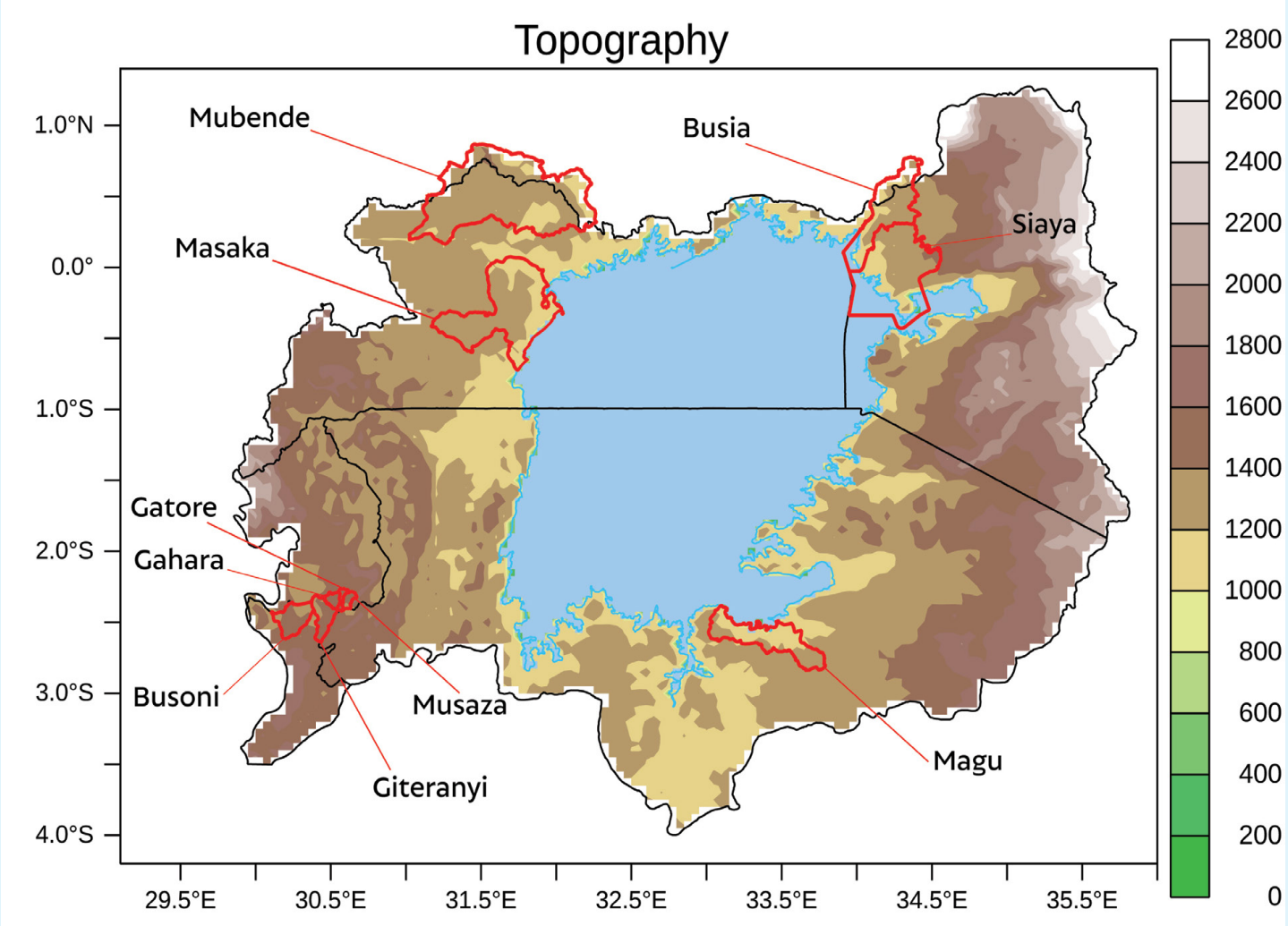
EAST AFRICAN COMMUNITY
LAKE VICTORIA BASIN COMMISSION

Observed, projected climate and extreme events over Lake Victoria Basin.

Towards Building Climate Change Resilience for Sustainable Livelihoods

POLICY BRIEF **March 2023**



Key Messages

Temperature

↗ The Lake Victoria Basin has experienced an overall increase in average temperature; warming by at least 2.0 °C in the period 1900-2020 relative to the 1961-1990 baseline period based on the Climate Research Unit (CRU) dataset. Minimum temperature has increased faster relative to the maximum temperature.

↗ Further increase in temperature is projected by the end of the 21st century, whereby the Basin is likely to warm by 1.0 - 2.0 °C under low-emission/mitigation scenario (RCP2.6), 2.0-3.5 °C under a medium-level scenario (RCP4.5), and 3.5-6.0 °C under a high-emission/business-as-usual scenario (RCP8.5) when compared to the 1971-2000 climate baseline period.

