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EARLY WARNING SYSTEM AND DROUGHT RESPONSE IN KENYA. A CASE STUDY OF BARINGO COUNTY GOVERNMENT

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ABSTRACT

Baringo County, Kenya, grapples with the profound challenges presented by recurrent drought, which threatens water resources, agricultural productivity, food security, and socio-economic stability. The main focus of this study was to assess the drought early warning information system on effective response in Baringo County Government, Kenya. The study was guided by the following specific objectives; to examine the effect of monitoring and early warning, preparedness and planning, response and mitigation, recovery and rehabilitation and evaluation and learning on effective drought response by Baringo County Government, Kenya. This study was guided by diffusion of innovation theory, resource dependence theory, contingency theory and organizational learning theory. This study used a cross-sectional survey design. This study targeted 59 officials from Directorate of Disaster Management in Baringo County Government. Census sampling technique was adopted. Therefore, the sample size for the study was 59 respondents. Data was collected using a self-administered semi-structured questionnaire. Piloting was done on 5 individuals representing 10% of study sample and was selected randomly from the target population and excluded from the final study. The data collected from the pilot group was used to test for validity and reliability of the questionnaire. Data obtained from the field was coded, cleaned, and entered into the computer for analysis using the SPSS version 28. Descriptive statistical included frequency, percentages, mean and standard deviation. Inferential statistical analysis used was multiple regression and correlation analysis. The significant of each independent variable was tested at a confidence level of 95%. The study's findings, based on the beta coefficients from the multiple regression analysis, revealed that monitoring and early warning ($\beta = 0.189$, $p < 0.05$), preparedness and planning ($\beta = 0.218$, $p < 0.05$), response and mitigation ($\beta = 0.156$, $p < 0.05$), recovery and rehabilitation ($\beta = 0.279$, $p < 0.05$), and evaluation and learning ($\beta = 0.303$, $p < 0.05$) all positively and significantly influence the effectiveness of drought response by Baringo County Government, Kenya. It is concluded that Baringo County's drought management can be significantly improved by enhancing each of these areas. The study recommends that the county invest in advanced monitoring technologies, regularly update response plans with stakeholder input, integrate traditional and modern response techniques, prioritize sustainable recovery initiatives, and establish strong feedback and knowledge-sharing mechanisms.

Keywords: *Drought Response, Early Warning System, Baringo, Preparedness and planning, Recovery and Rehabilitation, Response and Mitigation*

INTRODUCTION

Droughts represent one of the most pervasive and impactful natural disasters, posing significant challenges to water resource management, agricultural production, ecosystem health, and socio-economic stability globally (Wilhite, 2020). The frequency and severity of drought events have been worsened by climate change, leading to heightened vulnerability for communities (Hayes et al., 2021). In recent years, there has been a growing recognition of the importance of Drought Early Warning System (DEWS) in mitigating the impacts of droughts (Pulwarty & Sivakumar, 2018). In Australia, the integration of satellite-based remote sensing and ground-based monitoring systems has significantly enhanced the country's DEWS capabilities. Similarly, in the United States, the National Integrated Drought Information System (NIDIS) has been pivotal in improving drought preparedness and response through the provision of accessible, regionally relevant information (Hobbins et al., 2019). In Europe, Studies by Stahl et al. (2019) highlight the EDO's effectiveness in providing timely drought assessments and supporting decision-making processes at various governance levels. In Asia, countries like India Research by Krishnamurthy et al. (2020) emphasizes the importance of integrating traditional knowledge with modern forecasting techniques to enhance the relevance and effectiveness of early warning systems in rural areas.

In Africa, Ethiopia, for instance, where agriculture is the backbone of the economy and millions are reliant on rain-fed agriculture, DEWS have been developed with a strong focus on agricultural resilience (Adem et al., 2020). In South Africa, The South African National Space Agency (SANSA) has been actively involved in harnessing satellite technology to monitor drought conditions and predict rainfall patterns with greater accuracy (Diedericks et al., 2021). In Nigeria, The Nigerian Meteorological Agency (NiMet), in collaboration with international partners such as the World Meteorological Organization (WMO) and the United Nations Development Programme (UNDP), has invested in the modernization of weather observation networks and the deployment of advanced forecasting models (Adewuyi et al., 2021). In Tanzania, DEWS initiatives have evolved to incorporate indigenous knowledge systems and participatory approaches, recognizing the invaluable insights and coping mechanisms of local communities in responding to droughts (Sage, 2020).

Monitoring and Early Warning systems are integral components of effective drought management, providing essential information to anticipate, mitigate, and respond to drought events. Comprehensive Monitoring and Early Warning systems integrate various components, including data collection, analysis, interpretation, and dissemination, to facilitate informed decision-making and risk management (Smith & Ward, 2020). Secondly, Preparedness and Planning are fundamental pillars of effective drought management, encompassing various aspects such as resource allocation, contingency planning, and training effectiveness. Studies underscore the critical importance of allocating sufficient resources to support preparedness and planning efforts for drought management (UNDRR, 2019).

Recovery and Rehabilitation refer to the processes aimed at restoring affected communities, infrastructure, and ecosystems to pre-drought conditions or enhancing their resilience to future drought events. Smith and Jones (2021) emphasize the significance of time to recovery in assessing the effectiveness of Recovery and Rehabilitation efforts. Scholars highlight the importance of incorporating climate-resilient design principles, innovative technologies, and community participation in infrastructure restoration efforts to enhance durability, sustainability, and adaptive

capacity (Brown & Garcia, 2020). Evaluation and Learning refer to the processes of assessing the effectiveness of drought response strategies, policies, and interventions, and incorporating lessons learned to improve future decision-making and resilience-building efforts. According to Nguyen and Patel (2020).Scholars such as Lee and Garcia (2019) emphasize the critical role of feedback utilization in improving drought management practices. Effective policy adaptation is essential for enhancing the resilience of communities and ecosystems to drought events.

