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IMPACT OF CHANGING RAINFALL PATTERNS ON RURAL LIVELIHOODS IN KENYA: A CASE STUDY OF GARISSA AND EMBU COUNTIES

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Abstract. *Climate change has significantly affected economies, livelihoods, and biodiversity globally, with rural communities in Kenya being more severely impacted than urban counterparts. This study investigates the impact of changing rainfall patterns on rural livelihoods in Embu and Garissa counties, selected for their contrasting climatic conditions; Embu as an agricultural hub with higher and more stable rainfall, and Garissa as an arid region dependent on pastoralism. The study aimed to compare rainfall patterns and establish their effects on livelihoods in these counties. Descriptive statistics revealed that Embu receives significantly more rainfall (108.87 mm) than Garissa (28.32 mm), and paired samples analysis confirmed this difference as statistically significant. Regression results showed no significant long-term rainfall trend in either county, highlighting the unpredictability of rainfall. The analysis also found no significant relationship between rainfall and agricultural land area in Embu; however, a moderate but statistically significant relationship was identified between Garissa's average rainfall and grazeland area. These findings suggest that while rainfall affects agricultural and pastoral land use, the variation in rainfall across years plays a role in shaping livelihood strategies, underscoring the need for climate-resilient approaches in rural communities. Key findings revealed the differential impact of rainfall patterns on the livelihoods of these counties emphasizes the importance of region-specific adaptive strategies, particularly in arid and semi-arid areas like Garissa, which face greater vulnerability to climatic shocks.*

Key words: *climate change, rural livelihoods, rainfall patterns*

INTRODUCTION

Climate change in the past and present times has adversely affected precipitation patterns with the variance of rainfall rising significantly (Alexander 2016) in some regions. Studies conducted have shown that changing rainfall frequency has had significant impacts on socio-economic outcomes. Specifically, rainfall shocks are associated with an increase in conflict and criminal activities (MIGUEL ET AL. ,2004); SEKHRI & STOREYGARD, 2014).

Garrisa County Report (2023), highlights that rainfall patterns in Grarissa County in October to December 2022 occcured as expected. However, in early November short rainy season brought persistent, heavy rains, resulting in flash floods which brought about displacement of communities.

Food availability in Garissa County at household levels at the time was significantly influenced by the production of crops and livestock. In the last three years Garisssa has experienced a decline in the expansion of crop farming areas under rain-fed conditions due to mainly inadequate rainfall and increased drought.

This has subsequently resulted to conditions that have severely negatively impacted farmers' ability to maintain their livelihoods. Hence has reduced economic activity resulting to reduced income levels for farmers and job loss for full time and casual farm workers.

Based on a study conducted by KALELE ET AL (2021) on 'Climate change impacts and relevance of smallholder farmers' response in arid and semi-arid lands in Kenya,' findings revealed that impacts of climate change on livelihoods consist of food shortage, increased food

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prices and decreased availability of water. The findings illustrate that indeed climate change patterns affects arid and semi arid areas like Garisaa. However, all is not lost as new strategies are been sought to curb the harmful impact of excess or inadequate rainfall patterns such as introduction of climate smart agriculture has been introduced as a strategy to try and improve productivity in line with changing rainfall patterns experienced in Kenya.

On the other hand, Embu County experienced timely onset of the short rains season as expected in October 2022 though rains were unevenly distributed while increased rains were received from mid November to December 2022. Increased rainfall resulted to water flooding in farms around Mwea and Makima sub counties that led to crop failure and hence replanting was done. Consequently, high food prices were witnessed in the months of September to January 2022 (Emu County Report, 2023).

It is evident that both Garisaa and Embu rainfall patterns have affected food security. This implies that it does not matter the region whether arid, semi arid or agricultural the concern is about the amount of rainfall that falls which could impact positively or negatively on communities. It is against his background that this study sought to investigate the research question; what are the rainfall patterns encountered in Garissa and Embu Counties? What are the effects of rainfall patterns on rural livelihoods in Garissa and Embu Counties?

Theory of Precipitation or Rainfall

Rainfall is considered to be a natural process that takes place whereby atmospheric vapour is converted into water. As a result the water then falls as rainfall. In hydrology, rainfall is considered the third element of atmospheric division of the hydrologic cycle which is viewed as the change of state.