Rainfall

↗ Rainfall has slightly increased over some regions, especially in the recent decade (2011-2020), while other areas have experienced rainfall decline. Generally, decrease of between 20mm and 30mm has been observed during March-May (MAM) season, between 30 mm and 95 mm during June-September (JJAS) season and by between 95mm and 200mm during October-December (OND) season.

↗ Projections of rainfall across the Basin are not uniform and vary on seasonal and sub-regional scales. The MAM rainfall amount is expected to decrease whereas OND and annual rainfall amounts are expected to increase, over most parts of the basin especially the eastern parts in Siaya and Busia.

↗ The onset (starting) dates of the short rains (OND) are projected to be delayed while rainfall cessation (end of season) dates are projected to be early over most parts of the Lake Victoria Basin. On the other hand, the log-rains (MAM) are projected to experience a shift whereby the season is projected to start and end early.

Extremes

↗ In a business-as-usual (high emission) scenario, rainfall and temperature extremes are projected to be more frequent and intense in most parts of the basin.

↗ Climate projections indicate that the number of consecutive Dry Days (CDD) are likely to increase for all the seasons and at annual time scales, this implies that the Consecutive Wet Days (CWD) are likely to decrease over the lake region during March to May season under a business-as-usual scenario.

↗ The projected increase in temperature under the medium- and high-emission scenarios is likely to lead to greater evapotranspiration over the lake and this is likely to have an impact on the water budget of Lake Victoria.

Policy Recommendations

- Strengthen climate services value chain and promote climate change awareness and information amongst the lake basin communities.
- Strengthen regional, national and local collaboration in addressing climate change issues.
- Promote the sustainable exploitation and management of natural resources in the Lake Victoria basin e.g., fish, sand and other minerals.
- Promote research, information dissemination and capacity building of climate in order to address climate change issues.

Definitions

CDD Consecutive Dry Days (number of consecutive days that do not receive rainfall).

CWD Consecutive Wet Days (number of consecutive days that record rainfall activity of more than 1mm).

DJF December, January and February rainfall season.

JJAS June, July, August and September rainfall season.

OND October, November and December rainfall season.

MAM March, April and May rainfall season.

Onset Day that defines the start of rainfall season.

Cessation is when the rainfall season comes to an end.

Daily temperature range is the difference between the maximum and minimum temperature recorded in a day.

Future time periods considered refer to a 30-year period centered on 2030 (2016-2045), 2050 (2036-2065), and 2080 (2066-2095) also referred to as near, medium and far future periods.

Dry and wet spell is a period constituting of consecutive days when rainfall meets some threshold (usually below/above 1mm respectively.)

Climate Scenarios These are hypothetical representation of future climate conditions, based on a set of assumptions about how greenhouse gas emissions and other factors might change over time. Climate scenarios are typically developed using computer models that simulate the Earth'.

Climate Projections These are mathematical constructed climate states in different time periods (probably in the future). projections are used by scientists, policymakers, and other stakeholders to understand how the climate may change and to develop strategies for mitigating and adapting to these changes.

RCP Representative Concentration Pathways [refers to the hypothetical trajectories of future greenhouse gas (and other pollutants) concentrations caused by human activities. RCPs used in this brief are RCP2.6 (very low emission/mitigation scenario), RCP4.5 (moderate emission scenario) and RCP8.5 (business-as-usual/ high emission scenario)].

Background

The Lake Victoria Basin (LVB) with an estimated area of 251,000 km2 is home to approximately 47 million people. It is a cross boundary resource region which is critical to the East Africa Community (EAC), given the ecological, social, and economic role that the lake plays. Observations show that there is increase in the frequency and intensity of rainfall and temperature related hazards (floods, landslides, droughts) with devastating impacts on lives and livelihoods.

The over-reliance on natural resources and climate sensitive socio-economic activities including rain-fed agriculture compounds the impact of climate change on livelihoods.

The purpose of this policy brief is to provide evidence of the observed and projected changes in climate and extremes. It should serve as a call for urgent multi-level, and multi-sectoral interventions and concrete plans for building resilient ecosystems and communities in the basin. Through the support from the Adaptation to Climate Change in the Lake Victoria Basin (ACC-LVB) project, IGAD Climate Prediction & Applications Centre analyzed the observed and projected climate over LVB (Lake Victoria Basin) in support of the ACC-LVB goal of increasing climate resilience in the LVB through implementation of both regional and community-based climate change adaptation interventions/ technologies.

The analysis was carried out on the broader LVB (Figure 1), with focus on specific projects in Kenya (Siaya and Busia Counties), Tanzania (Magu District), Burundi (Busoni and Giteranyi Counties), Rwanda (Gatore, Musaza, and Gahara Sectors), and Uganda (Masaka and Mubende Districts). Figure 1. From the analysis three reports were produced: (1) Baseline Climatology, (2) Projected Climate Change and (3) Climate Extremes.

