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CLIMATE CHANGE, GREEN FINANCING AND COMMUNITY DEVELOPMENT

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Abstract: *Global warming has been experienced due to greenhouse gas emissions that blanket the earth thus trapping the sun's heat leading to severe storms, increased drought, rising ocean levels and unpredictable weather patterns. The objective of thisbaseline study was to explore means to transform and empower communities economically through transformative leadership by creating land-based carbon sink by establishing the climate and demographic changes in the last 30 years, estimation of the changes in area covered by vegetation and calculation of the amount of carbon dioxide that can be absorbed and sold as credits locally or internationally. The theories adopted for the study ware Sustainable Development Theory, Community Based Adaptation and Participatory Planning Theory. Temperature, precipitation, wind-speed data was obtained from satellite data using Glovis software and the Intergovernmental panel on climate change (IPCC) website. Demographic and land use data was collected through a surveyquestionnaires and from government records. Data analysis was done using descriptive statistics using excel software. From the results it was apparent that in the last 30 years, annual maximum temperatures have increased by 0.8^{o}C with the biggest change being experienced in the years between 2014 and 2024. Minimum temperatures have also reduced by 0.83^{o} C in the last 30 years with the biggest change being experienced in the years between 2004 and 2014. Precipitation increased by 760 mm with the highest change experienced in the years between 2014 and 2024 while wind speed also increasing by 3.7 km/hr. which significant changes between the years 2004 and 2014. Farm sizes also reduced by 50% while the number of trees per acre was reduced by 25%. Generally, the population increased by 75% with the number of men to women ratio being 1:2 respectively. Current and past forest cover data collected extrapolation has been used to determine below ground and above ground carbon changes. Carbon credits were then calculated using established standards. The same imaging and extrapolation, estimates were made from full county forest coverage verses current status and the figures converted to monetary value. This forms the basis for recommendations for the county on the best land use systems for transformative community empowerment economically through informed leadership by creating a land-based carbon sink.*

Key words: *Climate Change, Carbon Sequestration, Carbon trading, green financing.*

INTRODUCTION

HÖHNE et al. (2012) define Green finance as 'a broad term that can refer to financial investments flowing into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more sustainable economy. Green finance includes climate finance but is not limited to it. It also refers to a wider range of other environmental objectives, for example industrial pollution control, water sanitation, or biodiversity protection. Mitigation and adaptation finance is specifically related to climate change related activities: mitigation financial flows refer to investments in projects and programs that contribute to reducing or avoiding greenhouse gas emissions (GHGs) whereas adaptation financial flows refer to investments that contribute to reducing the vulnerability of goods and persons to the effects of climate change.

From the above definition it is evident that climate change and green financing ultimately impact on community development and economic development. In other words, human activity

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impacts on climate and determines the level of sustainable development for a given community or society. Therefore a balance needs to be drawn on farming practices conducted by agriculturalists and how industries promote green financing based on climate change patterns would ultimately determine the level of sustainable development and sustainable livelihoods. According to the United Nations (2024) the causes of climate change emerge from engaging in the following practices; generating power, manufacturing goods, cutting down forests using transportation, producing food through engaging in agriculture, powering buildings, over consumption for instance purchase of clothing, plastics and electronics. United Nations (2024) further reports the following as effects of climate change increased temperatures, more severe storms, increased drought, a warming, rising ocean, loss of species, food insecurity , increased health risks, increased poverty and displacement.

Sustainable Development Theory/Framework:

The first significant effort to present the concept of sustainable development from a global perspective was Brundtland Commission in 1987 (ZAHEDI, 2019). Sustainable development is now viewed as a key strategy that guides societies globally in social and economic transformation. Sustainable development could be defined in many ways depending on the context and varying factors. HANNA & CESARETTI (2019) suggest from a theoretical perspective that Sustainable development is determined by the utilisation of natural resources that will not be depleted for the benefit of future generations. Utilisation of natural resources, in other words, should not be exploited to a level that would harm the environment, and at the same time would not deplete natural resources in totality. Hence, there needs to be a continuous balance between the utilisation of natural resources and human activity that impacts suitable livelihoods and economic development.

Sustainable development dwells on the relationship between three elements, which are the environmental, societal and economic. These three elements impact sustainable development.

Almost all activity humans engage in or plans to engage in have implications for the environment, economy or society in one way or another. Wanamaker (2018), asserts that the environment, society and economy constitute a set of interrelated pillars which should form the foundation of human decisions and actions in the search for sustainable development.

