



# Drought vulnerability drives land-use and land cover changes in the Rift Valley dry lands of Ethiopia

Birhanu Biazin<sup>a,\*</sup>, Geert Sterk<sup>b</sup>

<sup>a</sup> Hawassa University, Wondo Genet College of Forestry and Natural Resources, P.O. Box, 128, Shashemene, Ethiopia

<sup>b</sup> Utrecht University, Department of Physical Geography, P.O. Box 80115, 3508 TC Utrecht, The Netherlands

## ARTICLE INFO

### Article history:

Received 29 September 2011

Received in revised form

13 September 2012

Accepted 21 September 2012

### Keywords:

Drought

Dry spell

Land-use change

Land management

Rift Valley

## ABSTRACT

The Ethiopian Rift Valley is a dry land zone where for a long time pastoral communities have made their living from acacia-based woodlands. But many pastoralists have changed from a pastoral way of life to mixed farming over time. The aim of this study was to evaluate land-use and land cover (LULC) changes in the Central Rift Valley dry lands of Ethiopia, and determine the role of drought vulnerability as a driver. A combination of GIS/remote sensing techniques, drought vulnerability analyses, field observation and surveying were employed. Because drought vulnerability is linked more closely to the types of land-uses and social contexts rather than only climatological events, it was examined based on locally perceived criteria of drought. Accordingly, the pastoral way of life was vulnerable to severe drought during 25% of the last 28 years while the mixed farming (livestock and maize farming combined) system was vulnerable to severe drought only during 4% of the years. Over the last 5 decades, cultivated lands increased to threefold while the dense acacia coverage declined from 42% in 1965 to 9% in 2010. The observed LULC changes were driven by the interplay of recurrent drought, socioeconomic and institutional dynamics, access to markets and improved technologies such as early-maturing maize cultivars and better land management. Proper policy and technological interventions are required to develop appropriate drought adaptation strategies and avert the increasing degradation of woodlands in the Rift Valley dry lands where a pastoral way of life is still present.

© 2012 Elsevier B.V. All rights reserved.

## 1. Introduction

Dry lands cover about 41% of Earth's land surface and are inhabited by about one third of world population (more than 2 billion people) (FAO, 1998; White et al., 2002). According to the UNCCD (2000), dry lands are characterized by a ratio of annual precipitation to potential evapo-transpiration (P/PET) ranging between 0.05 and 0.65. The FAO (2000) has also defined dry lands as those areas with a growing season length of 1–179 days and a climatic classification of arid, semi-arid and dry sub-humid. The UNEP (1992) definition of dry lands encompasses also the hyper-arid areas with the P/PET ratio of less than 0.05. By 2020, about 3 billion people will reside in arid and semi-arid environments (Fisher and Helig, 1997). Although every continent contains lands with these zones, dry lands are most extensive in Africa (nearly 13 million km<sup>2</sup>) and Asia (18 million km<sup>2</sup>) (UNDP, 1997). Over 40% of low-income countries are largely dry lands, where local people mainly depend on agriculture for their living. In Ethiopia, the dry lands occupy 65% (close

to 700,000 km<sup>2</sup>) of the total land mass of the country (EPA, 1998), and 46% of the total arable land (Yonas, 2001).

Dry lands are a vital part of the earth's human and physical environments. They encompass rangelands, arable lands, forests and urban areas (Koohafkan and Stewart, 2008). Rangelands (i.e. grasslands, shrub lands, savannahs, tundra, etc.) previously occupied more than 51% of the earth's terrestrial land surface and supported more than 50% of the world livestock (Allen-Diaz, 1996). Land-use changes including deforestation, intensification of agriculture, and urbanization have been occurring rapidly at the expense of rangelands (Lambin et al., 2001; Reenberg, 2001). A unidirectional and yet rapid conversion of rangelands and woodlands to cultivated lands was reported in many parts of Sub-Saharan Africa (SSA) during the 1980s and 1990s (Garedew et al., 2009; Lambin et al., 2003). However, in the Sudano-Sahelian zones of Ghana and Burkina Faso, there was a bidirectional pattern of land-use changes from woodlands to parklands (0.44–0.77%/year) and vice versa (0.25–0.45%/year) due to regeneration of savannah woodlands on abandoned farmland and long-term fallows during 1986–2001 (Reenberg, 2001; Wardell et al., 2003). Despite the growing consensus about the increasing degradation of woodlands and grasslands in Sub-Saharan Africa (Diouf and Lambin, 2001; Mortimore and Turner, 2005; Reenberg and Lund, 1998), there are uncertainties about the real image of the

\* Corresponding author. Tel.: +251 468200706; fax: +251 461109983.

E-mail addresses: [birhanubiazin@gmail.com](mailto:birhanubiazin@gmail.com), [birhanutemesgen@yahoo.com](mailto:birhanutemesgen@yahoo.com) (B. Biazin).

changing trends and the drivers behind them (Grainger, 2010; FAO, 2006).