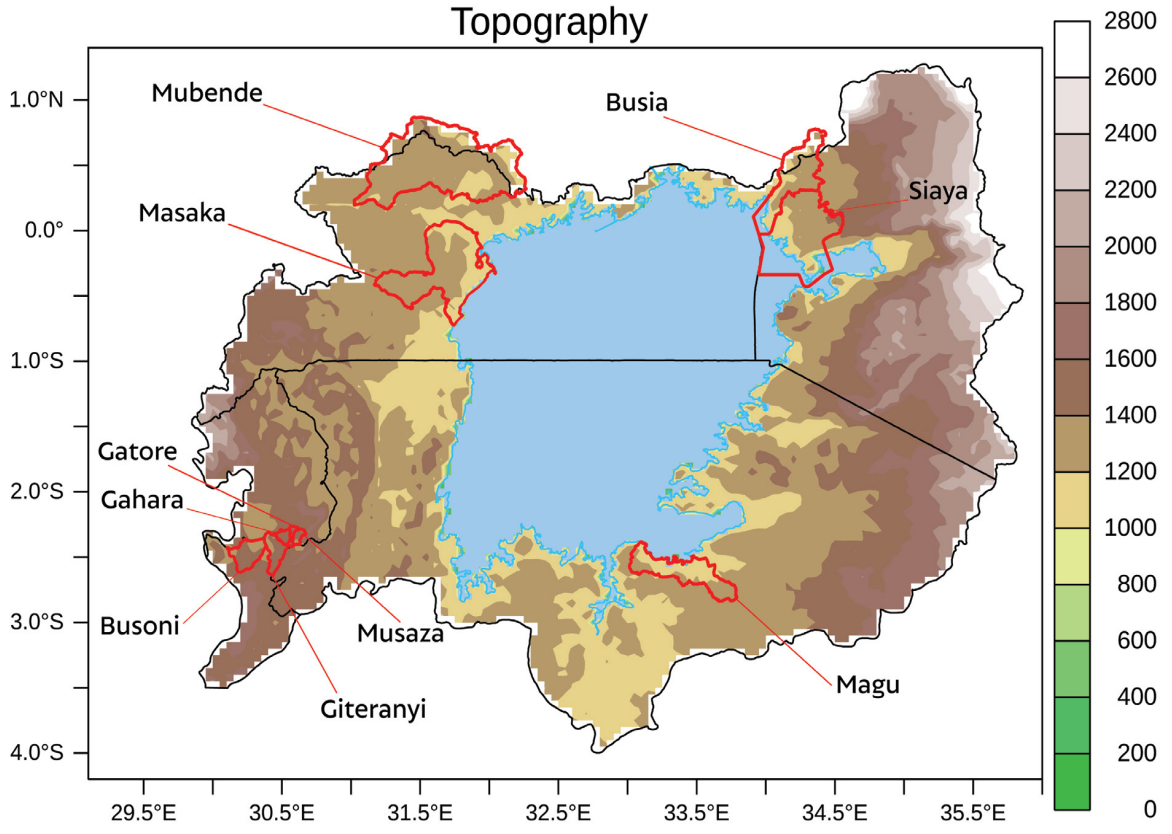


Figure 1: Topography in meters above mean sea level of Lake Victoria basin and project sites used for the analysis in red. Highlands are located to the west and east of the basin.

Observed and projected rainfall

The LVB is characterized by four rainfall seasons: March to May (MAM), June to September (JJAS), October to December (OND) and December to February (DJF) with significant differences in rainfall amounts across the basin. Like other parts of the world, the LVB has experienced changes in rainfall at different timescales.

Over the last 40 years (1981-2020), rainfall has increased by 10mm -to 100mm during the MAM season.

It was noted also that the project sites in Siaya, Busia (Kenya), Magu (Tanzania) and Mubende (Uganda) experienced an increase in rainfall amounts of between 10mm and 50 mm during the JJAS season. Rainfall has increased during the OND season in most project sites, except for Masaka and Mubende (Uganda) project sites which experienced a decrease in rainfall of between 11mm and 50mm.

The observed rainfall analysis for the past 120 years indicates that the Basin experienced high rainfall variability with a tendency of increased rainfall over the last 5 years (Figure 2).

Recent wet extreme rainfall during 2019 and 2020 caused increases in lake levels and flooding within the East Africa region, in particular Lake Victoria, has led to the disruption of lives and livelihoods across the Basin.

The Basin has experienced rainfall variability over the years, and projections show that this is expected to significantly increase although the patterns are expected to vary on seasonal and regional scales under RCP2.6 (low-emission scenario), RCP 4.5 (medium- emission scenario) and RCP 8.5 (business-as- usual scenario).