MONTALDO (2013) suggests that decisions that are based on environmental sustainability focus on land utilization, surface water management, and agricultural activities. Social sustainability includes aspects such as 'equity, empowerment, accessibility, participation, cultural identity as well as institutional stability' (DALY, 1992).

Sustainable development theory pillars (Social, economic and environmental) need to be monitored and integrated to ensure environmental, economic and social sustainability of a country. The three elements are inter link and cannot function in isolation. Human activity is guided by empowering the community to engage in sustainable activities to cater for both current and future generations.

Community-Based Adaptation (CBA) Framework:

This approach focuses on involving local communities in specifically planning and implementation of climate change adaptation strategies. Community-based adaptation to climate change is observed to be a community-led process. The process is anchored on communities' priorities, needs, knowledge, and capacities, which purpose to empower communities to plan and cope with the impacts of climate change. Climate change is one of the many natural, social, and economic challenges that may poor people encounter consequently

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results to conditions such as unemployment, increased prices of food and other essentials, community, conflict, for instance communities fighting for scarce resources such as water and grazing land by pastoralists in Africa. Hence it is unlikely that interventions focusing only on climate-related risks will be considered as priorities by different communities (REID et al, 2009).

MATERIALS AND METHODS

Materials

The suitability of the research was based on the Köppen climate classification system. This is the type of climate typically found near the equator. It is consistently warm throughout the year, with average monthly temperatures never dropping below 18 °C (64°F). There is no distinct dry season, as all months receive significant rainfall—at least 60 mm (2.4 inches) per month. The climate is very humid, creating ideal conditions for lush vegetation, including tropical rainforests. There are no traditional seasons like summer or winter; the weather remains relatively stable year-round. Therefore, Kisii County is one of the highlands in Kenya located at an elevation of 1694.13 meters (5558.17 feet) above the sea level. It has a tropical rain forest climate (classification: AF). The county yearly temperature is 21.12 °C (70.02 °F) and it is -1.38% lower than Kenya's averages. Kisii typically receives about 218.04 millimeters (8.58 inches) of precipitation and has 300.44 rainy days (82.31% of the time) annually. This location and attitude elevation makes the study site suitable for the comparative study for a systematic review using extrapolated data from 9 wards.

Methods

This study adopted exploratory research design. Data was obtained from satellite data from the metrological department in Nairobi for the last 30 years. The data was comprised of maximum temperature for the last 30 years, data on minimum temperature for the last 30 years, data on precipitation mm for the last 30 years and data on wind speed (km/h) for the last 30 years. A hectare of forest typically absorbs between 1 and 2 tons of CO_2 per year. However, the amount can vary depending on factors like forest type, age, and climate. For example, studies suggest afforestation or reforestation can sequester between 0.8 and 2.4 tonnes of carbon (equivalent to 2.9 to 8.8 tonnes of CO_2) per hectare per year in boreal forests, 0.7 to 7.5 tonnes in temperate regions, and 3.2 to 10 tonnes in the tropics. Mature tropical forests, in particular, can store a large amount of carbon, with estimates ranging from 300 to 400 tonnes of CO_2 per hectare (ANON 1, 2025).

Data Processing and Analysis

Data was analyzed using both qualitative and quantitative analysis. The descriptive statistics were analyzed using excel software. The data collected being for three decades, was first clustered into three decades and averages taken from the pool of ten years each. A close comparison of time series and trend analysis were used. The error bars were used to give the standard deviation. The qualitative data covered information that could not be obtained through panel data. Hence, interviews were used to gather such information from Agriculture extension officers (AEO).

RESULTS AND DISCUSSIONS

Kisii County Population

Based on available data, Kisii County has seen steady population growth over the years (Table 1)

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Table 1

Kisii county population over the last two decades

Year	Total Population	Male	Female
2009 Census	1,152282	550,464	601,818
2012	1,226,873	536,062	640,811
2015	1,306,652	624,171	682,481
2017	1,362,779	650,982	711,797
2019 Census	1,266,860		

In 2020-2024 Estimates: While exact figures for each year are not readily available, the county has maintained a steady growth rate of around 2.1% annually. The male-to-female ratio has consistently shown a higher number of females than males. Generally, the population increased by 75%, with the number of men to women ratio being 1:2, respectively.

Farm Size in Kisii County

In Kisii County, farm holding sizes are typically small, ranging from 0.5 to 4.5 acres. This is due to high population pressure, leading to subdivisions and fragmentation of land holdings. The county has over 135,000 land holdings, with households engaging in mixed farming. Additionally, 65% of agricultural parcels in the county are used for farming. The total arable land in Kisii County is 1,260.34 km², while non-arable land covers 190.66 km².

