Weather and Climate Extremes 3 (2014) 67–79

Contents lists available at ScienceDirect

Weather and Climate Extremes

journal homepage: www.elsevier.com/locate/wace

# Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options

Bekele Shiferaw [a,*], Kindie Tesfaye [b], Menale Kassie [c], Tsedeke Abate [c], B.M. Prasanna [c], Abebe Menkir [d]

[a] Partnership for Economic Policy (PEP), Nairobi, Kenya
[b] International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia
[c] International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya
[d] International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria

ARTICLE INFO

*Article history:*
Received 20 December 2013
Accepted 2 April 2014
Available online 21 May 2014

*Keywords:*
Climate variability
Drought
Drought risk management
Technology and policy options
Sub-Saharan Africa

ABSTRACT

Agriculture and the economies of Sub-Saharan Africa (SSA) are highly sensitive to climatic variability. Drought, in particular, represents one of the most important natural factors contributing to malnutrition and famine in many parts of the region. The overall impact of drought on a given country/region and its ability to recover from the resulting social, economic and environmental impacts depends on several factors. The economic, social and environmental impacts of drought are huge in SSA and the national costs and losses incurred threaten to undermine the wider economic and development gains made in the last few decades in the region. There is an urgent need to reduce the vulnerability of countries to climate variability and to the threats posed by climate change. This paper attempts to highlight the challenges of drought in SSA and reviews the current drought risk management strategies, especially the promising technological and policy options for managing drought risks to protect livelihoods and reduce vulnerability. The review suggests the possibilities of several ex ante and ex post drought management strategies in SSA although their effectiveness depends on agro-climatic and socio-economic conditions. Existing technological, policy and institutional risk management measures need to be strengthened and integrated to manage drought ex ante and to minimize the ex post negative effects for vulnerable households and regions. A proactive approach that combines promising technological, institutional and policy solutions to manage the risks within vulnerable communities implemented by institutions operating at different levels (community, sub-national, and national) is considered to be the way forward for managing drought and climate variability.



## 1. Introduction

Agriculture is the dominant form of land use globally involving major economic, social, and cultural activities and providing a wide range of ecosystem services. Because of its nature, however, agriculture remains highly sensitive to climate variations. The vast majority of smallholder farmers in sub-Saharan Africa (SSA) are dependent on rainfed agriculture for their livelihoods, and they are often afflicted by the vagaries of weather and climate (Gautam, 2006). Among the climatic factors, rainfall variability has a large impact on the livelihoods of the poor as well as the economies of most of the African countries (Gautam, 2006; Hellmuth et al., 2007). For millions of poor people in SSA, variability and unpredictability of climate is a major challenge and poses a risk that can critically restrict options and limit their development (Hellmuth et al., 2009).

Droughts and floods alone account for 80% of the loss of life and 70% of the economic losses in SSA (Bhavnani et al., 2008). Frequent drought conditions have reduced the GDP growth of many African countries (Jury, 2000; World Bank, 2005a; Brown et al., 2011) and threatened their development gains (Hellmuth et al., 2007). Drought has both direct and indirect impacts. Drought directly affects production, lives, health, livelihoods, assets and infrastructure that contribute to food insecurity and poverty. However, the indirect effects of drought on environmental degradation and reduced household welfare through its impact on crop and livestock prices could be larger than its direct effects (Zimmerman and Carter, 2003; Holden and Shiferaw, 2004). In the past five decades,

* Corresponding author.
*E-mail address:* b.shiferaw@pep-net.org (B. Shiferaw).

http://dx.doi.org/10.1016/j.wace.2014.04.004

drought has become a major problem of Africa and it has caused depletion of assets, environmental degradation, impoverishment, unemployment and forced migrations (Hellmuth et al., 2007; Bhavnani et al., 2008; Scheffran et al., 2012).

Although drought accounts for only 8% of natural disasters globally, it poses the greatest natural hazard in Africa accounting for 25% of all natural disasters on the continent occurring between 1960 and 2006 (Gautam, 2006). Over the four decades since the 1960s, Africa stands first in drought frequency with a total of 382 reported drought events that affected 326 million people (Gautam, 2006). Regions of highly variable rainfall in Africa include the Sahel, the Greater Horn and Southern Africa. These regions experience frequent and sometimes prolonged droughts that lead to famine associated with drought in combination with inadequate socioeconomic entitlements, exacerbating vulnerabilities of households and national economies (Hansen et al., 2004). Over the last five decades, the frequency of droughts has increased steadily in East Africa but declined in West Africa (Gautam, 2006).

