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Importance of Climate Change Adaptation in Drought Mitigation: A Review

Gana, A. H. and Sa'id, A. I.
Department of Biological Sciences, Yobe State University, Damaturu, Nigeria
Corresponding Authors Email: hassangana09@gmail.com

Abstract

Climate change is an ongoing challenge that creates a range of environmental challenges that countries will have to grapple with in the coming decades. Droughts will definitely occur, but climate change has largely exacerbated hydrological trends, making droughts start more rapidly and more intensely. This study looked at the measures and tactics used in South Africa, Australia, Mexico, Spain, and the United States to lessen the effects of drought. Adapting to climate change offers an opportunity to rethink some of the outstanding issues of tragedy reduction and ecosystem growth. This helps mitigate future climate change impacts and embrace options for such adaptation to climate change. The main impacts of climate change on drought vulnerability are public-based awareness-raising, revised timeframes and drought forecasting approaches, improved preparedness with a focus on drought monitoring and the creation of early warning systems, and all similar preparations are combined at the input level. Moreover, reactive approaches to drought remain prevalent in many countries, despite emergency funding being expensive, ineffective and failing to address long-term sources of vulnerability and lack of support. There is therefore an urgent need for a paradigm shift from crisis management to risk management, adopting a proactive approach based on standard risk mitigation and prevention. Additional efforts to embed local adaptation strategies into policies may increase local resilience to environmental change while contributing to broader development goals.

Key words: Climate Change, Drought, Mitigation and Adaptation

INTRODUCTION

The physical variations in the climate are caused by the interaction of economic, environmental, political, and social influences, making it a complex system (Muralikrishnan *et al.*, 2022). Industrialization is responsible for the release of greenhouse gases (GHGs), which have caused an average increase in atmospheric temperature of 0.07ºC per decade since 1880. Since 1981, this average rate has doubled (0.18ºC), accelerating the problems associated with global warming and climate change (IPCC, 2013). Numerous climate-related dangers, including storms, floods, droughts, hot summers, extreme heat waves, modest cool weather occurrences, and other extreme weather events, are brought on by climate change challenges (Swaminathan and Kesavan, 2012; Bana *et al.*, 2014).

The drought is the most severe natural hazard caused by climate change in terms of the number of people it directly affects, primarily in Asian, African, and Sub-Saharan countries (Lal, 2007). A drought is a period of time when an area or region experiences insufficient rainfall and precipitation that is below average. It causes the soil's moisture level to drop, as well as surface and underground water storage levels (Dass *et al.*, 2014).

Drought is one of the recorded intricate hydro-environmental threats affecting the world as it is very challenging to measure its severity (Wilhite and Pulwarty, 2017), and to evaluate its effects given the great number of systems affected and academic involved (Wilhite *et al.*, 2000). The challenge of describing and determining drought severity makes it tedious to determine the inception and end of a drought and the spatial degree of the occurrence (Mishra and Singh, 2010). Drought effects are usually linked to the agriculture and water resource sectors. They may cause substantial economic losses in the agricultural sector of developed nations through declines in crop yield or complete failure of harvests (Sweet *et al.*, 2017; Tian *et al.*, 2018). In worst cases, they can also lead to human relocation and famine in developing nations (Grolle, 2015). Hydrological droughts may also cause substantial problems to irrigated agricultural systems (Vidal-Macua *et al.*, 2018) and problems for urban water supply, industrial needs, reductions of hydropower production, etc. (Jerez *et al.*, 2013).

Adaptation to Climate Change

Adapting to climate change has been a challenge in recent years (Clemens *et al.*, 2016). Adaptation is referred to as the changes or adjustment to systems in response to unexpected climate stimuli and their impacts. Stabilising global emission through proper international framework will mitigate the impacts of global warming, considering a possible temperature increase of - 4ºC by 2100 (Adger and Barnett, 2009; Smith *et al.*, 2009). Most adaptation challenges are not considered new as previously humans have survived different hardships and have lived with climate variability. Climate change is a reality that societies, organisations and individuals have adjusted to, in the past. However, many are now contemplating to alter future climatic conditions through proactive measures (Adger *et al.*, 2005). Adaptation comprises of actions from different aspects of society, individuals, groups and governments (Smit *et al.*, 2009). Adaptation can be encouraged due to many factors, for example, protecting economic well-being and improving people and environmental safety to meet sustainable growth (Adger, 2003). Climate change adaptation can be undertaken or initiated by individuals, groups and governments. General inclusiveness is also important in climate change adaptation; hierarchical actions play a vital role at all levels (Adger *et al.*, 2005). Individuals and groups can play a role but there are restrictions to their commitments, due to institutional processes and regulations.