The Ethiopian Rift Valley has long been occupied by pastoral communities making their living from rangelands (Abule et al., 2005). Having the largest livestock population in Africa, Ethiopia gets about 30% of its gross national product and 12–15% of its total export earnings from this sector (Solomon et al., 2003). The Ethiopian Rift Valley is also home to a chain of lakes that vary in size, and hydrological and hydro-geological settings (Ayenew, 2004). These lakes are used for irrigation, soda extraction, commercial fish farming, and recreation, and they support a wide variety of endemic birds and wild animals. Despite its huge environmental and economic benefits, the Ethiopian Rift Valley is faced with pressing natural and anthropogenic challenges. Drought, overgrazing and increases in human population are the perceived problems of the pastoral communities in the Ethiopian Rift Valley (Abule et al., 2005; Angassa and Oba, 2010). A study based on the long-term records of rainfall and cattle population data in the southern Rift Valley dry lands of Ethiopia revealed that annual rainfall variability strongly influenced the dynamics of cattle population, calving rates and mortality (Angassa and Oba, 2007). Droughts in 1983–1985 and 1991–1993 resulted in the deaths of 37% and 42% of all cattle, respectively (Desta and Coppock, 2002). The declining condition of the livelihood of the pastoral people is evident on numerous levels such as changing trends in livestock holding and declining productivity (Solomon et al., 2007).

There have been few studies on LULC changes in the vast Rift Valley dry lands of Ethiopia (Dessie and Kleman, 2007; Garedew et al., 2009; Tsegaye et al., 2010). All of these studies reported that there has been a steady rate of conversion from rangelands and native woodlands to cultivated arable lands during the last four decades. However, these studies were all undertaken far from the main Central Rift Valley (CRV) where the remnant acacia-based woodlands are present. Garedew et al. (2009) reported that in the two villages of the Rift Valley, the woodland areas decreased by 85% in Keraru and 100% in Gubeta-Arjo while the cropland area roughly increased in similar rate by 126%.

Beyond quantifying the LULC changes using GIS/remote sensing techniques, a thorough understanding of the interaction of the changes with the main bio-physical and socioeconomic drivers is required for the development of informed and appropriate land-use policies in the Rift Valley dry lands of Ethiopia. Based on the people's accounts, Tsegaye et al. (2010) reported that severe drought during 1973/1974 and 1984/1985 stimulated land-use changes from rangeland into cultivated arable land, with maize being the most widely cultivated crop in the Northern Rift Valley of Ethiopia. Thus, for a further scientific understanding of the effect of drought on land-use conversions, a comparison of the drought vulnerability of the pastoral way of life and the mixed farming system based on long-term rainfall records is needed.

While the effects of droughts are well understood, it is difficult to get a universally working definition of drought (Downing and Bakker, 2000; Quiring and Papakryiakou, 2003). In line with the focus of this paper, agricultural drought has been most commonly defined as the interval of time when the moisture supply by the climate of a region consistently falls below the appropriate amount for crop or range production thus adversely affecting the yield (Beran and Rodier, 1985; Hisdal and Tallaksen, 2000; Mckee et al., 1993; Quiring and Papakryiakou, 2003). On the other hand, drought vulnerability largely defines drought risk rather than only the frequency and severity of weather anomalies (Downing and Bakker, 2000). It shows the degree of susceptibility of society to a drought hazard, which could vary either as a result of variable exposure to the hazard, or because of coping abilities (Chambers, 1989; Downing and Bakker, 2000; Keenan and Krannich, 1997). The stronger and more diverse the household's asset base, the more



Fig. 1. Location map of the study area in the Rift Valley dry lands of Ethiopia.

drought resilient it is likely to be, and the greater its options in terms of switching between different livelihood strategies in response to drought (Wilhite, 2005). Investigation on the factors that affect drought vulnerability of the society in Nebraska indicate that the most vulnerable areas to agricultural drought were non-irrigated cropland and rangeland on sandy soils, located in areas with a very high probability of seasonal moisture deficiency (Wilhelmi and Wilhite, 2002). Less is known about the interplay between drought vulnerability and land-use/land cover changes in drought-prone tropical areas such as Ethiopia. Accordingly, a comparative study on drought vulnerability of the pastoral way of life against the semi-pastoral (mixed livestock and crop farming) system would be important to the future planning of sustainable dry land management in the Ethiopian Rift Valley. Due to the vulnerability of the pastoral people to drought risks (Carter et al., 2004), the loss of livestock or decline in productivity after drought might have initiated land-use conversion to smallholder mixed-farming system as a better coping strategy. Therefore, in this study, we hypothesized that drought vulnerability of the pastoral way of life has triggered land-use changes to mixed farming system and the consequent decline in woodland cover in the CRV of Ethiopia.

The objective of this study was, therefore, to evaluate LULC changes, and determine the role of drought vulnerability as a driver in the Central Rift Valley dry lands of Ethiopia. Based on long-term rainfall data and perceived criteria for drought vulnerability of either livestock keeping or maize farming, the probability of drought either for pastoral system (livestock keeping only) or mixed farming system (livestock and maize farming combined) was evaluated. The results of this study could be used as valuable information for initiatives in the sustainable management of the drought-prone and fragile Rift Valley dry lands in Ethiopia.

## 2. Materials and methods

### 2.1. Description of the study area

The study was conducted in the CRV of Ethiopia around Langano (Fig. 1) which is situated approximately 200 km south of the capital, Addis Ababa. Apart from being the middle of the vast Ethiopian Rift Valley dry lands, the CRV was chosen for this study due to the fact that there has been recent changes from the predominantly pastoral system to subsistent mixed farming system. Hence, it could be possible to examine the drivers behind the observed changes in the LULC and the interplay with drought vulnerability. The study

Download English Version:

<https://daneshyari.com/en/article/8488182>

Download Persian Version:

<https://daneshyari.com/article/8488182>

[Daneshyari.com](https://daneshyari.com)