + Relocation of the current exposed persons, activities and infrastructures + Early warning systems. The adaption strategy needed to address water problems must consider issues such as landscape restoration, integrated water resource management, Integrated waste water management, ground-water management including managed aquifers recharge systems. It is expected that there will be increased demand for pro-tective infrastructure, such as buffer zones to address rising lake levels.	High	RV_A5	
Flash/ surface flood	High	High	Increase	Increase	Short -term		Transport	High	RV_S2		Persons living in sub standard conditions	Governmental & Institutional	Physical planning to avoid new constructions and settlements in risky areas + Relocation of the current exposed persons, activities and infrastructures + Early warning systems + Reinforce the control of new construction submitted to prior authorization (permits)	High	RV_A6	
River Flood	High	High	Increase	Increase	Short -term		Informal Housing	High	RV_S1		Persons living in sub standard conditions	Governmental & Institutional		High	RV_A5	
Lake Flood	High	High	Increase	Increase	Short -term	The Lake Victoria basin, covering Kisumu County, has recently experienced extreeme floods due to the rise of the level of the lake.	Health	High	RV_S7		Persons living in sub standard housing	Governmental & Institutional		High	RV_A10	
Storms	[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop-down]	[Please Specify]	[Drop - down]	[Drop - down]	

Severe Wind	Moderate	Moderate	Increase	Increase	Long- Term	Destruction of field crops and fragile roofing of buildings; increased frequency of black-outs as a as winds interefere with power lines	Energy	moderate	RV_S4		Other	Governmental & Institutional	Improve the efficiency and capacity of the electricity supply system	Low	Rv_A3	
Lightning / Thunderstorm	High	Low	Increase	Not Known	Not Known		Buildings	Moderate	RV_S1		Children	Technological		Low	RV_A11	
Mass Movement	[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Please Specify]	[Drop - down]	[Drop - down]	
Land slide		[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Please Specify]	[Drop - down]	[Drop - down]	
Oth-er (please specify)	[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Drop - down]		[Drop - down]	[Drop - down]	[Please Specify]	[Drop - down]	[Drop - down]	

Comments & Methodolical specifications

Definitions

Buildings	Refers to any (municipal/residential/tertiary, public/private) structure or groups of structures, surrounding spaces, permanently constructed or erected on its site.
Transport	Includes road, rail, air and water transport networks and related infrastructure. It comprises an extensive range of both public and private assets and services and excludes all related vessels, vehicles (and related parts and processes).
Energy	Refers to the energy supply service and related infrastructure. It includes coal, crude oil, natural gas liquids, refinery feedstocks, additives, petroleum products, gases, combustible renewables and waste, electricity and heat.
Water	Refers to the water supply service and related infrastructure. It also covers water use (e.g. by households, industry, energy production, agriculture, etc.) and (waste-, rain-) water management system, that includes sewers, drainage and treatment systems.
Waste	Includes activities related to the management (including collection, treatment and disposal) of various forms of waste, such as solid or non-solid industrial or household waste, as well as contaminated sites.
Land Use Planning	Process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, and the subsequent formulation and promulgation of plans or regulations that describe the permitted or acceptable uses.
Agriculture & Forestry	Includes land classified/designated for agriculture & forestry use, as well as organisations and industries linked to creation and production within and surrounding the boundaries of the municipality.
Environment & Biodiversity	Environment refers to green and blue landscapes, air quality, including urban hinterland; Biodiversity refers to the variety of life in a specific region, measurable as the variety within and between species, and the variety of ecosystems.
Health	Refers to the geographical distribution of dominance of pathologies, information indicating effect on well-being of humans linked directly/indirectly to the quality of the environment. It also includes the health care service and related infrastructure.
Civil Protection & Emergency	Refers to the operation of the civil protection and emergency services by or on behalf of public authorities and includes local disaster risk reduction and management (i.e. capacity building, coordination, equipment, emergency planning etc.).
Tourism	Refers to the activities of persons travelling to and staying in places outside their usual environment for not more than 1 year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited.
ICT(Information & Communications Technology)	Refers to the technologies related to integrated telecommunications systems, computers, audio-video technologies and related software, which allow users to create, store and exchange information.
Education	Refers to the process of learning through an organised and sustained communication.
Society, Community & Culture	Refers to the society as a group of individuals variously aggregated and organised who interact in order to pursue one or more common objectives . Culture refers to traditions, public goods and historic and cultural values.
Others	Any other sectors (e.g. Industry, Financial)

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TRANSPARENCY INTERNATIONAL KENYA

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

COUNTY GOVERNMENT OF KISUMU
HARBOUR OF PROSPERITY