This precipitation and rainfall are interchangeably used by scholars. Precipitation is however a term used for types of moisture that falls for instance rainfall and snow. During summer or sunny spells evaporation take place after which water lost in evaporation finds room in an air mass and is added to the atmospheric vapour storage. Evaporation loss is excessive during the hot season and hence the capacity of the air mass is also more. This large quantity of vapour as a result makes the air mass moist. Ultimately, the change of state from atmospheric vapour to water takes place when the capacity of the air mass to hold the vapour particles increases (SELVAM, 2012).

There have been critiques on theories of rainfall and new findings about rainfall are been sought such as the theories for past and future monsoon rainfall changes (HILL, 2019). Hence new paradigms continue to be brought forth by scholars. Change in rainfall patterns could adversely affect agricultural activity and therefore it is crucial for agriculturalists to understand rainfall patterns to guide when it comes to growing of crops in order to have high production yields.

Sustainable Livelihood Framework

SLF is viewed to be a practical concept that has been used to explain the capacity of human communities to increase its resources and abilities in the aspect of unexpected occurrence of different events that would negatively impact livelihoods such as change in climate for instance reduced rainfall or excess rainfall that would impact negatively on livelihoods as well as a country's economy.

SLA framework aims to identify the most needed resources in a community and how the resources can be utilized to enhance and positively impact a community over a period of time (SU, ET AL, 2018). Thus, this will enable a community to become independent as opposed to creating a dependency syndrome.

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The Sustainable livelihoods framework is observed to have five elements which consist of human assets for instance talents, expertise, labour capability, create and renovate, right healthiness); Societal assets which comprised of networks and associations that are in human society and utilized by individuals in meeting their livelihood; physical assets such as infrastructure, machinery and equipment, that enhances livelihood; economic assets for example economic resources that support people's livelihood for instance money at hand, cash reserves, access to reserves and loans with the privilege to hurriedly and effortlessly change a different resources into money. Others include natural assets for example natural resources which profit the public, such as biodiversity, among others (CORTES, 2008) all of which are determined on rainfall patters.

MATERIAL AND METHODS

The study adopted secondary method of data collection. Raw rainfall data obtained from the Kenya Metrological Department in Nairobi was converted into useful statistical data. Data has been analyzed using t-test, analysis of variance and linear and multiple linear models. The results are presented in the form of tables.

RESULTS AND DISCUSSIONS

Objective 1: Comparing the rainfall patterns in Garissa and Embu Counties
The descriptive statistics in Table 1 reveal marked differences in rainfall patterns between Embu and Garissa counties, affirming the rationale behind the comparative case study design.

Table 1

Descriptive statistics comparing 30-year average annual rainfall in Embu and Garissa Counties

Statistic	Embu Avg. Rainfall (mm)	Garissa Avg. Rainfall (mm)
N (Valid)	30 years	30 years
Mean	108.87 mm	28.32 mm
Median	103.73 mm	24.50 mm
Standard Deviation (SD)	26.10 mm	15.85 mm
Range	116.61 mm	68.11 mm

Embu records a significantly higher mean annual rainfall (108.87 mm) compared to Garissa (28.32 mm), consistent with Embu's classification as a high rainfall, agriculturally productive area and Garissa's designation as arid/semi-arid, where livelihoods predominantly rely on pastoralism.

The close alignment between the mean and median in Embu suggests a relatively symmetrical rainfall distribution, whereas Garissa's slightly higher mean compared to its median indicates a right-skewed distribution, likely influenced by sporadic high-rainfall years such as 1997 and 2018.

While Embu exhibits a higher absolute standard deviation, Garissa demonstrates greater proportional variability, with a coefficient of variation of 56% compared to Embu's 24%. This heightened variability underscores Garissa's exposure to climatic shocks, reinforcing its vulnerability and the need for resilient pastoral systems. The wide range in annual rainfall in both counties further highlights the year-to-year unpredictability, though the relative impact is more pronounced in Garissa. These patterns not only support the study's theoretical framing but also highlight the importance of adaptive livelihood strategies in arid regions. The paired samples analysis in Table 2 provides strong statistical evidence that rainfall patterns in Embu and Garissa counties differ significantly.