During the period of 2050s, most parts of the Basin are projected to experience about 5-50% decline in rainfall during MAM and JJAS while during OND and DJF most parts of the basin are expected to experience an increase in rainfall of up to 50% (Figure 3) over the eastern part of the lake basin.

The projections indicate a likely shift in the March–May rainfall season (i.e., early onset and early cessation of rainfall). During the October-December season, most parts of the Lake Victoria Basin are projected to experience shorter length of rainfall season, where the onset will be delayed and cessation is projected to be early, except over some areas in Mubende and Busia.

These projected changes, though uncertain, may impact on key activities in the Basin such as agriculture (including crop, animal, and fish

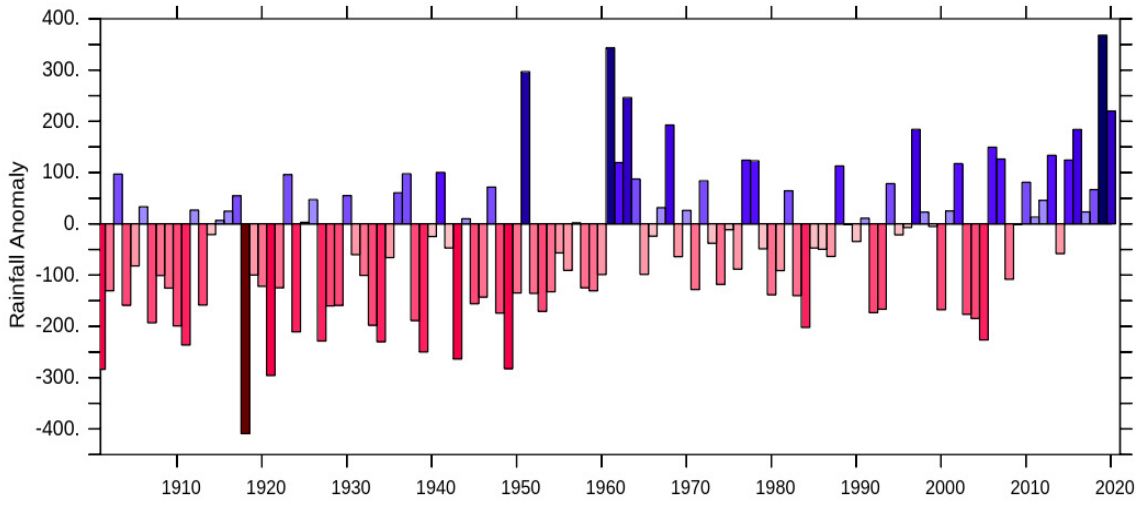


Figure 2: Annual rainfall anomalies (mm) for the LVBC from CRU data for the period from 1900 to 2020 relative to 1961 to 1990 average. Blue bars indicate wetter-than-average years; red bars indicate drier-than-average years. The figure shows that increased wetter than normal conditions have been observed in the last 10 years.

