



Human dimensions of land use and land cover change related to civil unrest in the Imatong Mountains of South Sudan

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A B S T R A C T

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Civil unrest disrupts not only the lives of people in the impacted area, but also the environment in ways not well understood. While armed conflict generally has a negative impact on the immediate environment, the absence of people due to war can be beneficial to local ecosystems and wildlife. Lack of access to a warzone during conflict, however, makes it difficult to gather primary data on the effects of conflict in real time. Satellite imagery has been used successfully to document changes on the landscape during and after war, but additional information is needed to explain the underlying drivers of these observed changes in land use and land cover. To understand how human decisions and actions during war and peace impact land use and subsistence practices, we combined results from key informant interviews with observations made from remotely-sensed satellite imagery and compared expected results with findings in seven major thematic areas. In the high biodiversity region of the Imatong Mountains in South Sudan, we discovered that while some people fled the area during the various conflicts, many others escaped to higher ground to live off the resources available from the forest. Earlier studies indicated that the impact on forest cover during and after the war were minimal in the Imatong Mountains, and extensive in the nearby Dongotana Hills. Discussions with local inhabitants confirmed these findings and provided further insights for how migration and land use patterns impacted forest cover and wildlife in this volatile region.

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Introduction

The field of 'land change science' seeks to understand the human and environmental dynamics that give rise to changed land uses and covers in terms of type, magnitude and location (Rindfuss et al., 2004). Numerous advances have been made in this field using and combining a variety of approaches across multiple disciplines in both the social and physical sciences. In addition to the socio-economic and biophysical drivers of change, it is important to account for the specific human-environment conditions within which these drivers operate (Lambin et al., 2001). War, for example, is recognized as one of many underlying causes behind tropical deforestation (Geist & Lambin, 2002). Over 90% of the major armed conflicts between 1950 and 2000 occurred within countries containing biodiversity hotspots and more than 80% actually occurred within a hotspot (Hanson et al., 2009). The Imatong Mountain region in South Sudan is part of the Eastern Afrotropical 'biodiversity hotspot' (as identified by Conservation International) due to

the numerous species of plants found here, many of which are endemic to the region (see <http://www.biodiversityhotspots.org>) and has also provided the backdrop to several ongoing armed conflicts over the past few decades. As a mountainous landscape, this region is unique from a conservation perspective. That is, hilly regions are typically less populated than other low-lying areas; however, many more people depend on the resources mountains provide including water, energy, minerals, forests or recreational areas (Bequette, 1994).

Lack of reliable data and danger inherent in a warzone necessitates the use of various methods for assessing impacts, including the use of spaceborne imagery. These data alone, however, cannot explain the individual decisions that ultimately drive changes in land use. Previous studies have used satellite remote sensing to monitor changes in forest in the Imatong Mountains and neighboring Agoro-Agu forest reserve in northern Uganda (Gorsevski, Kasischke, Dempewolf, Loboda, & Grossmann, 2012). We build on these earlier efforts by recording local impressions of war and its effects, and by comparing various interpretations of satellite-derived land cover imagery in order to explore the nuances behind the overarching premise that the Sudan civil war caused mass out-migration of people, and that this trend was later

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reversed following the signing of the Comprehensive Peace Agreement (CPA) in 2005.

Information on human inhabitants is lacking for the Imatong Mountain region. While it is widely accepted that millions of people left Sudan during its two main civil wars (1956–1972 and 1983–2005), there is little record of current and historic human migration and land use patterns in this region, as the few humanitarian organizations working here were forced to evacuate during the conflicts. Because of the region's close proximity to northern Uganda as well as the shared ethnic identity of a portion of the population (the Acholi), a reasonable assumption would be that most people fled across the border to safety. If this were the case, one would expect to see the resulting impact on the natural landscape in the form of abandoned agricultural plots and regeneration of natural vegetation, as has been demonstrated in other war-torn regions (Witmer, 2008). Conversely, if people remained in the area, the opposite might occur (e.g. increased deforestation in order to meet basic needs during wartime).