Table 2

Paired Samples Analysis of Rainfall in Embu and Garissa (1994–2023)

Paired Samples Correlation	**N**	**Correlation**	**Sig. (2-tailed)**
Embu&Garissa Rainfall	30	0.681	0.000
Paired Samples Test			
Mean Difference			

80.54 mm			

On average, Embu receives 80.54 mm more rainfall than Garissa annually—a difference that is both statistically significant ($t(29) = 22.99$, $p < .001$) and practically meaningful. The strong positive correlation between the two counties' rainfall patterns ($r = .681$, $p < .001$) suggests that while both regions are influenced by similar broader climatic trends, the magnitude of rainfall differs substantially.

This reinforces the theoretical premise that rural livelihoods in these counties operate under vastly different hydrological regimes—Embu's agricultural productivity is supported by higher and more stable rainfall, whereas Garissa's pastoralist systems must adapt to more limited and variable precipitation. These findings justify deeper investigation into how such differences translate into land use, vulnerability, and livelihood outcomes. The regression results in Table 3 show that there is no statistically significant change in average annual rainfall over time in either Embu or Garissa.

Table 3

Regression Analysis Summary for Annual Rainfall Trends (Embu and Garissa, 1990–2019)

County	**R**	**R^2**	**Adjusted R^2**	**Std. Error**	**Coefficient (Year)**	**Sig. (p-value)**
Embu	0.083	0.007	-0.029	26.46 mm	0.247	0.662
Garissa	0.203	0.041	0.007	15.79 mm	-0.365	0.283

In Embu, the relationship between year and rainfall is weak and positive (B = 0.247), but with a high p-value of 0.662, indicating that the slight increase is not statistically meaningful. Similarly, Garissa shows a weak negative relationship (B = -0.365, p = 0.283), suggesting a slight decline in rainfall over time, though also not statistically significant.

These results imply that rainfall in both counties has not followed a clear upward or downward trend over the past 30 years.

Furthermore, the R-squared values are very low for both counties (Embu: 0.007, Garissa: 0.041), meaning that year-to-year variation in rainfall is largely unexplained by the passage of time alone. This highlights the erratic nature of rainfall patterns, especially in arid areas like Garissa, where unpredictability contributes to increased vulnerability to drought and climate shocks. These findings reinforce the need for climate-resilient livelihood strategies rather than relying on assumptions of long-term climatic improvement.

Objective 2: Establish the effects of rainfall patterns on rural livelihoods

The regression analysis results suggest that there is no significant relationship between average rainfall in Embu and livelihoods (measured by agricultural land area (p = 0.517)). Although the coefficient for rainfall (B = 0.175) is positive, its effect on agricultural land area is weak and not statistically significant, as indicated by the low R-square value (0.015). This implies that factors other than rainfall may have a stronger influence on the distribution of agricultural land in Embu.

The regression analysis shows a moderate relationship between Garissa's average rainfall and grazeland area, with a significant model fit (F = 4.524, p = 0.05).

Table 4

Regression Analysis of GarissaGrazeland Area and Average Rainfall

Model Summary	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**F Change**	**Sig. F Change**
	0.288	0.083	0.050	174.93	4.524	0.05
Coefficients	**Unstandardized Coefficients**		**Std. Error**	**Standardized Coefficients**	**t**	**Sig.**
Constant	9483.160		66.285		143.067	0.000
Garissa Average Rainfall (mm)	5.257		2.050	0.388	2.589	0.05

The predictor variable, Garissa average rainfall, has a positive impact on grazing land area, though the strength of this relationship is relatively weak ($R^2 = 0.083$). Despite this, the model still achieves statistical significance, suggesting that while other factors likely contribute to grazeland area variation, rainfall plays a role.

CONCLUSIONS

Rainfall patterns affect agricultural and pastoral land use in many ways. Hence livelihoods are affected. Strategies such as planting drought resistant crops, water harvesting for irrigation and livestock, harvesting of grass and storage could be adopted to reduce the chances of the negative impact of harsh unpredictable rainfall patterns. Farmers and pastoralist communities' need to be educated on how such strategies can be implemented through extension officers working for the government or Non Governmental Organisations. Adoption of favourable strategies will impact positively on livelihoods, economic growth and ultimately impact development to some extent. The key limitation of this study is that the data provided by the Kenya Metrological department in Nairobi for rainfall is for the year 2022. Data for 2023 and 2024 has not been compiled for use for research purposes.Appreciation is accorded to the Kenya Metrological Department in Nairobi Kenya for providing essential data for analysis for this study.