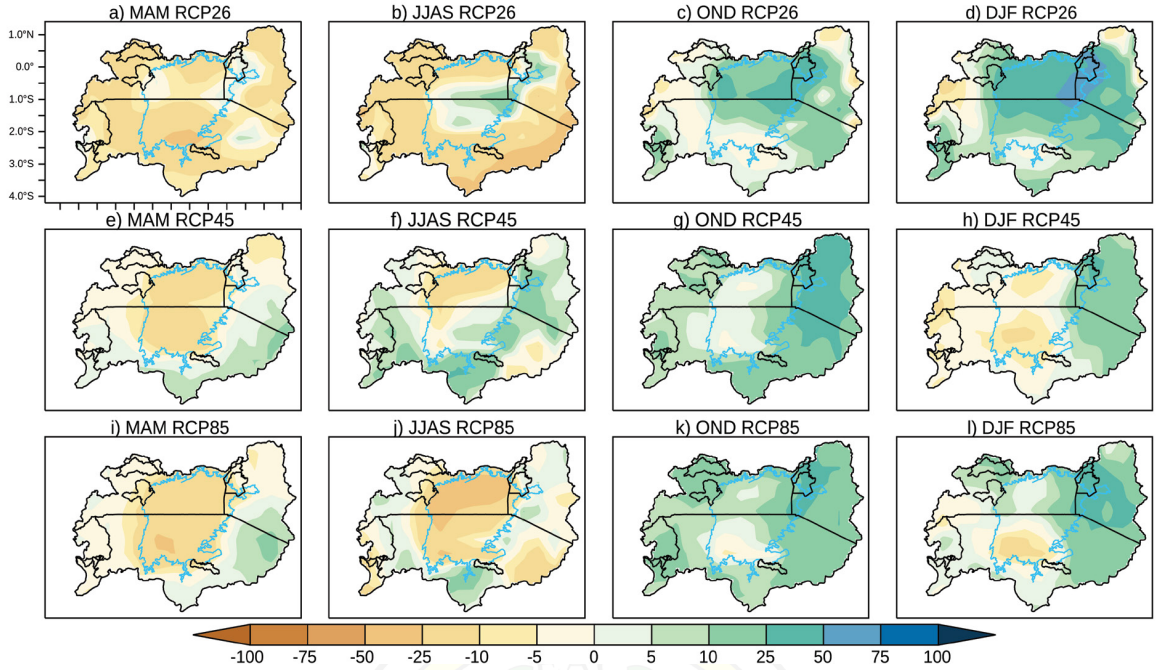


Figure3 Projected rainfall changes (%) for the different rainfall seasons during the period 2050s under different scenarios over Lake Victoria Basin.

farming), water resource management, energy, transport, and health. Expected increase in scarcity of resources amidst rapid population increase, has a high potential to increase resource-based conflicts. In terms of extreme rainfall events, Consecutive Dry Days (CDD) are projected to increase during the long rains (March to May) season and at annual time scales under the high-emission scenarios.

However, the projected changes in Consecutive Wet Days (CWD) show a decrease at annual time scales in several parts of the Basin, especially over the lake, in all future time periods and under all future scenarios.

Summary of rainfall characteristics in LVB

- Observations indicate that in most project sites, MAM rainfall and JJAS has been declining over the last 40 years (1981-2020) by between 20mm and 30mm, and between 30 mm and 95 mm during JJAS in Siaya, and Magu. However, OND rainfall has increased in most parts of the region except in Masaka and Mubende which have both experienced a decline in rainfall of between 11mm and 50mm per decade.

- The recent 10 years (2011-2020) have recorded some of the highest frequency of above average rainfall events.

- On average, a shift of the March–May season is projected under all scenarios with the season starting and ending early. During October-December season, most parts of the Lake Victoria Basin are projected to experience shorter length of rainfall season, where the onset are projected to be delayed and cessation is projected to be early, except some areas of Mubende and Busia.

- Greater increase in consecutive dry days (CDD) is projected under a business-as-usual scenario across all seasons and at annual time scales, while a greater decrease in consecutive wet days CWD is projected over the lake during March to May season under the same scenario.

- Evapotranspiration is projected to be high over the lake under the medium- and high-emission scenarios and this will have an negative impact on the lake's total volume.

Observed and projected temperature

Changes in temperature is one of the indicators of climate change. Globally, temperatures have been rising. This is partly due to increase in anthropogenic activities from developed countries. A comparable situation has been observed over the Lake Victoria Basin. Temperature analysis over the Basin suggests that the Basin has experienced a warming (of about 2°C) over the last 120 years (Figure 4).

Climatologically, highest temperatures are usually observed over the north-eastern parts of the Basin (around Siaya and Busia). The Basin usually experiences stable temperature conditions all year round with the cold season being observed during June to August Season.

Observed maximum and minimum temperature have risen steadily over the past 40 years (1981-2020) by between 0.01°C and 0.2°C and between 0.21°C and 0.35°C respectively. The highest number of years with minimum temperature above the mean value have been recorded in the recent decade.

Similarly, highest mean temperature values in LVB have all been observed in the recent decade (e.g., 2011-2020).

Analysis of the projected changes in mean surface air temperature indicate that all areas of the Lake Victoria Basin are projected to experience warming. The magnitude of warming is greater during JJAS compared to other seasons.

Future rise in temperature depends on the future economic activity and the amount of greenhouse gases the world emits. Annual temperatures are projected to increase in the far future by between 1.0 and 2.0 °C under low-emission scenario (RCP2.6), between 2.0 and 3.5 °C under a medium-level scenario (RCP4.5), and between 3.5 and 6.0 °C under a high-emission scenario (RCP8.5) (Figure 5).

Projections indicate that that daily temperature range is likely to be smaller under the low-emission scenario due to the steady rise in nighttime temperatures. However, under the medium and high-emission scenarios, the reduction in daily temperature range is due to the steady rise in daytime temperatures.