Eastern and southern Africa regions are characterized mainly by semi-arid and sub-humid climates with a pronounced dry season in part of the year. Therefore, in contrast to West Africa, the variability of rainfall in these regions is concentrated on relatively short time scales in a year and it has a direct connection with global processes such as El Niño/La Niña-Southern Oscillation (ENSO) (Nicholson, 2001).[1] ENSO events have a strong influence on the inter-tropical convergence zone (ITCZ), regional monsoon wind circulation, and patterns of rainfall anomalies over many parts of SSA (Dilley and Heyman, 1995; Jury, 2000; Singh, 2006). The impacts, however, vary significantly from season to season and across countries depending on geographic conditions. For example, El Niño episodes are often associated with the above normal rainfall conditions over the equatorial parts of eastern Africa during October to December and below-normal rainfall over much of the Horn of Africa during the June to September rainfall season. On the other hand, La Niña events often give rise to below-normal rainfall over much of the Greater Horn of Africa during October to December and March to May and above-normal rainfall during the June to September rainfall season (Janowiak, 1988; Singh, 2006).

Drought has a covariate or widespread nature which can cross national borders making informal risk management arrangements ineffective (Gautam, 2006; Vicente-Serrano et al., 2010). This has led to an increase in the number of people affected, rising economic costs and increasing humanitarian assistance for the rising numbers of affected populations (Gautam, 2006). The effects of natural climatic variability and drought conditions are further accentuated by the looming threat of climate change that is projected to increase extreme events and drought frequencies in many parts of Africa. Alternative agricultural investment options and policy and institutional innovations with varying profitability and success exist for managing climatic risks (Rosenzweig and Binswanger, 1993; Shiferaw and Okello, 2011). The main purpose of this paper is to highlight the state of vulnerability to drought and its impacts in SSA and present the promising technological, institutional and policy options for drought risk management to reduce vulnerabilities and livelihood impacts in the region.

[1] El Niño and La Niña refer to the warming and cooling of sea-surface temperatures (SST) in the equatorial Pacific Ocean, respectively which influence atmospheric circulation and consequently rainfall and temperature in specific areas around the world. Since the changes in the Pacific Ocean (represented by "El Niño/La Niña") and the changes in the atmosphere (represented by "Southern Oscillation") cannot be separated, the term ENSO is often used to describe the ocean-atmosphere changes (Singh, 2006).

## 2. Drought vulnerability and impacts

### 2.1. Vulnerability

Understanding people's vulnerability to drought is complex because this depends on both biophysical and socioeconomic drivers of drought impact that determine the capacity to cope with drought (Naumann et al., 2013). Vulnerability is defined in many ways and it has different meanings when used in different disciplines and contexts (e.g., Chambers, 1989; Smit et al., 1999; Brooks et al., 2005; Adger, 2006; Füssel, 2007). In this paper, drought vulnerability is used to highlight the socioeconomic and biophysical characteristics of the region that makes it susceptible to the adverse effects of drought.

The vulnerability of a society to climate disasters such as drought depends on several factors such as population, technology, policy, social behavior, land use patterns, water use, economic development, and diversity of economic base and cultural composition (Wilhite and Svoboda, 2000; Naumann et al., 2013). As Amartya Sen argued, prevalence of drought and decline in food availability should not necessarily lead to famines and loss of livelihoods. Whether food availability decline would lead to disaster will depend on *capability failure* which in turn depends on market access and people's social, economic and political entitlements (Sen, 1999). In SSA, rainfed agriculture provides about 90% of the region's food and feed (Rosegrant et al., 2002) and it is the principal source of livelihood for more than 70% of the population (Hellmuth et al., 2007). Because of heavy dependence on rainfed agriculture, about 60% of Sub-Saharan Africa is vulnerable to frequent and severe droughts (Esikuri, 2005).

Although expanding irrigation is an important strategy to reduce the vulnerability of agriculture to climate risks, water resources are inextricably linked with climate and the prospect of global climate change has serious implications for water resources and regional development (Riebsame et al., 1995). Although Africa has a huge water resource, there is large variation in its spatial and temporal distribution. Moreover, many African countries are expected to face water stress, scarcity and vulnerability by 2025 (Fig. 1) indicating that water resources are highly dependent on, and influenced by, climate.

Furthermore, unsustainable use of land and other resources increase the vulnerability of people in SSA. Millions of smallholder farmers and pastoralists earn a living in degraded areas which make them highly vulnerable to droughts and other climate hazards. Land degradation often stems from the nexus between poverty and lack of capacity to invest in more sustainable agricultural practices and change extractive land-use systems (Holden et al., 1998; Shiferaw and Okello, 2011). Poverty makes people vulnerable and limits their choices. Therefore, apart from climate, human activity is one of the major factors responsible for environmental degradation in SSA that slowly depletes productive natural assets and increases vulnerability to drought and climatic variability.

Another widely accepted reason for the aggravation of drought vulnerability and impacts in Africa is the continuous increase in population growth which has huge implications when complemented with poverty and inadequate policies (Tadesse, 1998). High population growth increases pressure on limited and fragile land resources and leads to unsustainable resource exploitation, resulting in environmental damage. If crops fail, subsistence farmers have few or no alternative means to provide food for their families. When they run out of alternatives, the poor are forced to exploit land resources, including fragile ones for survival, and inevitably they become both the victims and willing agents of environmental degradation and desertification. In general, high level of chronic poverty contributes to low adaptive capacity to