Baringo County, Kenya, faces profound challenges due to recurrent droughts, significantly impacting water resources, agricultural productivity, food security, and socio-economic stability. Over the past decade, the frequency and severity of drought occurrences have escalated markedly. Statistical data from the Kenya National Bureau of Statistics (KNBS, 2020) reveals that the number of households affected by drought has increased annually by an average of 8.5% between 2010 and 2020. Severe drought periods have resulted in maize yield losses of up to 40%, exacerbating food insecurity and livelihood challenges for rural communities (KNBS, 2020). The impact of drought extends beyond agriculture to critical water resources. Approximately 70% of Baringo County's population faces acute water shortages during prolonged droughts (KNBS, 2020).

The Baringo County Government in Kenya has been proactive in implementing drought early warning systems (DEWS) to mitigate the impacts of recurrent drought events on local communities. The Baringo County Meteorological Department plays a pivotal role in collecting and analyzing weather data, which is then used to generate early warnings and advisories for local stakeholders (Baringo County Government, 2019). Moreover, the Baringo County Government has invested in the development of community-based early warning systems (CBEWS) to enhance the resilience of vulnerable communities to drought impacts. Despite efforts by the Baringo County Government and its partners to implement drought management strategies and interventions, significant gaps persist. Challenges in effectively leveraging early warning information for proactive response and resilience-building include inadequate institutional coordination, limited resources, and difficulties in translating early warning information into actionable measures at the community level. Existing studies on drought early warning information primarily focused on other countries and regions, leaving a gap in understanding and addressing the unique challenges faced by regions like Baringo County.

Several studies highlight the importance of effective drought early warning systems including Drechsler and Soer (2016) demonstrated the potential effectiveness of predictive tools in drought response through Ethiopia's Productive Safety Net Programme. Heim et al. (2017) discussed the importance of drought early warning and information systems in enhancing preparedness and response. Fisher, Petit, and Porod (2021) explored the role of early warning systems in strengthening community resilience to extreme events, providing insights applicable to regions vulnerable to drought. These studies underscore the importance of localized research and tailored solutions to address the challenges of leveraging early warning information for effective drought response and resilience-building in regions like Baringo County. Therefore, this study sought to address these challenges through a comprehensive assessment of drought early warning information and its impact on effective response within the context of the Baringo County Government, Kenya with an overall objective to assess the early warning system and drought response in Kenya. a case study of Baringo County Government. This study holds significance for various stakeholders in Baringo County, Kenya, and beyond, as it provides valuable insights into

the effectiveness of drought response strategies and the utilization of early warning information by the county government. The study was guided by the following specific objectives; to examine the effect of monitoring and early warning, preparedness and planning, response and mitigation, recovery and rehabilitation and evaluation and learning on effective drought response by Baringo County Government, Kenya.

LITERATURE REVIEW

Theoretical Literature Review

The Diffusion of Innovation Theory

The Diffusion of Innovation Theory, pioneered by Everett Rogers in 1962, which was the study anchor theory, at its core, defines innovation as any idea, practice, or object perceived as novel by individuals or groups (Rogers, 2003). Innovations span a broad spectrum, encompassing tangible products and intangible concepts like new technologies, social behaviors, or organizational strategies. Rogers identifies several crucial factors influencing diffusion, including innovation attributes, communication channels, social systems, and adopter characteristics. Central to the theory is the classification of adopters into categories based on their readiness to embrace innovations (Rogers, 2003). These categories include innovators, early adopters, early majority, late majority, and laggards, each with distinct characteristics and behaviors influencing the diffusion process.

Innovators and early adopters typically drive initial adoption, followed by the majority, while laggards are the last to adopt innovations. In the specific context of examining the adoption and dissemination of early warning technologies within the Baringo County Government, Rogers' Diffusion of Innovation Theory (Rogers, 2003) offers invaluable insights; researchers can gain deeper insights into the factors shaping early warning technology adoption, identify potential barriers, and devise strategies for effective implementation. Critics of the Diffusion of Innovation Theory highlight its potential oversimplification of adoption processes and its limited consideration of contextual factors (Dearing & Cox, 2018). They argue that the theory's focus on individual characteristics may overlook broader structural and power dynamics influencing adoption decisions (Valente, 1995).

Resource Dependence Theory

Resource Dependence Theory (RDT), developed primarily by Pfeffer and Salancik in the 1970s, offers a comprehensive framework for understanding organizational behavior within the context of resource availability and dependence (Pfeffer & Salancik, 1978). This theory posits that organizations are not autonomous entities but rather interdependent systems that rely on external resources for survival and success.At the core of RDT is the recognition that organizations require various resources to function effectively, including financial capital, human resources, information, technology, and social networks (Pfeffer & Salancik, 1978). Resource Dependence Theory can shed light on the Baringo County Government's reliance on external resources and its efforts to secure adequate resources for drought preparedness and planning. Critiques of RDT highlight its deterministic view of organizational behavior and its limited consideration of internal dynamics and agency (Hillman et al., 2009).