Stakeholder Roles in the Adaptation Strategy

From an economic standpoint, there are three primary roles for governments and the public sector. These are the roles that they play: The stabilization of the economy, facilitation of the effective distribution of goods and services, such as stable conditions for the environment, education, and security, and adequate income distribution (Aakre *et al.*, 2010). Government plays a crucial role in ensuring that all laws and predetermined rules are observed. However, government adaptation policy ought to at the very least incorporate these four goals: (i) Improve infrastructure robustness, (ii) Susceptible management systems' flexibility and adaptability, (iii) Trends that create vulnerability are reversed, and (iv) Awareness and readiness are raised (Klein and Tol, 1997). According to Berkhout (2005), there is no need for governments to influence climate change adaptation when there is a strong reason for taking mitigation measures to safeguard public goods like climate systems. However, Berkhout (2005) added seven more goals for addressing public climate change, some of which overlapped those put forth by Klein and Tol (1997). These include providing information to those who may be at risk, helping with disaster relief, offering incentives for adaptation, mainstreaming climate-proofing public policy, planning and regulating long-term infrastructural assets to lessen future vulnerabilities, regulating adaptation, and making up for the uneven distribution of climate impacts.

Government's Exposure to Climate Change

Studies highlighted that governments become exposed to climate event risks because they provide public good and services, which tend to make them vulnerable. There is a need for other sectors, such as the private sector to also intervene in risk and post-event management. On the other hand, governments are referred to as *insurers* as the last resort (Dass *et al.*, 2014). It is also regarded as the most effective insurance instrument of society, because they are the final alternative for an exposed private sector to acquire for post-event and pre-event compensation (Aakre *et al.*, 2010).Governments are exposed to risk due to expenditure on members of the public in need of support after disaster event(s). During post-events, poor people and those at risk of falling into poverty need support from government relief to enable them maintain basic living standards (Smit *et al.*, 1999). Countries with low income and resource constraints face difficulties during and after climate-related disaster. The challenges also affect budgets and preparedness (Stern, 2007).

Investment in Climate Sensitive Infrastructure

Due to increasing climate-related events there is a need to consider climate change in future infrastructure investments (Iglesias *et al.*, 2009). Many decision-making processes mostly consider short-term consequences of climate change, they should also be climate-sensitive as well (Carter *et al.*, 2007). For example, buildings, roads, water systems and other ecological defence systems should be climate-sensitive. During the design and initiation of projects, all stakeholders, architects, engineers, builders and decision-makers should be climate sensitive (Carter *et al.*, 2007).

Future climate might have significant impacts on infrastructure, which in turn cost fortune to adjust and reconstruct. Investing in climate sensitive infrastructure may be difficult and expensive in the short-term, but can make a difference in the long term (Hallegatte, 2009). There has been increased awareness recently on climate sensitive investments in infrastructure. The new awareness and positive shift in this direction has its challenges.

Inadequate climate knowledge, information and cost are challenges to decision-makers and climate scientists (Carter *et al.*, 2007). Even though there is strong belief that knowledge on climate will improve in the future. Robust climate models are required to achieve the positive outcome of the new paradigm (Hallegatte, 2009).

Challenges of Drought Proactive Preparedness

Droughts pose socioeconomic problems in many sectors because of their harmful nature and spatial and temporal variability (Hill *et al.*, 2014). The impacts of most droughts vary in detail and also depend on systems such as community and agricultural sector vulnerability and vulnerability to damage. This affects their ability to mitigate damage and prepare for drought recovery actions. Increased adaptability means less vulnerability and vice versa (Smit and Pilfosova, 2003). System adaptability can be affected by resource and livelihood choices. This indicates that each system experiences drought differently and has different adaptation strategies. Drought preparedness methods, capacities and strategies vary from system to system (Rusca *et al.*, 2012; Hill *et al.*, 2014). Traditional crisis management approaches are being challenged by extreme drought and severe uncertainties surrounding future climate and water resources, necessitating the adjustment of proactive management approaches. In order to mitigate extreme drought more effectively, a proactive approach to involving all stakeholders in the planning process should be emphasized. This ensures that the best possible solution is accepted by all involved.

- It is difficult for all stakeholders to consider all the factors that affect drought preparedness.
- It is also difficult to plan for severe droughts based on the experiences and records of victims.
- Difficult due to sporadic droughts. As such, it is difficult to manage due to time and financial constraints (Rusca *et al.*, 2012).