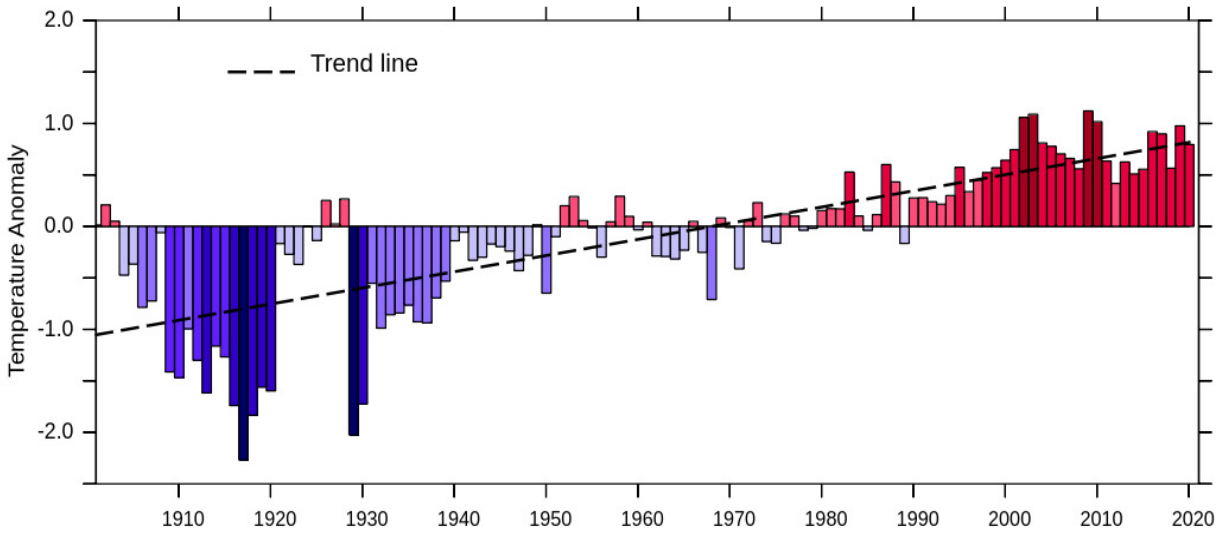


Figure 4: Annual surface temperature anomalies (°C) for the LVB from CRU data for the period from 1900 to 2020 relative to 1961 to 1990 average. Blue bars indicate cooler-than-average years; red bars indicate warmer-than-average years. The highest frequency of above average temperatures has been observed in the last 40 years (1981-2020) within the LVB.

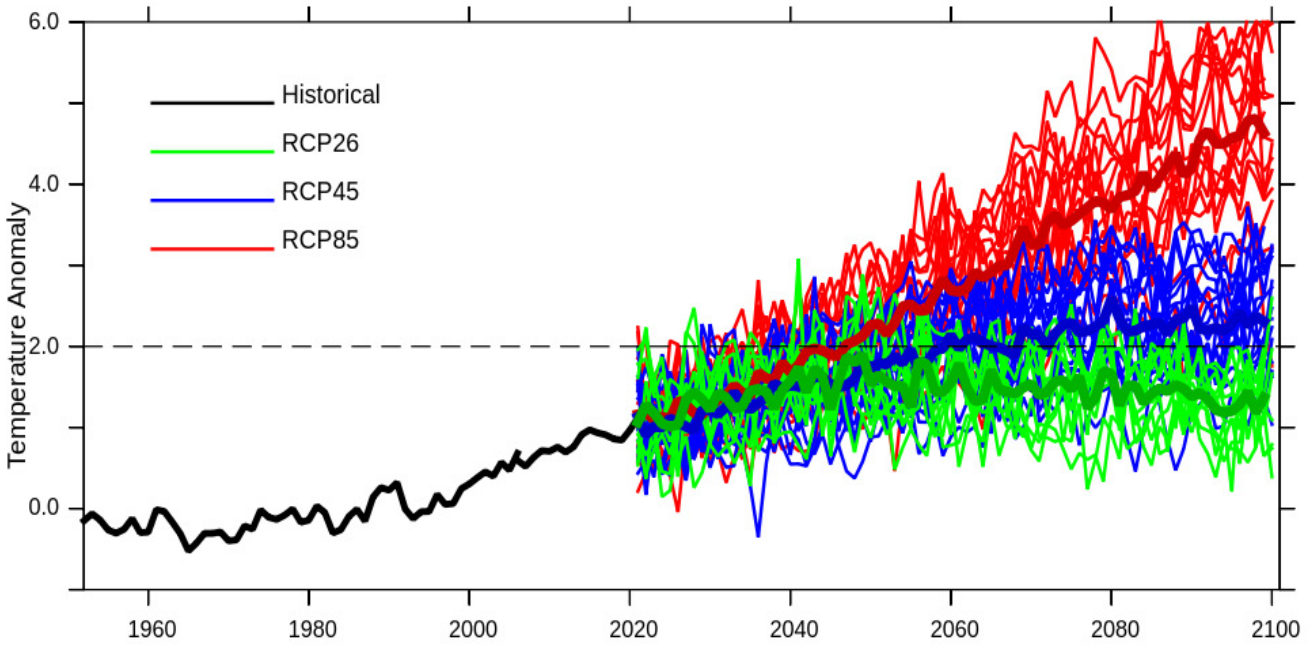


Figure 5: Historical (black) and projected temperature 1950-2100. Colored lines show time series of temperature anomalies averaged over LVB relative to 1971-2000 from multiple climate model simulations under three different representative concentration pathways (RCPs) of CO2, other greenhouse gases and aerosol pollution.