Contingency Theory

Contingency Theory, developed in the late 1960s and early 1970s by scholars such as Fred Fiedler,

Joan Woodward, and Paul Lawrence, provides a comprehensive framework for understanding organizational behavior by emphasizing the importance of context and situational factors (Fiedler, 1967; Woodward, 1965; Lawrence & Lorsch, 1967). This theory posits that there is no one-size-fits-all approach to management, and the effectiveness of organizational practices depends on the alignment between the characteristics of the situation and the strategies employed. Different situations require different approaches, and what works well in one context may not be effective in another. Therefore, managers must analyze the contingencies they face and tailor their actions accordingly. Critics argue that it can be difficult for managers to determine which factors are most salient in a given situation and how to effectively adjust their practices accordingly. The theory will offer insights into the county government's response strategies and mitigation efforts during drought events.

Organizational Learning Theory, pioneered by Argyris and Schön (1978), provides a foundational framework for understanding how organizations acquire, interpret, and apply knowledge from past experiences to improve future performance (Argyris & Schön, 1978). This theory underscores the significance of continuous learning and adaptation within organizational contexts, emphasizing the dynamic process through which knowledge is generated, disseminated, and integrated into organizational practices. Critics of Organizational Learning Theory argue that it may overemphasize the importance of learning processes and overlook the structural and power dynamics within organizations. In the context of drought management, the Theory can offer valuable insights into the county government's evaluation processes and its capacity to learn from previous drought events (Gunderson et al., 2002). The Theory can inform strategies to enhance the county government's resilience to future drought events (Berkes & Folke, 1998). The county government can develop more robust drought management strategies, build partnerships with diverse stakeholders, and mobilize resources effectively to mitigate the impacts of droughts on communities and ecosystems.

Empirical Literature Review

Monitoring and Early Warning on Effectiveness of Drought Response

Deltares and Futurewaters (2017) worked on technical assistance on drought information and early warning systems aimed at providing technical and intuitional advice following the severe drought in 2016 in Bolivia that affected the country. It became evident that response to the drought event was different across the country as was shown by comparing La Paz/El Alto with Potosí water supply companies. Lack of communication and of a proactive attitude caused a slow response in La Paz/El Alto and all stakeholders agree that the impacts could have been considerably less severe if action was taken in an earlier phase. AghaKouchak et al., (2023) examined toward impact-based monitoring of drought and its cascading hazards. In this Perspective, the study advocate for impact-based drought monitoring and integration with broader drought-related hazards.

Sandstorm et al (2020) studied the Fluctuating Rainfall, Persistent Food Crisis— Use of Rainfall Data in the Kenyan Drought Early Warning Systems(EWSs), which have been developed to trigger timely action to disasters, yet persistent humanitarian crises resulting from hazards such as drought indicate that these systems need improvements. they focus their research on Turkana County in Kenya, where drought repeatedly results in humanitarian crises, especially regarding food insecurity. They recommended further steps

to be taken towards standardization of methodologies and cooperation between various institutions to ensure streamlining of approaches.Shilenje and Ojwang (2019) studied the role of Kenya Meteorological Service in early warning in Kenya. The methodology employed literature review. The study argues that early warning and weather information communication are essential elements of effective governance of weather risks through a well-developed warning system. The study recommends strengthening of the existing structures with respect to weather monitoring.

Preparedness and Planning on Effectiveness of drought response

Masinde (2018) studied An Effective Drought Early Warning System for Sub- Saharan Africa: Integrating Modern and indigenous approaches. The paper describes an effective drought early warning system that integrates indigenous and scientific drought forecasting approaches. The research applied correlational structured research to identify the similarities and differences between modern science and indigenous ways. Indigenous knowledge ensures that the system is relevant, acceptable and resilient. The system is anchored on a novel integration framework called ITIKI (acronym for Information Technology and Indigenous Knowledge with Intelligence).Haigh, et al (2023) examined planning strategies and barriers to achieving local drought preparedness. The study used a national survey of American Planning Association members (n = 537) to examine local planners' perceptions of drought planning strategies and barriers, as well as their jurisdictions' current and future drought-addressing plans. Explanatory factors included planner experience, communication with water managers and hazard planners, and factors characterizing the drought threat and capacity of their jurisdictions. The study found planners most amenable to collaboration with water conservation and hazard mitigation planning processes, somewhat amenable toward integrating drought into local land use plans and day-to-day policies, and less interested in undertaking standalone drought plans.

Tuitoek and Wausi (2018) looked at the effect of DEWS in drought mitigation and management in ASALs in Kenya using a descriptive research design, The findings indicated that DEWS have enabled a timely and useful provision of drought related information. The system ease of use has enabled capacity building among stakeholders, especially communities living in ASALs. Golicha and Wanyonyi (2018) while investigating the influence of pastoralists' drought management practices on their livelihoods in Isiolo North Sub-County, Kenya. found that most of the areas in Isiolo North Sub-County are frequently struck by drought and water scarcity, putting the pastoralists at a great drought disaster. The study deduces that the pastoralists are familiar with drought contingency planning. Drought relief strategy affects drought disaster risk reduction in Isiolo North. Pastoralists are knowledgeable about rehabilitation mechanisms as a mitigation strategy. The study recommends the need to enhance community communication and feedback mechanism.

Response and Mitigation on Effectiveness of drought response

Salmoral, Ababio and Holman (2020) evaluated how an intense drought in 2018 impacted the UK livestock sector and the responses adopted by key actors, though a combination of analysis of weekly agricultural trade publications and semi-structured interviews with livestock farmers. Drought impacts centred on feed and fodder availability, animal productivity and welfare, farm economics, and farmer well-being, with strong inter-

dependencies observed.

