



Long-term environmental change and geographical patterns of violence in Darfur, 2003–2005[☆]



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ARTICLE INFO

Article history:

Available online 3 December 2014

Keywords:

Darfur
Environmental change
Long term
Violence
Civil war

ABSTRACT

This paper investigates spatial associations between environmental change and violence in Darfur. Long-term variations in the geographical distribution of water and vegetative resources can foster migration from areas with decreasing levels of resource availability to areas with increasing levels. Rising ethnic diversity and resource competition can, in turn, escalate the risk of violence in areas of high in-migration. This paper employs a multimethod approach to investigate this hypothesis. Qualitative evidence is used to demonstrate the plausibility of the argument for the case of Darfur. The quantitative analysis is based on information retrieved from satellite imagery on long-term vegetation change and the spatial distribution of attacks on villages in the early phase of the civil war (2003–2005). The findings indicate that violence has been more likely and intense in areas that experienced increasing availability of water and vegetative resources during the 20 years prior to the civil war.

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Introduction

Many publications that investigate connections between environmental change and violence refer to the case of Darfur (Benjaminsen, Alinon, Buhaug, & Buset, 2012; Raleigh & Kniveton, 2012; Salehyan, 2008). Qualitative studies emphasize that decreasing access to water and fertile land has played an important role in the violence in western Sudan (e.g. De Waal, 1989; Flint & Waal, 2005; Harir, 1994). Quantitative research, on the other hand, generally concludes that natural resource availability has not been a primary cause of the civil war (e.g. Brown, 2010; Kevane & Gray, 2008; Olsson & Siba, 2013). This case-specific debate mirrors the more general research on the links between environmental change and violence: while some studies find correlations, most find evidence against such a connection (see overviews in Bernauer, Böhmelt, & Koubi, 2012; Gleditsch, 2012).

This paper aims at contributing to this debate. It argues that previous research has not adequately considered the role of spatial variations in longer-term ecological developments. Studies have

focused on the role of natural resource availability in general terms, on short-term variations, or on geographically aggregated longitudinal trends. Environmental change can, however, affect subnational regions in different ways. The increase in the availability of natural resources in some areas versus a decrease in others can, in the long run, shape the geographical distribution of livelihood opportunities and lead to migratory processes that may in turn affect conflict risks.

This paper investigates these claims in the case of Darfur. More specifically, it analyses whether longer-term changes in the subnational distribution of water and vegetative resources can contribute to explaining the spatial distribution of violence in the early phase of the civil war (2003–2005). The empirical analysis presented in the paper consists of two parts. The first uses qualitative and descriptive quantitative information to demonstrate the plausibility of the argument in the case of western Sudan. More specifically, it presents evidence that corroborates the assumed causal steps linking environmental change to the geography of violence. The second consists of a quantitative analysis that treats the argument more systematically. The main explanatory and outcome variables are based on information extracted from satellite imagery of the region. The Humanitarian Information Unit (HIU) of the US State Department provides a data set on villages that have been damaged or destroyed during the civil war. I use remote sensing information on changes in vegetation to construct variables of environmental change in the 20 years prior to the

[☆] A previous version of this paper has been presented at the 2013 annual meeting and exhibition of the American Political Science Association (APSA), Chicago, August 29 – September 1, 2013.

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beginning of the civil war in 2003. I complement both data sources with additional socio-economic data to construct a data set of artificial grid cells covering all populated areas of northern and southern Darfur. Estimations using these grids as units of analysis yield robust correlations between the probability and intensity of violence and long-term changes in natural resource availability.

Natural resources and violent conflict

Associations between environmental change and violence have received considerable attention over the past 10 years (Bernauer et al., 2012; Gleditsch, 2012). Empirical studies can roughly be attributed to one of three different approaches, depending on how they consider temporal variation: The first focuses on natural resource availability in general terms. The second approach focuses on short-term variations in environmental conditions – namely rainfall. The third investigates the role of long-term developments.

A central underlying argument of the first approach goes back to Homer–Dixon's finding that resource scarcity can create grievances against the state and increase the likelihood of political violence (Homer–Dixon, 1991, 1994). Various studies have investigated this claim. A country-level analysis by Theisen (2008) found limited explanatory power in natural resource scarcity (see also Raleigh & Urdaal, 2007). Meier and colleagues found that pastoralist conflicts along the borders of Ethiopia, Kenya and Uganda have actually been the most intense in times of low availability of rainfall, vegetation and forage (Meier, Bond, & Bond, 2007) while Witsenburg and Adano argue that cattle raiding in northern Kenya has generally been more frequent in wet seasons when livestock is in good health (Witsenburg & Adano, 2009). John Sulik finds evidence of a positive association between vegetation abundance and the odds of conflict incidence in Darfur (Sulik, 2011), while Olsson and Siba (2013) only found very weak support for such a correlation.