RCP2.6 (green lines): The models show minimal increase in temperature across the near future period (2020-2050) and a decrease in temperature thereafter towards the end of the century. Despite inter-model differences the projected temperature change over the Basin remains well below 2 °C.

RCP4.5 (blue lines): models project a likelihood of lower but consistent increase in temperature in future periods with higher inter-annual variability compared to RCP2.6. A temperature increases of about 2.0-3.5 °C is expected in the Lake Victoria Basin under this scenario.

RCP8.5 (red lines): higher temperature changes of up to 3.5 - 6.0 °C are projected across the lake Basin. The increase in temperature under this scenario is faster than that projected under RCP4.5 especially between 2050-2100.

Summary of temperature characteristics in LVB

- Observed minimum temperature in the LVB has increased by between 0.21°C and 0.35°C compared to between 0.01°C and 0.2°C for maximum temperature over the last 40 years (1981-2020). Recent years have recorded minimum and maximum temperature that are higher than their long-term average.

- Future projections indicate that all areas within the LVB are expected to experience increase in warming with the greatest increase being experienced during the June to September season.

- Annual temperatures are projected to increase by 1.0 to 2.0 °C under the low-emission pathway, 2.0 to 3.5°C under the medium-emission pathway and 3.5 to 6.0°C under the high-emission pathway. These future changes depend on the economic activities and the amount of greenhouse gases.

- Minimum temperature is expected to continue rising into the future and this will have an impact on diurnal and extreme temperature range.

- Except over the north-eastern parts of the Basin, the rest of the Basin is projected to experience greater reduction in the diurnal and extreme temperature range under the low-emission scenario suggesting an increase in night-time warming.

Sectoral implications of observed and projected climate changes and extremes

↗ **Water Resources:** Lake Victoria Basin is a source of fresh water that supports domestic, industrial processes and irrigation for millions of people across the basin. This role of the lake will be threatened if the observed decline in rainfall continues across the Basin and lake catchment. Increase in temperature may further increase evaporation from the lake thus reducing water availability.

On the other hand, during periods of high intense rainfall (e.g., 2019/2020), the lake levels have been observed to increase resulting into displacements and affecting several communities specifically in the urban and peri-urban areas around the lake. Projections over the lake basin indicate that such extreme events are more likely and will increase the risk of flooding.

↗ **Energy:** Consistent hydropower production is key for national and regional sustainable development (Sustainable Development Goal – 7). Fluctuations in lake levels due to drought and intense rainfall conditions, affects capacity of power production especially for large dams like Karuma, Kiira and Nalubale that are a major source of electricity for many countries in the Lake Basin. Increased warming episodes can also have significant influence on the power demands for cooling. The compounding impacts on the energy sector (increased rainfall variability, high temperature, and increased population) are likely to present additional stress on the sustainable supply of energy in the basin.

↗ **Agriculture and food security:** Increasing rainfall extremes and increasing temperature are posing serious/potential risks to farmers in the Lake Victoria basin. There is reported late start date of the rainfall season, increase in dry spells, increase in the frequency and severity of droughts, and early cessation of the rainfall season. This results to poor harvest and reduction in livestock production leading to loss of income thereby exacerbates food insecurity and reduce availability of food in schools.

↗ **Tourism sector:** Beach tourism, eco-tourism, cultural tourism, and sports tourism among others provide an important source of foreign exchange in the basin. The projected climate changes and extremes are likely to cause increased frequency and severity of floods which will negatively affect tourism sector hence reduce the inflow of foreign exchange to the region. On the other hand, climate change is expected to affect species distribution and extinction under the worst-case scenario.

↗ **Environment and natural resource:** When agriculture fails due to bad weather, farmers often resort to exploit unsustainably the available natural resources, such as cutting down of trees for timber, charcoal, quarrying and sand harvesting to compensate for the livelihood loss. As a result, environmental degradation has continued and is likely to increase leading to the widespread soil erosion and silting in the lake, diminished groundwater recharge, run-off, eutrophication and drying of rivers within the lake basin. Drought occurrences can also increase the dryness index in the region leading to higher risk of wildfire that accelerates environmental degradation and loss of biodiversity.

↗ **Transport and infrastructure:** Owing to the weak road and housing infrastructure, heavy rainfall, landslides, and flash floods have caused damage to several infrastructure including houses, schools, roads, bridges, and beach facilities in the Lake Victoria basin. During, heavy rainfall periods, transportation of agricultural produce and other tradable goods is usually disrupted thus leading to slow down of business and loss of incomes in many places. Landslides and flash floods have also affected settlement in both hilly and lowlands thereby leading to forced displacement and risk of conflict. Projected occurrence of floods due to heavy rainfall continue to limit access to school/education institutions and other facilities. This can impact the quality of services and well-being across the Lake Victoria Basin.