Most drought responses by farmers were reactive short-term coping strategies to address feed shortages, with three main strategies applied: management of available grazing and feed; selling livestock to reduce feed demand and to obtain income; and buying-in additional feed. Few longer-term adaptive measures were identified due to a range of constraints. Moving forwards, the UK livestock sector needs to convert the learning from the reactive measures implemented in 2018 into pro-active drought planning approaches. Vogel and Olivier (2019) researched on re-imagining the potential of effective drought responses in South Africa. In South Africa, droughts are regular occurrences presenting several opportunities to learn from and improve on drought risk reduction efforts. Recent extreme droughts, occurring over 20 years later, appear to have produced interventions that have taken place with little focused recollection of these past drought responses. The persistent truths of recurring drought, a failure to learn from the process of drought rather than the event, the problems of the scientific uncertainty linked to droughts and the usual crisis response to drought made by a select few, are all shown to be threats to ensuring adaptation to repeated droughts in the future.

Grover and Lucinda (2021) did an evaluation of the policy response to drought in the city of São Paulo, Brazil: an election cycle interpretation of effectiveness. Using microdata on household water consumption and a difference-in-difference design, they found out that that a penalty-based instrument induced household conservation behaviour but that a reward-based instrument did not. they examine why the reward-based instrument, which was both ineffective and expensive, was implemented at all. The study suggested explanation lies in political budget cycle theory. Exploratory tests imply that the reward-based instrument increased the share of votes to the incumbent governor. Penalty-based instruments are the technically effective drought response, but water sector decision makers in developing countries may need to contend with the distortionary effect of electoral cycles to implement them.

Ruwanza, Thondhlana and Falayi (2022) did a research progress and conceptual insights on drought impacts and responses among smallholder farmers in South Africa: a review. The study used three bibliographic databases (Scopus, Web of Science, and EBSCOHost) to search for peer-reviewed literature published on South Africa. In total, 18 articles were reviewed, and information on drought impacts and responses among smallholder farmers was analysed and synthesised. Although most of the reviewed papers identified several socio-economic (e.g., loss of livestock, income, and employment) and environmental (e.g., loss of grazing land and vegetation) impacts of drought, the identified impacts were rarely quantified, and there is a lack of analytical depth of these impacts. Smallholder farmers in South Africa implement several drought responses, and these were categorised based on (i) changes in local practices and lifestyles e.g., practising conservation agriculture, (ii) structural measures e.g., government relief programmes, and (iii) technical interventions e.g., rain harvesting.

None of the reviewed papers reported on the impacts of and responses to drought on smallholder farmers in urban settings. Overall, the review noted that the literature on

drought in South Africa lacks detailed quantification and analysis of drought impacts and responses, the urban drought context is poorly understood, and there is a lack of clarity on the distinction between adaptation and mitigation strategies. Improving understanding of drought impacts across a rural-urban gradient is important if responses are to effectively reduce smallholder farmer drought vulnerability.

Recovery and Rehabilitation on Effectiveness of drought response

Asawo and Wanyonyi (2021) studied the effect of drought early warning systems on vulnerability of Kenyans living in the ASALs. A comparison of the situation before and after introduction of DEWS, using multigroup Interrupted Time Series (ITS) analysis was undertaken. Data from the National Drought Management Authority (NDMA) database on the number of people facing food insecurity in the 23 ASAL counties of Kenya over the years was utilized. The study found that Turkana was the worst affected county in the ASALs with a 41 per cent increase in food insecure population before DEWS, and 20 per cent increase in food insecure population after DEWS. There was, however, a significant marginal reduction in number of people facing food insecurity in Turkana - a reduction of 20 per cent post-DEWS. DEWS effect was insignificant in the counties of Garissa, Marsabit, Isiolo, Narok, Samburu, Taita Taveta and Tana River. Two counties recorded a significant reduction in food insecure populations with the adoption of DEWS. Mandera recorded a 67 per cent reduction in food insecure populations over time after DEWS adoption, and Laikipia recorded a 45 per cent reduction in food insecure populations immediately DEWS were adopted. they concluded that DEWS are significant in reducing vulnerability levels of populations living in the ASALs, as illustrated from regression results. However, more effort is needed in increasing its effectiveness.

Engor (2019) studied drought early recovery strategies influencing sustainable livelihood options among households in Turkana Central Sub County, Kenya. The results indicated that drought has had a huge negative impact on the lives of pastoralists. Livestock mortality accounted for 51.5% of the effects of drought on pastoral households while shortage of food accounted for 25.5%. Water shortage and poor nutritional diets accounted for 20% and 3% of the effects of drought on livelihoods respectively. The study also revealed further that among the drought early recovery strategies used in the area, crop farming and provision of food for school going children were the most effective early recovery strategies as they addressed long-term needs.

Smith and Frankenberger (2022) researched on recovering from severe drought in the drylands of Ethiopia: Using Difference-in-Difference Propensity Score Matching (DID-PSM) in one of the first causal resilience evaluations, this paper demonstrates that, nevertheless, the resilience-strengthening interventions extended to project households had a positive impact on their ability to recover, serving to slow the decline in food security considerably. Delving deeper into how this impact was achieved, the paper finds that two programming approaches optimized resilience impacts. First, “Comprehensive Resilience Programming”, whereby interventions spanning multiple sectors were implemented simultaneously in the same geographical areas, made a major difference. Second, while interventions were mainly implemented at a systems-level (e.g., establishing veterinary pharmacies), many households made the decision to actively participate in

them. The paper finds that the impact on their resilience was far greater when they did so. The lessons for future resilience projects are that greater impacts can be achieved by taking advantage of the synergies induced when interventions are layered cross-sectorally.