Climate change has significantly impacted forest cover in Kisii County. The county has experienced deforestation and degradation due to changing rainfall patterns, increased temperatures, and human activities. Wetlands, which play a crucial role in maintaining biodiversity, have also been affected, with 30-40% of natural wetland ecosystems lost**.** Kisii county climate change framework policy (2019).

Through panel discussions, it was noted that, 'Farm sizes also reduced by 50% while the number of trees per acre reduced by 25%." (FDG). The relationship between high population and farm size warrants the reasons for the rout cause of climate change.

Increase in population contributes to increase of deforestation and degradation. This contributes to decrease in land size and these human activities has led to increase in temperatures which ultimately affect the climate change.

Maximum temperatures

A summary of the temperature for comparison over the last 30 years was analyzed in blocks of ten years each as displayed below. The Figure below presents the percentage increase of maximum temperatures.

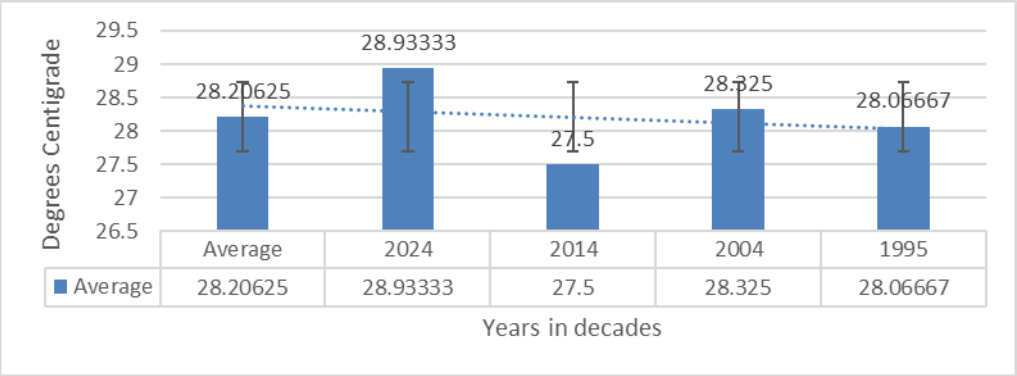

Figure 1. Maximum average temperatures in Kisii county in the last 30 years

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Maximum temperatures have increased by 0.8 ºC with the biggest change being experienced in the years between 2014 and 2024.

Minimum temperatures

The average of the minimum temperatures were summarized in blocks of ten years based on the monthly averages over the years. The Figure below presents the percentage reduction of Minimum temperatures.

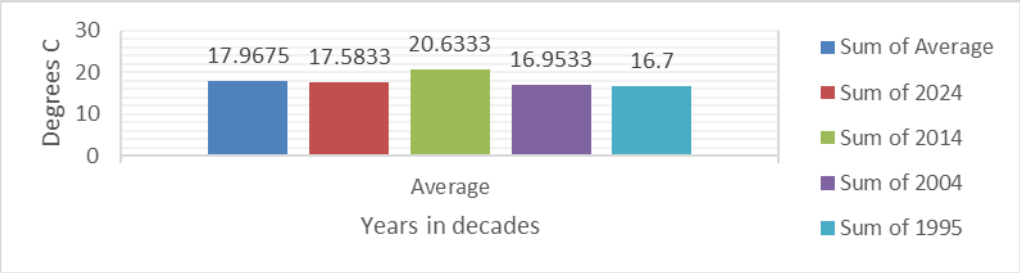

Figure 2. Minimum average temperatures in Kisii county in the last 30 years.

Minimum temperatures have also reduced by 0.83 ºC in the last 30 years with the biggest change being experienced in the years between 2004 and 2014.

In the context of climate change, any form of water, rain, snow, sleet, or hail that falls from the atmosphere to the Earth's surface forms the precipitation patterns. They shift due to rising global temperatures. Warmer air holds more moisture, leading to more intense and frequent storms in some areas, while other regions experience drier conditions and prolonged droughts. The following figure represents the precipitation percentages.