↗ **Disaster Risk Management:** The LVB is highly vulnerable to climate-induced disasters and future climate projections are likely to exacerbate the frequency and intensity of droughts, floods, landslides, lightning and strong winds. This is likely to further strain the limited existing resources needed to manage and respond to emergencies.

↗ **Fisheries:** The fishing industry is affected by heavy storms associated with intense winds and thunderstorms that endanger the lives of fisherfolks. The projected high temperatures in the Lake Basin and heavy rainfall have negative impacts on the fish breeding sites and shocks from extreme weather events, pollution, eutrophication can lead to fish mortalities, hence a decline in fish stocks. This can have a significant impact on the Basin's economy given that Lake Victoria has a potential to yield fish valued at over $800 million.

↗ **Health:** Projected changes in climate and extreme events are likely to create a conducive environment for mosquitoes, ticks and fleas-related borne diseases such as malaria, dengue and yellow fever and chikungunya. Similarly, high chances of waterborne diseases such as diarrhea, cholera, dysentery and typhoid. Furthermore, cases of malnutrition due to food shortage and price fluctuations.

Policy Recommendations

The study recommends several measures in the Lake Basin to ensure sustainability of socio-economic activities and reduction of climate related risks.

The recommendations follow a no-regret approach where integrated plans are put in place taking into consideration all three potential future emission pathways. These include;

- Strengthen climate monitoring including in-lake water stratification, prediction, and early warning systems to support critical sector-specific decisions. This will increase access and uptake of user-tailored information on rainfall and temperature variability and change including extremes. The target information should be on rainfall and temperature anomalies, annual and seasonal total rainfall, rainfall intensity, rainfall onsets, cessation, length of season, wet spells and dry spells signals over LVB.
- Promote climate change awareness, through education and communication of climate information trigger action and enhance adaptive capacity and resilience for the agriculture, fisheries, water, and energy sectors. Education and communication initiatives should consider the different user groups and the less privileged in the society.
- Mainstream climate change in all climate-sensitive sectors for example climate proofing agriculture, transport, housing and port infrastructure, water, sanitation, and health sectors in all the basin Member States.
- Promote investment in clean and renewable energy, clean transport, and climate smart agriculture including forest and land cover management, safe water harvesting and blue economy.
- Protect, restore and rehabilitate environmental, ecosystem. Plant trees and dig terrace, and wetlands protection must be enforced across the lake basin.
- Develop and implement climate change and environmental policies strategies and programs across regional, national and subnational levels.
- All new policies, strategies and programs need to be aligned to the Nationally Determined Contributions (NDCs) and the Sustainable Development Goals (SDGs).
- Support socio-economic diversification and reduce heavy reliance on natural resources, rain-fed agriculture, and other climate sensitive sectors. New crop varieties that

are drought tolerant need to be introduced and adopted by farmers to reduce on crop failure rates during drought seasons that are becoming more frequent and severe.

- Support climate financing to address challenges from the increasing climate change shocks, the available funding is still inadequate. It is imperative that national and regional capacity to access climate financing, supported by prioritization of budgetary allocation of climate finance towards water, is enhanced to support adaptation interventions. Increased financing should be backed with skilled human resource and access to modern technology for climate monitoring, data processing and information sharing, as well as climate change adaptation technologies.

- Promote research, information dissemination and capacity building of climate in order to address climate change issues across sectors.

- Promote the sustainable exploitation and management of natural resources in the Lake Victoria basin e.g., fish, sand and other minerals.

- Strengthen regional, national and local collaboration in addressing climate change issues.

About LVBC

Lake Victoria Basin Commission (LVBC) is a specialized institution of the East African Community (EAC) located in the City of Kisumu, Republic of Kenya and within the Lake Victoria Basin (LVB). The Commission is mandated to coordinate sustainable development and management of the Lake Victoria Basin in the 5 EAC Partner States.

Lake Victoria is hydrologically delineated and covers an area of approximately 183,000 Square Kilometers with lake surface of covering about 68,800 square kilometers. Lake Victoria is the 2nd largest freshwater body in the world. The East African designated Lake Victoria Basin as an area of 'high economic interests' and a 'regional economic growth zone,' to be developed jointly by the EAC Partner States.

Vision

A prosperous population living in a healthy and sustainably managed environment providing equitable opportunities and benefits.

Mission

To promote, facilitate and coordinate activities of different actors towards sustainable development and poverty eradication of the Lake Victoria Basin.

Core Values

Maintain integrity.
Practice equity.
Be result-oriented.
Be responsive.

For further information about the Lake Victoria Basin Commission (LVBC), Adapting Climate Change in Lake Victoria Basin Program, please contact:

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