Evaluation and Learning on Effectiveness of drought response

Balint et al. (2019) developed a drought monitoring methodology for Kenya and the Horn of Africa that could measure the natural components of droughts by comparing the prevailing situation to the multiyear average situation in a year at a given place. A statistical approach that combines different parameters to an index, the CDI, was developed. According to the study, the index could clearly trace the footprints droughts in Kenya, had the potential to give short-term early warning up to the end of the season, had the potential for use in climate trends and climate change analysis, and the results were supported with drought reports in the country. Deltares and Futurewaters (2017) study underscored the critical role of evaluation and learning following the 2016 drought in Bolivia. It emphasizes the importance of continuous improvement and adaptation in response strategies to mitigate the impacts of future drought events. The research highlights the need to incorporate lessons learned into future planning and preparedness efforts, thus enhancing the overall effectiveness of drought response mechanisms.

Tuitoek and Wausi (2018) their study on the impact of drought early warning systems (DEWS) in Kenya's Arid and Semi-Arid Lands (ASALs), Tuitoek and Wausi emphasize the significance of evaluation and learning in improving the effectiveness of DEWS. Through assessing the performance of DEWS in providing timely information and capacity building among stakeholders, the research underscores the importance of incorporating feedback and lessons learned into the enhancement of early warning systems, thereby enhancing their ability to respond effectively to drought events.

Sandstorm et al. (2020) focus on the utilization of rainfall data in Kenya's early warning systems, highlighting the crucial role of evaluation and learning in enhancing response capabilities. The study stresses the need for standardization and cooperation between institutions to improve the effectiveness of early warning systems. By evaluating existing methodologies and identifying discrepancies in data usage, the research aims to inform improvements in response strategies and coordination mechanisms, thus contributing to more efficient drought response efforts.Asawo and Wanyonyi (2021) examined the effect of DEWS on vulnerability levels in Kenya's ASALs, Asawo and Wanyonyi highlight the role of evaluation and learning in enhancing the effectiveness of DEWS. Their study indicates significant reductions in food insecurity in certain counties post-DEWS adoption.

Van Ginkel and Biradar (2021) explored drought early warning in agri-food systems, emphasizing the importance of evaluation and learning in improving response effectiveness. Their study highlights successful examples of early warning systems in mitigating the impacts of droughts on agriculture and food security.

Summary of Research Gaps

The reviewed studies on drought response and mitigation offer valuable insights into monitoring, preparedness, response, recovery, and evaluation strategies (Deltares & Futurewaters, 2017; Tuitoek & Wausi, 2018; Sandstorm et al., 2020; Asawo & Wanyonyi, 2021; van Ginkel and Biradar, 2021). However, they also reveal several research gaps that necessitate further investigation, aligning with the objectives of the present study.this includes there remains a significant gap in understanding the socio-economic impacts of these systems, particularly in vulnerable regions like Sub-Saharan Africa and the Horn of Africa. Additionally, there is a dearth of studies evaluating the long-term effectiveness and sustainability of drought early warning systems, including their adaptability to changing climatic conditions and socio-economic contexts.

There is a need for more holistic assessments considering the interconnectedness of environmental, economic, and social factors in shaping drought resilience and adaptation. Furthermore, the limited research on the effectiveness of policy interventions and governance structures in supporting drought-affected communities, underscores the importance of exploring the role of Preparedness and Planning on effective drought response by the Baringo County Government, Kenya. Lastly, the lack of studies exploring the role of indigenous knowledge systems and traditional coping mechanisms in drought resilience highlights the need for a comprehensive examination, aligning with the objective of the present study to examine the effect of Recovery and Rehabilitation on effective drought response by the Baringo County Government, Kenya. While the existing research provides valuable insights, addressing these research gaps is crucial for enhancing drought resilience efforts. This study aimed to contribute to filling these gaps by exploring how assessment of drought early warning information can lead to effective response strategies in the context of the Baringo County Government, Kenya

CONCEPTUAL FRAMEWORK

According to Walliman (2017), a conceptual framework is a diagrammatical representation That shows the relationship between independent variables and dependent variables. Figure 1 shows the conceptual framework for this study.