BIBLIOGRAPHY

ALEXANDER, L. V. (2016), 'Global observed long-term changes in temperature and precipitation extremes: A review of progress and limitations in ipcc assessments and beyond', Weather and Climate Extremes 11, 4–16

BERGONZINI L, RICHARD Y, PETIT L, CAMBERLIN P. Zonal circulations over the Indian and Pacific Oceans and the level of lakes Victoria and Tanganyika. Int J Climatol. 2004;24:1613-1624.

BODRI L, CÉRMÁK V. Climate of the past millennium inferred from borehole temperatures: Regional patterns of climate changes Glob Planet Change. 1999;2:225-235.

CORTES, G.P. (2008). The Sustainable livelihoods approach: Principles and tools to analyze and define intervention strategies in the Economic Justice area. Thematic Paper for Change 2. Retrieved December 5, 2018, from at: https://www.researchgate.net/publication/269221554

DANCEA L., T. M. EPEKO (2021) Assessment of the environmental conditions of the isiro public slaughterhouse march to june 2020 https://www.rjas.ro/paper_detail/3389 https://www.cabi.org

EMBU COUNTY (Mbeere) .(2023). Short rains food security assessment report

GARISSA COUNTY. (2023). short Rains Food Security Assessment Report

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http://doi.org/10.59463/RJAS.2026.2.10

HILL, S A (2019) Theories for Past and Future Monsoon Rainfall Changes Current Climate Change Reports 5(14):1-12

KOSLOWSKI G, GLASER R. Variations in reconstructed ice winter severity in the western Baltic from 1501 to 1995, and their implications for the North Atlantic Oscillation.Climate Change. 1999;41:175-191.

LUTERBACHER J, DIETRICH D, XOPLAKI E, GROSJEAN M, WANNER H. European seasonal and annual temperature variability, trends and extremes since 1500.Science. 2004;303:1499-1503.

LUTERBACHER J, LINIGER MA, MENZEL A, ESTRELLA N, DELLA-MARTA PM, PFISTER C, ET AL. The exceptional European warmth of autumn 2006 and winter 2007: Historical context, the underlying dynamics and its phenological impacts. Geophy Res. 2007;34:L12704.

MIGUEL, E., SATYANATH, S. &SERGENTI, E. (2004), 'Economic shocks and civil conflict: An instrumental variables approach', Journal of political Economy 112(4), 725–753

Ogilvie A. Documentary evidence for changes in the climate of Iceland, A.D. 1500-1800. Climate since A.D. 1500, Routledge, London. 1992:92-117.

OLGA TIMOFEEVA1, IRINA MINAKOVA1, TATYANA BUKREEVA1, SVETLANA STARYKH1, AND L. DANCEA 2021 Cluster approach to production and consumption waste management in regional socio-economic systems E3S Web of Conferences 311, 03004 (2021) https://doi.org/10.1051/e3sconf/202131103004

PLEOGEO PALEOCLIMATOL PALEOCOL.2011;303:133-139.Huang S. Merging information from different resources for new insight into climate change in the past and future. Geophy Res. 2004;31:L13205.

RODRIGO FS. A new method to reconstruct low frequency climate variability from documentary sources: Application of winter rainfall series in Andalusia (South Spain) from 1501 to 2000.Climate Change. 2007;87:471-487.

SEKHRI, S. &STOREYGARD, A. (2014), 'Dowry deaths: Response to weather variability in india', Journal of development economics 111, 212–223. 21

SELVAM, A. M A (2012)General Systems Theory for Rain Formation in Warm Clouds Indian Insitute of Tropical Meteorology, Pune 411008, IndiaPowers LA, Johnson TC, Werne JP, Castaneda IS, Hopmans EC, Schouten S, et al. Organic geochemical records from Lake Malawi (East Africa) of the last 700 years.

VERSCHUREN D. Decadal and century-scale climate variability in tropical Africa during the past 2000 years. Climate Change. 2004;6:219-256.