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# Examining the relationship between environmental factors and conflict in pastoralist areas of East Africa

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## HIGHLIGHTS

- 29 years of vegetation and precipitation data is used to test if environmental stresses have any predictive power in locating conflict incidents.
- Impact of topographic setting is explored.
- Results indicate that environmental stressors were only partly predictive of conflict events.

## GRAPHICAL ABSTRACT

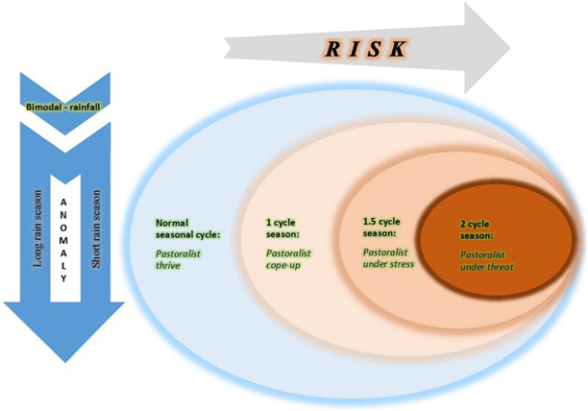


Fig. 1 definition diagram of stress cycles experienced by east African pastoralist communities.

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## ABSTRACT

The eastern Africa region has long been known for recurring drought, prolonged civil war and frequent pastoral conflicts. Several researchers have suggested that environmental factors can trigger conflicts among pastoralist communities, but quantitative support for this hypothesis is lacking. Here we use 29 years of georeferenced precipitation and Normalized Difference Vegetation Index (NDVI) data to evaluate long term trends in scarcity of water and forage for livestock, and then ask whether these environmental stressors have any predictive power with respect to the location and timing of 11 years of conflict data based on Armed Conflict Location and Event Data Project (ACLED) and Uppsala Conflict Data Program (UCDP). Results indicate that environmental stressors were only partly predictive of conflict events. To better understand the drivers behind conflict, the contribution of other potential stressors to conflict need to be systematically quantified and be taken into consideration.


## 1. Introduction

The eastern Africa region has long been known for recurring drought, prolonged civil wars, and frequent conflicts (Fearon and

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Laitin, 2003; Oba, 1992; Slegers and Stroosnijder, 2008). Many publications presented climate and environmental factors as major triggers of conflicts among pastoralist communities (Kevane and Gray, 2008). While various hypotheses exist for these phenomena, it is widely accepted that environmental factors exacerbate conflict (Faris, 2007; Ki-Moon, 2007; Sachs, 2006; Scheffran and Battaglini, 2011). Droughts of various severities have been reported in Northeastern Africa (Benjaminsen et al., 2012; Haro et al., 2005; Little et al., 2001; Raleigh and Urdal, 2007). In recent years the frequency of drought has dramatically increased from 10 years on average in the 1900s to every 4 years in the 1980s (Huho and Mugalavai, 2010; Morton and de Haan, 1999). Records also show that conflict incidents increased in the last 15 years (Sundberg et al., 2012). In the greater horn of Africa, the frequency of drought has doubled from once every 6 years to once every 3 years (Meier et al., 2007). The likely impacts of increasing drought are worse in dry environments where non-equilibrium ecology dominates.

Past studies have given mostly descriptive explanations for the causal relationship between environmental resource scarcity and pastoral conflict (Homer-Dixon, 2010; Kahl, 1998; Markakis, 1998; Mkutu, 2001). Sachs (2006) argued that a drought-induced famine is much more likely to trigger conflict in a place that is already impoverished and lacking any cushion of physical or financial resources. Meier et al. (2007) used georeferenced precipitation, vegetation and forage data of 2002–2006 and developed the first well established approach to empirically describe environmental factors that may influence pastoral conflicts. Results indicated that aggravating behavior, along with a reduction in peace initiatives and reciprocal exchanges, is associated with an escalation in pastoral conflict, particularly when coupled with an increase in vegetation that may provide cover for organized raids. More recently Raleigh and Kniveton (2012) used precipitation variability to explore the marginal influence of the climate on conflict and concluded small-scale conflict is likely to be exacerbated with increases in rainfall variability. On the contrary, several authors also argue that unusually wet seasons encourage raiding in pastoralist areas (Adano and Witsenburg, 2008; Meier et al., 2007; Turner, 2004). Some recent quantitative analysis of climate and conflict data has resulted in either a null or negative relationship between scarcity and conflict (O'Loughlin et al., 2012). A new and extensive meta-analysis by Hsiang et al. (2013) concluded that warmer temperature and extreme precipitation lead to an increase in intergroup conflict. All these studies lead to a lack of a clear consensus.