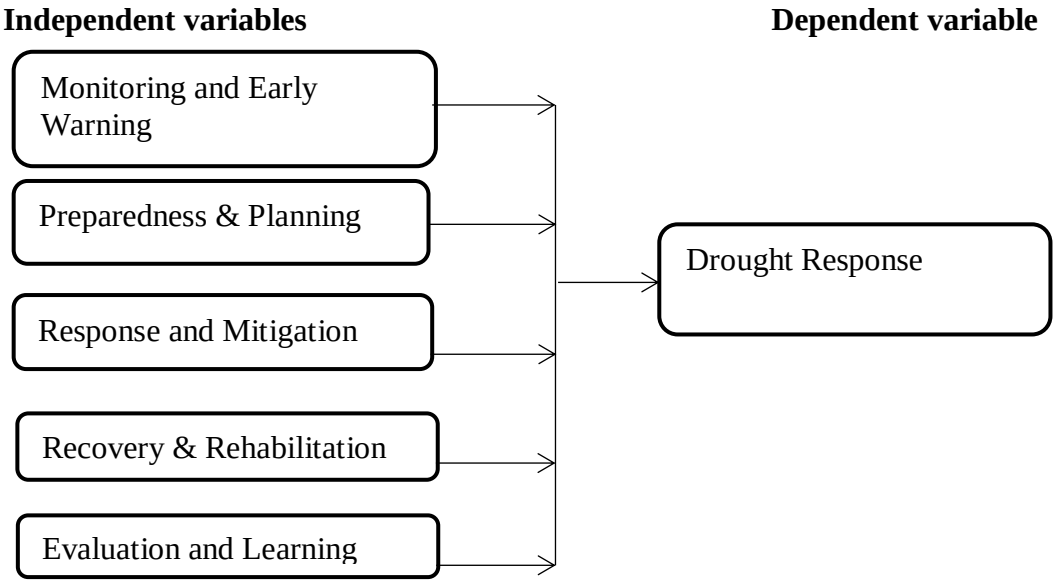

Figure 8: Conceptual Framework

RESEARCH METHODOLOGY

This study used a cross-sectional survey design. It was employed to collect data on indicators that describe the variables, which was to be done through sampling of the respondents. This study targeted 59 officials from the Directorate of Disaster Management in the Baringo County Government. They play a key role in formulating policies, implementing strategies, and coordinating response efforts related to drought management. They were therefore the ideal population to provide information needed for the study. Table 1 below provides the study population.

Table 1: Target Population

Category	Frequency
Top Manager	1
Middle Level Managers	8
Junior Staff	50
Total	**59**

Due to the small size of the target population, census sampling technique was adopted. The sample size for the study was 59 respondents. Data was collected using a self-administered semi-structured questionnaire. A five-point Likert scale was used to measure all variables. The lowest rating of 1 signifies a low opinion by respondent while a high rating of 5 signifies a high rating by the respondents. The semi-structured questionnaire used included both open-ended and closed-ended questions and consisted of two parts. First part captured respondents' socio-demographic data, while the second part was divided into five sections.

Sections two to four covered the four independent variables, and section five pertains to the dependent variable.The questionnaire in this study was carefully prepared, underwent appropriate editing, and received assessment from the researcher's supervisors to ensure its validity and reliability (Singpurwalla, 2017).

A pilot test was conducted on 5 individuals representing 10% of study sample and was selected randomly from the target population and excluded from the final study to determine validity and reliability of the data collection instrument. According to Mugenda and Mugenda (2017) the pretest sample should be between 1% and 10% depending on the sample size. The data collected from the pilot group was used to test for validity and reliability of the questionnaire. The current study used content validity. Cronbach's alpha coefficient was used to test the reliability of data. Cronbach's alpha whose range is between 0 and 1 measures internal consistency and the extent of the relationship between the set of items in a group. It also quantifies scale reliability (Kultar, 2017). If the alpha coefficient is high then there is high reliability among the items under study. An acceptable value of Cronbach alpha is 0.7 or more, a value that is lower than 0.7 is questionable (Singpurwalla, 2017).

The actual study data was collected by research assistants who were trained and used the drop and pick later technique where respondents were allowed two weeks to fill in the questionnaires. Data obtained from the field were coded, cleaned, and entered into the computer for analysis using the SPSS version 28. Descriptive statistical included frequency, percentages, mean and standard deviation. Inferential statistical analysis used was multiple regression and correlation analysis. The significant of each independent variable was tested at a confidence level of 95%. he multiple regression model was as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where;

Y = dependent variable (Effectiveness of drought response by Baringo County Government)
X_1 = Monitoring and Early Warning
X_2 = Preparedness and Planning
X_3 = Response and Mitigation
X_4 = Recovery and Rehabilitation
X_5 = Evaluation and Learning
β_0 = the constant term
β_{1-5} = the Beta coefficient
ε = the error term

RESEARCH FINDINGS

The study recorded a response rate of 90.7%, which is considered excellent according to Sekaran and Bougie's (2016) criteria. They suggest that a response rate of 50% or above is adequate, 60% or above is good, and 70% or above is excellent for analysis.

Monitoring and Early Warning on Effectiveness of Drought Response

The descriptive statistics for the statements regarding monitoring and early warning indicating a general agreement among respondents supported by the aggregate mean score is 3.839, with a standard deviation of 0.805. This suggests a positive perception of the effectiveness of monitoring and early warning systems in enhancing drought response. These findings align with the work of Deltares and Futurewaters (2017), which emphasized the importance of robust early warning systems in providing timely information and reducing drought impacts through improved preparedness. Similarly, AghaKouchak et al. (2023) advocated for impact-based monitoring to link drought conditions with physical and societal impact, highlighting the critical role of accurate and timely monitoring in effective drought management. The agreement among respondents in this study underscores the necessity of continuous investment in monitoring and early warning infrastructure to bolster community resilience and mitigate the adverse effects of droughts.

Preparedness and Planning on the Effectiveness of Drought Response

The findings from descriptive statistics for preparedness and planning indicate general agreement that preparedness measures enhance response effectiveness. The aggregate mean score of 4.019 (SD = 0.736) indicated that respondents generally agreed on the significant impact of Preparedness and Planning on the effectiveness of drought response by the Baringo County Government, Kenya. This consensus aligns with the findings of Masinde (2018), who emphasized the integration of modern and indigenous approaches in drought early warning systems to ensure relevance, acceptance, and resilience in preparedness efforts. Furthermore, Haigh et al. (2023) highlighted the critical link between local planning strategies and enhanced drought preparedness, noting that comprehensive response plans and stakeholder involvement are essential for effective coordination and resource allocation.

Response and Mitigation on Effectiveness of Drought Response

The findings, supported by an aggregate mean score of 4.041 (SD = 0.768), indicate that respondents agreed on average that response and mitigation significantly affect the effectiveness of drought response by the Baringo County Government, Kenya. This agreement is consistent with the research by Salmoral, Ababio, and Holman (2020), who found that proactive response actions, such as efficient resource management and stakeholder collaboration, are crucial in mitigating the socio-economic impacts of drought. Similarly, Vogel and Olivier (2019) emphasized the need for comprehensive and coordinated drought response strategies to enhance resilience and reduce vulnerability to droughts.