Not only are the results of these studies mixed, they also fail to tell us how temporal changes in resource availability may impact on violent conflict. Specific temporal dynamics may, however, in themselves play an essential role.

Most studies that investigate associations between environmental change and violence focus on short-term variation in precipitation. Hendrix and Glaser (2007) found that change in rainwater availability relative to the previous year increases the risk of conflict onset in Africa (see also Hendrix & Salehyan, 2012; O'Loughlin et al. 2012; for contrary findings see Theisen, Holtermann, & Buhaug, 2012). In their analysis of violence in Uganda, Kenya and Ethiopia, Raleigh and Kniveton (2012) found that rainfall may impact different types of violence in distinct ways – specifically, that the risk of rebel violence was higher in particularly dry years, whereas communal violence seemed to be more intense in years that displayed above-average precipitation (see Fjelde & Uexkull, 2012 for contrary findings).

As compared to short-term developments and annual deviations, the relevance of long-term environmental change has rarely been investigated in studies of violent conflict. It may, however, have effects that differ from short-term associations.

Only two previous studies can be considered *long term* in the actual sense of the term. The first is Zhang et al.'s study on the relationship between climate change and war in China over the last millennium. They revealed a strong correlation between climate change and the incidence of war, with increased war occurrence during cold periods (Zhang et al. 2006). The second is Tol and Wagner's study, which mirrored Zhang et al.'s results in the context of Europe (Tol & Wagner, 2010). Two studies on Darfur have investigated the role of decadal ecological developments in the occurrence of violence. As resource availability increased rather than decreased prior to the civil war, both works concluded that

climate change was not a main cause of violence (Brown, 2010; Kevane & Gray, 2008).

These studies consider temporal ecological developments beyond yearly variations. Their approach masks, however, potential subnational spatial variations in long-term trends. Some areas may experience favourable developments in terms of natural resource availability, whereas others experience relative or absolute declines. These diverging trends may have socio-economic effects that influence the risk of violence in the respective areas.

This paper is interested in the role of such subnational geographical patterns of long-term environmental change. I use the rather generic term of 'environmental change' to refer to spatio-temporal variations in the availability of natural resources (see for example Bernauer et al., 2012; Brown, 2010; Homer–Dixon, 1991). In line with the previous research cited above, I focus on two specific aspects deemed particularly relevant for livelihoods in many developing countries: rainfall and vegetative resources. 'Long term' refers to decadal rather than daily or yearly variation. More precisely, as detailed below, I investigate variation in a specific 20 year period as measured by the difference between two five-year averages of rainfall and vegetation indicators at the beginning and the end of this period.¹ As I am interested in the *consequences* of observable environmental change, I avoid terms such as 'climate change', 'land degradation' and 'desertification', which may be associated with specific *causes* of changing precipitation and/or vegetation patterns (see discussion in Andersson, Brogaard, & Olsson, 2011; Benjaminsen, 2008; Ellis & Swift, 2006; Hellden, 1991; Scoones, 2001; Warren & Olsson, 2003).

Environmental change, migration and violent conflict

The main argument of this paper consists of three causal steps that link long-term environmental change to violence: First, environmental change can lead to migration. Second, migration can change demographic constellations and increase resource competition in areas of high in-migration. Third, both factors taken together can increase the risk of violent interethnic resource conflict in subnational regions that experience long-term increases in the availability of water and vegetative resources compared to areas where the availability of these resources is decreasing. Before I elaborate on these causal steps, I briefly sketch three main limitations of the overall argument.

First, it only applies to specific country contexts, namely to those that display substantial subnational variation in long-term environmental change, a minimum degree of ethnic diversity and a strong local livelihoods-dependency on environmental conditions (i.e. those countries that are highly dependent on agriculture). These framework conditions define the scope of the hypotheses presented below.

Second, none of the linkages sketched above are deterministic. People can adapt to environmental hardship, while motives and capacities for migration also depend on household-level socio-economic conditions (see for example Black et al. 2011; Eriksen & Lind, 2009; Joseph & Wodon, 2013; Perch-Nielsen, 2004). Similarly, the selection of destinations as well as the effects of high-level in-migration will also depend on pre-existing social ties or social institutions. Political institutions intervene on various levels by affecting social consequences of environmental change, patterns of migration, and the management of resource conflicts (Benjaminsen, 2008; De Châtel Forthcoming; Koubi, Bernauer, Kalbhenn, & Spilker, 2012; Tir & Stinnett, 2012). Conditional on such factors, resource competition may foster cooperation rather than conflict (Bogale & Korf, 2007; Martin, 2005). These issues underscore the need for a context-specific analysis of

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