The Importance of Land Use Management in Drought Countermeasures

Population growth, increased demand for freshwater resources and severe drought threaten global food security (Lei *et al.*, 2016). With its fragile natural environment and densely populated rural communities in northern China, recurring severe droughts threaten food security. This has significant implications for socio-economic sustainability, leading to higher production costs, lower productivity, crop damage and increased poverty. As climate change increases, it is important to explore potential avenues for effective drought risk solutions to reduce rural poverty. A number of studies have examined the role of land use management as an adaptation strategy to mitigate the impact of drought on agriculture (UNISDR, 2011). During severe climatic droughts, poor land-use practices can amplify drought impacts, while good land-use practices can increase productivity and reduce losses (Zhou *et al.*, 2014).

In Malaysia and South Africa, land use management is considered one of the strategies for adapting to climate change. Better adapted crop varieties, altered planting times, and altered farming styles have shown positive results in terms of adaptation planning to drought and climate change (Bryan *et al.*, 2009). The Chinese government has implemented reforestation projects across the country as a drought and climate mitigation measure, which has yielded environmental benefits (Zhou *et al.*, 2014). However, these large-scale climate change and drought adaptation strategies can adversely affect socioeconomic factors and destabilize the livelihoods of local farmers. Research into eco-friendly adaptation measures is important for future climate change to mitigate the effects of drought (Lei *et al.*, 2016).

The Need for National Drought Policies

National drought policies need to be established to provide guidelines for managing drought and monitoring its impacts (Wilhite, 2016). Crisis management approaches have delivered poor results for decades, so more emphasis needs to be placed on preventative or risk management approaches. This should be guided by the application of appropriate precautions and mitigation measures (HMNDP, 2013). The complexity of droughts and their impacts, combined with multiple climatic and socioeconomic factors, determine the level of societal resilience (Wilhite, 2016). Factors such as poor soils, poor water management, poverty, rural vulnerability, population growth, changing consumption patterns, climate change and land-use change can exacerbate the impacts of drought-affected areas. There is a nature. Adopting drought policies can help establish guidelines and clear principles for drought management by identifying preparedness and mitigation strategies (HMNDP, 2013). Drought mitigation requires the use of all components of the disaster management cycle (risk and crisis management), not just crisis management (Figure 1).

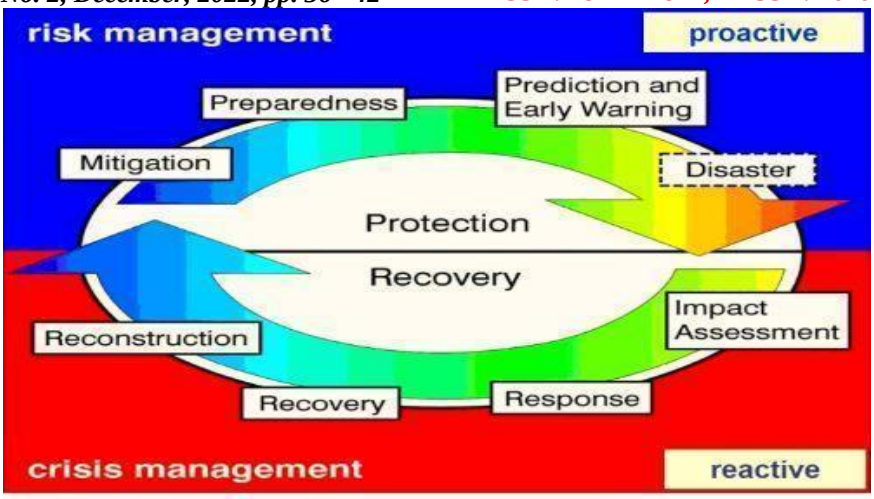

Figure 1: Disaster Management Cycle **Source**: Wilhite (2016).

All rules need to deliver extra emphasis to decreasing danger thru setting up ok attention and expertise reasons of drought vulnerability. They need to encompass strategies of higher expertise the proactive technique adoption that can enhance societal resilience. Shift from conventional strategies of disaster control to danger control, may be completed with the aid of using enhancing seasonal climate forecasts, incorporated tracking and early caution systems. Drought professionals recommend that preparedness need to be deliberate in any respect levels, as a part of the mitigation procedure which creates protection internet for remedy and emergency reaction (HMNDP, 2013).

Challenges of Drought Preparedness

Preparedness is an essential issue of catastrophe control methods and its development is crucial (Wilhite, 2016). For example, drought has passed off within side the sub-Saharan Africa which affected over forty million human beings throughout the place within side the 1980s. New coping techniques want ok early caution systems, which may be hard because of drought variability, tempo and importance of modifications in unique areas. Some of the constraint of preparedness is loss of methodologies for policy-makers and planners for correct steerage of suitable making plans methods (Wilhite et al., 2000). Characteristics of drought range regionally, for this reason making preparedness making plans hard.