Recovery and Rehabilitation on Effectiveness of Drought Response

The aggregate mean score of 4.090 (SD = 0.747) shows that respondents generally agreed that Recovery and Rehabilitation significantly affect the effectiveness of drought response by the Baringo County Government, Kenya. This consensus is in line with the findings of Smith and Frankenberger (2022), who highlighted the importance of comprehensive resilience programming in helping communities recover from severe droughts, thereby enhancing their ability to withstand future shocks. Additionally, Engor (2019) emphasized that effective recovery strategies, including crop farming and provision of food for school-going children, are crucial for sustainable livelihoods and long-term resilience in drought-affected regions. These studies support the

respondents' views in the current study, underscoring the necessity of robust recovery and rehabilitation efforts to restore ecosystems, support livelihoods, and build community resilience against future drought events in Baringo County.

Evaluation and Learning on Effectiveness of Drought Response

The findings from descriptive analysis showed that the aggregate mean score was 4.124, with a standard deviation of 0.702 which showed that the respondents agreed on average that evaluation and learning affect drought response by Baringo County Government, Kenya. The findings in Table 1 below showed that the respondents agreed on average that regular evaluation helps identify strengths and weaknesses (M= 4.131, SD= 0.702); that learning from past events enhances future response strategies (M= 4.148, SD= 0.692); that feedback mechanisms from stakeholders contribute to improvement (M= 4.120, SD= 0.713); and that adaptation of response strategies based on evaluation leads to better outcomes (M= 4.127, SD= 0.701). They further agreed that knowledge sharing among stakeholders facilitates collective learning (M= 4.142, SD= 0.683); that incorporating community feedback improves response relevance (M= 4.089, SD= 0.723); and that evaluation and learning contribute to community resilience (M= 4.110, SD= 0.699)

Table 2: Descriptive Statistics

Statement	Mean	Std. Dev.
Regular evaluation helps identify strengths and weaknesses.	4.131	0.702
Learning from past events enhances future response strategies.	4.148	0.692
Feedback mechanisms from stakeholders contribute to improvement.	4.120	0.713
Adaptation of response strategies based on evaluation leads to better outcomes.	4.127	0.701
Knowledge sharing among stakeholders facilitates collective learning.	4.142	0.683
Incorporating community feedback improves response relevance.	4.089	0.723
Evaluation and learning contribute to community resilience.	4.110	0.699
Aggregate Score	**4.124**	**0.702**

The aggregate mean score of 4.106 (SD = 0.755) suggests a strong consensus among respondents that these factors are crucial for effective drought response by the Baringo County Government, Kenya. These results support the findings of Salmoral, Ababio, and Holman (2020), who argue that effective drought management requires timely and well-coordinated responses that adequately address the needs of affected communities while ensuring that resources are efficiently allocated and stakeholder engagement is prioritized. Their research highlights how timely and effective responses are critical for mitigating the impacts of drought and building community resilience. Additionally, Vogel and Olivier (2019) emphasize the importance of comprehensive and coordinated drought response strategies to enhance resilience and reduce vulnerability to droughts. These studies underline the importance of timely and effective mitigation measures, which resonate with the respondents' perspectives in the current study.

Correlation Analysis

The correlation analysis revealed a significant positive correlation between the effectiveness of drought response and Monitoring and Early Warning ($r = 0.658$, $p < 0.05$). This suggests that improvements in monitoring and early warning systems are associated with enhancements in the effectiveness of drought response. Similarly, the analysis showed a significant positive correlation between the effectiveness of drought response and Preparedness and Planning ($r = 0.703$, $p < 0.05$). which supports the assertions by Haigh et al. (2023), who highlighted that comprehensive preparedness and planning efforts, including regular reviews and stakeholder involvement, are critical for effective drought management.

In terms of Response and Mitigation, the study found a significant positive correlation with the effectiveness of drought response ($r = 0.715$, $p < 0.05$). This is consistent with the findings of Salmoral, Ababio, and Holman (2020), who pointed out that prompt response actions and effective mitigation strategies significantly reduce the socio-economic impacts of drought. The analysis also revealed a significant positive correlation between Recovery and Rehabilitation and the effectiveness of drought response ($r = 0.731$, $p < 0.05$) which aligned with the work of Smith and Frankenberger (2022), who noted that effective recovery and rehabilitation efforts are crucial for building community resilience and ensuring sustainable livelihoods post-drought. Finally, the correlation between Evaluation and Learning and the effectiveness of drought response was also significant and positive ($r = 0.742$, $p < 0.05$). This is in line with the research by Asawo and Wanyonyi (2021), who emphasized that continuous evaluation and learning from past drought events enhance the overall effectiveness of future response strategies.

In summary, the correlation analysis has established significant positive relationships between the effectiveness of drought response and various factors such as Monitoring and Early Warning, Preparedness and Planning, Response and Mitigation, Recovery and Rehabilitation, and Evaluation and Learning. To gain further insights into the individual effects of these variables, regression analysis was employed. This provided a comprehensive understanding of how these factors contribute to the effectiveness of drought response by the Baringo County Government, Kenya.