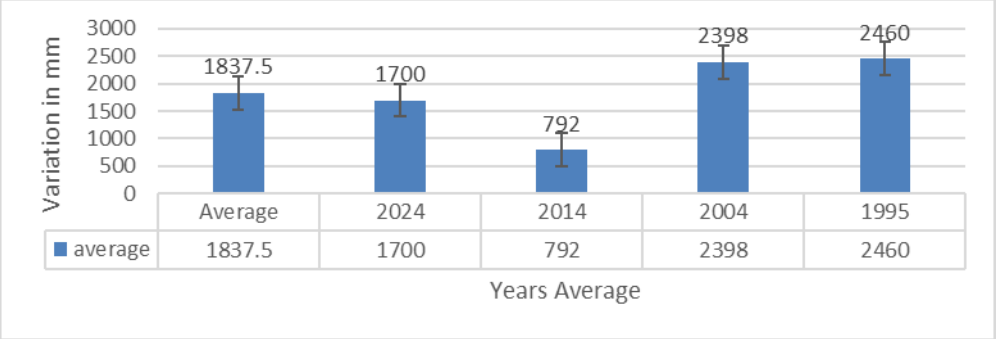

Figure 3. Precipitation Percentage change in Kisii county in the last 30 years

Precipitation increased by 760 mm with the highest change experienced in the years between 2014 and 2024 while wind speed also increasing by 3.7 km/hr. This means increase in wind speed causes drier conditions which ultimately affect the vegetation.

Wind Speeds

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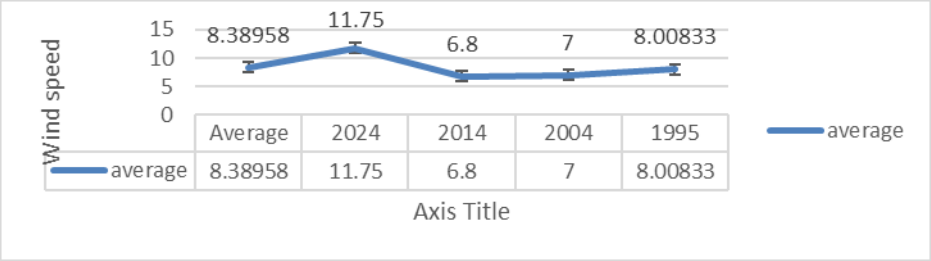

Figure 4. Wind speeds in Kisii County in the last 30 years

In 2024 the average wind speed was 6.8 but increased in 2014 to 11.75, showing an increase of 4.95, which is very high meaning the forest cover has increased with a ripple effect from the high population and high deforestation.

Forest cover changes in Kisii County in the last 30 years

Forest cover in Kisii County is decreasing between (OGEGA, 2025). In 1994 the forest cover in the county was estimated to be 26.6 percent while between 2004 and 2014 forest cover was estimated to be 24.73 percent of the total area. In 2024, forest cover decreased to approximately 22.8percent. Kisii County has a tree cover of Mainly these are non-gazette forests mainly in Nyangweta, Ritumbe, Ndonyo, and Nyansembe forests in Gucha South, and others in Kisii South, Sameta, Nyamache, Kenyenya, and Masaba South districts.

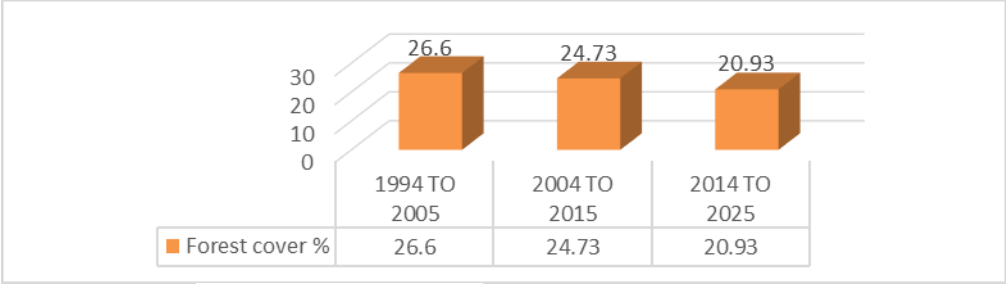

Figure 5. Forest Cover Trend in Kisii county in the last 30 years

The forest cover indicates a declining trend at the rate of vegetative cover which results in increased wind speeds and with increased precipitation there has been a change in climatic patterns. The increased precipitation could be a result of cloud movement due to increased wild speeds.

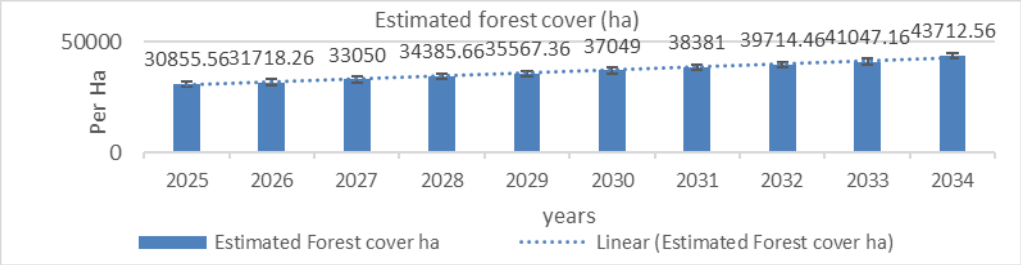

Figure 6. Kisii Estimated forest Cover for the next ten Years

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The projection targets to tap carbon from the air and store it in the dry forest cover before sink.