Importance of Early Warning Systems in Decision Making

Early Warning System (EWS) is device of facts series to display human beings accessibility to meals, with the intention to offer well timed records of viable meals disaster threats (Buchanan-Smith, 2000). The device need to offer this record, however whether or not it succeeds relies upon on many factors, specifically the decision-making procedure (NDPC, 2000). Mostly drought inclined and meals-insecure international locations have a tendency to rely extra on authorities donations in the course of the making plans procedure for viable droughts. However, others sectors additionally want to take part within side the procedure, for example, industrial traders, farmers and NGOs. Using EWS on my own in the course of making plans is in powerful and insufficient. The EWS need to be capable of causing well timed reaction for intervention earlier than the disaster takes place to shield threatened lives and livelihoods (Davies *et al.*, 1991). Furthermore, the device need to be capable of shield destiny intake capability and preserve present day status. However, in latest years each NGOs and authorities companies have collaborated in joint exams if you want to minimise distrust and harmonise responses to imminent crises (Buchanan-Smith, 2000; NDPC, 2000). An early caution device needs to contain of the following;

- Meteorological records.
- Agricultural records.
- Price traits of meals and feed.
- Availability of ingesting water.
- Household vulnerability.

EWS offer records of droughts on-set, continuation and termination to decision-makers in any respect levels. Many professionals recommend that EWS need to know no longer be a procedure of facts series and evaluation as a lead to itself, however be seemed as a procedure inside drought mitigation techniques (Monnik, 2000). Drought EWS need to additionally consciousness at the vulnerability of farmers and negative rural communities. The vulnerability profile of a place or vicinity presents decision-makers with most records and route of powerful responses to a catastrophe (Monnik, 2000).

The Importance of Monitoring Drought Indicators

Drought mitigation is primarily achieved through an integrated approach of proactive and reactive measures to reduce risks and impacts. Dedicated drought systems for monitoring indicators are important for predicting risks in both short-term and long-term management (Andreu *et al.*, 2013).

Researchers see drought risk management as an ongoing process that follows the disaster management cycle, with proactively planned actions to prepare for future drought events and reactive emergency response when droughts begin. Equipped with behaviour (Rossi, 2000; Kampragou *et al.*, 2011). Active drought risk management then includes implementing mitigation measures, improving preparedness for future drought events, and establishing and improving early detection systems for drought events. Ex-post drought risk response includes conducting impact assessments during and after a drought event, understanding response actions in affected areas, and remediating drought damage (Wilhite *et al.*, 2000).

DISCUSSION

It is important to understand the threats pose by intensifying climate change in future, where this showcases the need for shift to climate change adaptation strategies. All regions around the world have their peculiar climate and weather related issues and threat that needs proper attention and mitigation. Many studies and scholars have emphasis on the current practices and how shift from the usual strategies to new paradigm will decrease future climatic threat on biodiversity, economic growth and the environment (Iglesias *et al.*, 2009). Countries and regions have been making efforts in recent years, as the number of climate and weather related events have more than double in last three decades compared to the non-climate related (HMDP, 2013). This has prompted EU to seek for possible climate adaptation measures and even considering climate sensitive project implementation in the future. For example, during the COP21 summit in Paris November 2015 many countries have pledge to take measures in order to reduce activities that threatens the future climate cutting the amount of carbon emission and forest deforestation. These are issues that cause frequency of weather related events (e.g. drought, flood and hurricane storms).

Among resources in stress due to the changing environment and climate is water. All ecosystems require and need this resource in order to function (Dass *et al.*, 2014). Recently, there are many problems of water scarcity and crises in every region of earth. Droughts have caused high human and environmental refugees in recent years than any other in time the history of mankind. This disaster has caused more death than any natural disaster in the 2nd half of the 20th century (Wilhite 2016). This posed the need for shift from reactive or crisis management measures to more proactive measures. Countries such as Australia, Mexico and Spain have implemented policy to reduce the impacts of drought and other water related crisis in their countries. Scholars have highlighted the importance of the shifts and steps in order to mitigate future climate impacts.

CONCLUSION

Adaptation to climate change is important because it prepares communities, organisations, nations and regions to unexpected climate change shock. This is a measure that can aid mitigation of weather events in the future. This study has discussed steps and strategies taken in Spain, Mexico, Australia, USA and South Africa in mitigating impacts of drought. The process is shaping with continues improving and reviewing policies and strategies. Policies and strategies that worked several decades ago might not necessarily work today or in the future. However, it can be a stepping stone in directing our policies and strategies to deal with drought. The current climate regime around the world demands proper assessment to understand possible strategies to mitigate the impacts of drought on socio-economic activities and the environment in the area. This is a review on the need for climate change adaptation and shift from reactive measures of drought mitigation to proactive measures.

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