The challenge in producing empirically sound statistical evidence to substantiate the claim that environmental factors trigger conflict emanates from contradicting circumstances to the hypothesis itself. This is mainly because conflict is context-specific and it is hardly possible to find a single cause describing it (GSDRC, 2015). The nexus between environmental factors and conflict has four possible real world scenarios, with circumstances as follow: areas with good (above long-term mean) climatic/vegetation condition where conflict prevails (e.g. Central African Republic, Congo Democratic Republic, South Sudan), countries with good climatic/vegetation condition and no conflict, poor (below long-term mean) climate/vegetation and persistent conflicts (e.g. Ethiopia, Kenya, Sudan, Uganda) and poor climate/vegetation and no conflict (e.g. Sahel).

The scope of this study is limited to the eastern Africa region, home for 20 million pastoralists, where environmental stresses (e.g. reoccurring drought) and pastoralist conflicts are frequently reported (Kimani, 2008). These communities represent the largest grouping in the world. Pastoralists represent 60% of total population in Somalia, 20% in Sudan and 12% in Ethiopia. They possess a significant part of the livestock wealth (30–40% in Ethiopia and 70% in Kenya where livestock production accounts for 24% of total agricultural output) (Ahmed et al., 2002). Given the mixed results from past studies, we anticipated that this focus would best allow us to determine whether or not an association might exist. New remote sensing products have enabled monitoring of long term climate and environmental factors of east Africa. (Balk et al., 2006; Balk and Yetman, 2004; Hulme, 1992, 1994; Hulme et al., 1998; Tucker et al., 2005). We used 29 years of vegetation and precipitation data to look at long term trends in scarcity of water and forage for livestock, and then for the 11 years for which we have a detailed conflict analysis (2000 − 2010) we test whether environmental stresses have any predictive power in locating conflict incidents.

## 2. Materials and methods

### 2.1. Study area

The study area comprises nine countries: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, Tanzania, and Uganda (Fig. 1). Pastoralist communities inhabit the arid and semi-arid land in these countries. Much of the region is characterized by a bimodal precipitation cycle. The main rainy season is from March to May, and shorter rains occur in October and November. The areas of highest relief surrounding Mt. Kenya and Mt. Kilimanjaro and the rugged terrain northwest of Lake Victoria and in southern Ethiopia receive the most precipitation during the main rainy season (Nicholson, 1996).

### 2.2. Data and methods

Climatic and environmental factors that can potentially contribute to conflict in pastoralist areas are mainly linked to the imbalances in the supply and demand of forage and water. Demand for forage and water is driven by the need to sustain humans, livestock, and the cultivation of short duration crops, such as sorghum and millet (Mace et al., 1993). The spatial distribution of these variables can be mapped using geographic information systems (GIS) and remotely-sensed products. The supply side mainly refers to the seasonal precipitation. The use of vegetation indices (VIs) augments the spatial analysis not only as a surrogate to evaluate the aerial distribution of precipitation but also as an indicator of availability of fodder for livestock. With anticipated growth in demand due to population and livestock growth, analyzing the trend in supply could help explain conflict incidences in pastoral areas of East Africa if shortages are predicted. The following datasets were used in the analysis.

#### 2.2.1. Conflict data and analysis

Incidences of conflict in pastoralist areas of East Africa have been extensively published (Oba, 1992; Odhiambo, 2012; Raleigh and Kniveton, 2012; Reuveny, 2007). Conflict data were downloaded from two sources: Armed Conflict Location and Event Data Project (ACLED) (Raleigh et al., 2010) and Uppsala Conflict Data Program (UCDP) Non-State Conflict Dataset (Sundberg et al., 2012). These datasets include the coordinates of the incidences, type of conflict, warring groups, and estimated fatalities among other factors. The UCDP non-state conflict data of 1997–2010 are used in this study due to its explicit *i*) definition of conflict, *ii*) actors and *iii*) set of well-defined procedure to the inclusion of an incidence into the database. Eck (2012) provided a detailed comparison of the two datasets. The two datasets are closely comparable in the east Africa. The UCDP data are available up to the year 2010 and therefore the data for the years 2011 to 2013 were taken from the ACLED data. Note that other datasets forced us to limit the final analysis period to 2000–2010, but 1997–2013 was used in this initial stage to locate clusters of conflict.

In locating conflict hotspots we isolated the non-state conflict data for the years 1997–2013 and applied Global Moran's I (Getis and Ord, 1992) method to assess if a spatial autocorrelation exists in the conflict dataset (but this method does not actually map where the clusters