Carbon IV Oxide Emission Changes in Kisii County in the last 30 years

Carbon emissions in Kisii County have been increasing, between 2001 and 2023, Kisii County lost 1.87ha of tree cover, which was a 3.8% decrease, and resulted in 1.11 Mt of CO_2 emissions (OGEGA, 2025).

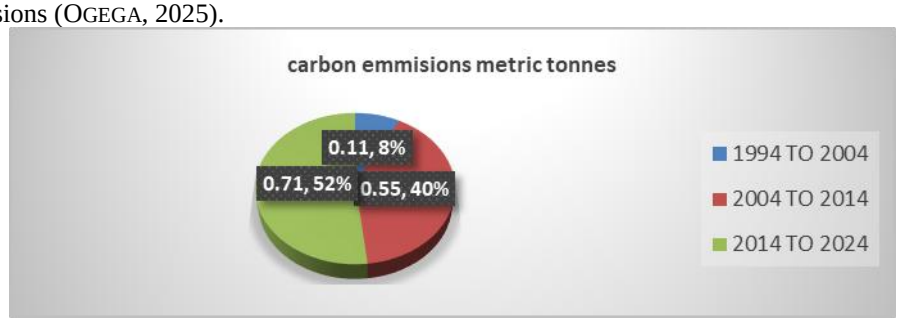

Figure 7. Finally, estimates made from full county forest coverage.

Kisii County has a total area of 1,332.7 square kilometers (km²) or 133,270 hectares (Anon, 2025). If the country is reforested to 32.8% in the next 10 years, the increase in carbon credit per year will be as follows. For CO2 captured via "direct air capture," Section 45Q pays $***180 for every ton stored in the ground*** and $130 when it's used for EOR (ANON, 2 2025)

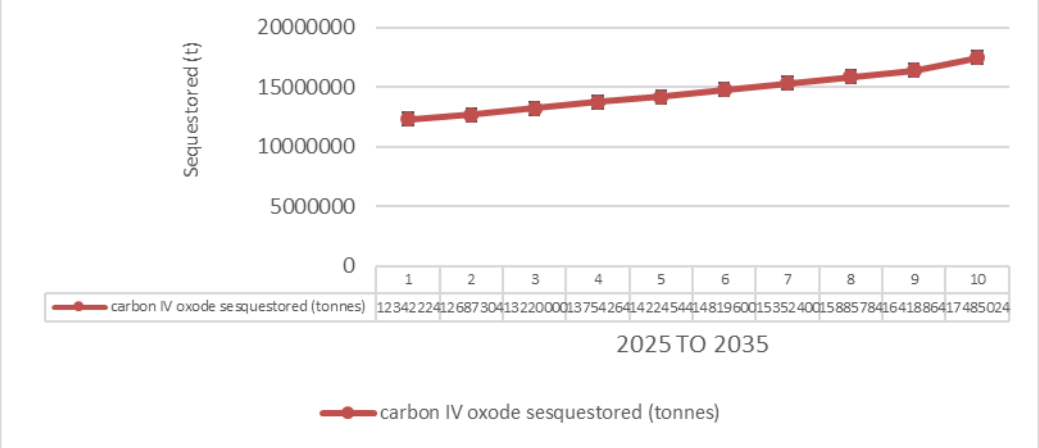

Figure 8. Carbon credits to be generated in the next ten years after reforestation

Projected carbon credits estimates using international standards for the next ten years indicate that if the forest cover is increased to 30% with a one percent increment per year the county can create a carbon sink that is worth 3,273,053 USD in 2034.

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CONCLUSION AND RECOMMENDATION

Conclusion

Control of carbon is real and possible. Therefore, it is good and bad depending on how it is handled. The massive increase of population has reversely affected the natural ecosystem and the entire natural habitats. The balance between carbon emission and carbon sink is crucial in ensuring that the ecosystem sustains humanity.

Recommendation

Efforts should be made to sustainably manage the landscape through restoration practices to reduce deforestation and degradation. This will enhance carbon harvesting and balance in the ecosystem. The agricultural sector together with the government shall be in a position to continuously monitor carbon stock control. It is also important to estimate net carbon storage and sequestration. Further research is needed in order to enhance the other type of vegetation.

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