Multiple Regression Analysis

Multiple regression analysis was used to establish the effect of Monitoring and Early Warning, Preparedness and Planning, Response and Mitigation, Recovery and Rehabilitation, and Evaluation and Learning on the effectiveness of drought response by Baringo County Government, Kenya. The findings returned an R-squared value of 0.769, suggesting that 76.9% of the variation in the effectiveness of drought response can be explained by changes in Monitoring and Early Warning, Preparedness and Planning, Response and Mitigation, Recovery and Rehabilitation, and Evaluation and Learning. This finding highlights the substantial influence of these variables on the effectiveness of drought response. However, it also suggests that there are other factors beyond the scope of this study that contribute to the remaining 23.1% of the variation in response effectiveness. The strong and positive relationship among the study variables is further supported by the correlation coefficient (R) of 0.877 which is significant, demonstrating a robust and positive relationship between the variables.

This result aligns with previous literature emphasizing the importance of effective monitoring, preparedness, and evaluation in achieving favorable drought response outcomes (Deltares & Futurewaters, 2017; Haigh et al., 2023). It confirms that these factors are closely interconnected and collectively contribute to enhanced drought response effectiveness. Analysis of Variance (ANOVA) was conducted to determine the fitness of the model in predicting the dependent variable (effectiveness of drought response). The findings indicated by Prob>F (5, 43) = 0.000, was lower than the conventional threshold of 0.05 suggesting that the model, with its inclusion of Monitoring and Early Warning, Preparedness and Planning, Response and Mitigation, Recovery and Rehabilitation, and Evaluation and Learning, is capable of predicting drought response effectiveness.

These findings concur with research by Deltares and Futurewaters (2017), which emphasized the importance of monitoring and evaluation in enhancing drought response performance, as well as that of Haigh et al. (2023), which highlighted the positive impact of preparedness and planning on drought response success. Additionally, beta coefficients were used to fit the regression model where Y is the effectiveness of drought response; X_1 is Monitoring and Early Warning; X_2 is Preparedness and Planning; X_3 is Response and Mitigation; X_4 is Recovery and Rehabilitation; and X_5 is Evaluation and Learning. The results was;

$Y= 0.241 + 0.189X_1 + 0.218X_2 + 0.156X_3 + 0.279X_4 + 0.303X_5$

The findings showed that holding all variables constant at zero, the effectiveness of drought response would be 0.241. The constant ($\beta= 0.241$) was significant at the 0.05 significance level ($P= 0.019$).

Monitoring and Early Warning, had a beta value of 0.189 meaning that for every one-unit increase in Monitoring and Early Warning, there is an expected increase in the effectiveness of drought response by 0.189 units. This coefficient is statistically significant at $p < 0.05$ (sig. = 0.014), indicating a positive relationship between Monitoring and Early Warning and drought response effectiveness.

Preparedness and Planning, the beta value of 0.218 suggests that an increase in Preparedness and Planning by one unit corresponds to a 0.218 unit increase in drought response effectiveness. This coefficient is also statistically significant at $p < 0.05$ (sig. = 0.012), indicating a positive and significant relationship between Preparedness and Planning and drought response effectiveness.

Regarding Response and Mitigation, the beta value of 0.156 implies that a one-unit increase in Response and Mitigation is associated with a 0.156 unit increase in drought response effectiveness. This coefficient is statistically significant at $p < 0.05$ (sig. = 0.018), indicating a positive and significant relationship between Response and Mitigation and drought response effectiveness.

For Recovery and Rehabilitation, the beta value of 0.279 suggests that a one-unit increase in Recovery and Rehabilitation is associated with a 0.279 unit increase in drought response effectiveness. This coefficient is statistically significant at $p < 0.05$ (sig. = 0.009), indicating a strong positive relationship between Recovery and Rehabilitation and drought response effectiveness.

Lastly, Evaluation and Learning demonstrates the highest beta value of 0.303, suggesting that a

one-unit increase in Evaluation and Learning is related to a substantial 0.303 unit increase in drought response effectiveness. This coefficient is highly statistically significant at $p < 0.05$ (sig. = 0.006), indicating a strong positive relationship between Evaluation and Learning and drought response effectiveness.

CONCLUSION

This study sought to assess the impact of drought early warning information on the effectiveness of drought response in Baringo County Government, Kenya, guided by five specific objectives namely; to examine the effect of Monitoring and Early Warning on effective drought response; to determine the effect of Preparedness and Planning on effective drought response. To assesse the effect of Response and Mitigation on effective drought response; and lastly; To examine the effect of Recovery and Rehabilitation on effective drought response. The study concludes that Monitoring and Early Warning systems significantly enhance response preparedness and facilitate timely decision-making during drought events; That adequate preparedness measures and comprehensive response plans significantly contribute to better coordination and resource allocation during drought events; That prompt response actions and effective mitigation measures are essential in alleviating the socio-economic burden of drought; that effective recovery measures and rehabilitation efforts play a vital role in helping communities bounce back quickly after drought events. Lastly, the study concludes that regular evaluation of response efforts and learning from past drought events significantly enhance the effectiveness of future response strategies.

RECOMMENDATIONS

Based on the findings of this study, several recommendations were made. Firstly; Further research should focus on developing and refining early warning systems tailored to the specific climatic and socio-economic conditions of Baringo County. Studies should also investigate the long-term impacts of current drought response strategies to identify areas for improvement and innovation. At a policy level, policymakers should prioritize the allocation of resources for the development and maintenance of advanced monitoring and early warning systems. Effective policies should be established to ensure that these systems are continuously updated and integrated into the county's disaster management plans. There is need to build the capacity of local communities to respond to drought events through targeted training and awareness programs. Educational institutions should incorporate modules on drought management and resilience into their curricula, particularly in areas prone to drought.

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