In this paper we present the results of a study that investigated issues related to war, migration and the environment by focusing on the Imatong Mountains and nearby Dongotana Hills – located in the State of Eastern Equatoria on the border with northern Uganda, where people living in and around the forests were deeply affected by several ongoing conflicts. Using information from interviews with local inhabitants and government officials who were shown a satellite image of the forest cover of the region, we explored how people were impacted by the Sudan civil war and other concurrent conflicts, and how decisions related to these conflicts have affected land use practices and forest cover over time.

Conflict landscapes

Evidence from the current and previous centuries indicates that across the globe, armed conflicts have a negative impact on the natural environment to some degree, including adverse effects on wildlife habitat, which in turn causes changes to biodiversity (Hanson et al., 2009). Examples include the bombing of Kuwaiti oil wells in the early 1990s which resulted in extensive near-term air, water and land pollution (El-Gamily, 2007) and changes in surface sediment and morphological features leading to land-surface degradation over the long term (Koch & El-Baz, 1998; Pearce, 1995). Intentional and widespread defoliation of forest vegetation using herbicidal chemical agents occurred during the Vietnam War to deny sanctuary to the National Liberation Front (FNL) (Westing, 1971). More recently, chemical defoliant have been used in the so-called “war on drugs” in Columbia to eradicate cocoa production with the unintended consequence of destroying adjacent forest-land (Messina & Delamater, 2006). Wars often lead to a breakdown of law and order, allowing various factions to appropriate control of natural resources such as timber and wildlife to fund war efforts (Baral & Heinen, 2005; McNeely, 2003). In developing countries, where people tend to be more directly dependent on natural resources for their livelihoods and where democratic institutions are not always established (Kanyambwa, 1998), studies have shown that wars can amplify existing threats to the environment that already existed during peacetime (Glew & Hudson, 2007). Numerous examples of past and present conflicts demonstrate the negative impact of war on the environment and on biodiversity (Hanson et al., 2009), such that a new term, “warfare ecology”, has been coined to encompass this growing field of study (Machlis & Hanson, 2008).

And yet there are cases where conflict has been found to have a negligible or even positive effect on the environment through the formation of a buffer or “no-go zone.” Here, the absence of human activity allowed for regrowth of vegetation as well as reduces

hunting pressure on wildlife (Joshi, 2006; Kaimowitz & Faune, 2003; Kim, 1997; Martin & Szuter, 1999; Nietschmann, 1990; Robinson & Sutherland, 2002). The most frequently cited example of this phenomenon is the demilitarized zone (DMZ) between North and South Korea where the absence of humans resulted from the war's diplomatic solution. The 2.5 mile wide, 155 mile long stretch of land within the DMZ has provided a haven for wildlife, particularly migratory birds (Brady, 2008; Kim, 1997). Another example is the resurgence of leopards, bears and other wildlife in Jammu and Kashmir (India) due to local inhabitants' fear of being caught in exchanges between militants and security forces (Joshi, 2006).

One important consequence of conflict on the landscape that can be felt during and often long after the war ends involves abrupt and large-scale movements of human populations. This produces either an absence of people in a formerly populated area due to their having fled the conflict or conversely, a concentration of people in ‘safe havens’ such as internally displaced persons (IDP) and refugee camps. There is general agreement that emigration reduces land-use pressure at the origin and increases pressure at the destination (Hugo, 1996). The burden of additional people can result in deforestation, and land degradation (Allan, 1987; Biswas & Tortajada-Quiroz, 1996; Ghimire, 1994; Hugo, 1996; Sato, Yasui, & Byamana, 2000) due to a dramatic increase in the demand for resources following the creation of settlements (Martin, 2005). For example, the flood of refugees from Darfur to Chad in recent years put a severe strain on natural resources such as water and firewood, and competition between refugees and the local community led to violent attacks, particularly on women (Bauer, 2006). Similarly, the end of the Rwandan civil war in 1994 caused 1.5–2 million people to move to the Democratic Republic of Congo (then Zaire) resulting in the destruction of over 150 km² of forest in the Virunga National Park by refugees (Draulans & Van Krunkelsven, 2002). Conflicts over natural resource use between host and refugee communities always takes place within complex political-ecological landscapes of war (Martin, 2005) and it is likewise important to note that the impact of refugees on the environment relies less on the sheer number of people involved than the political-economic processes which influence access to land which govern its use (Black & Sessay, 1997).

The return of refugees and IDPs following war's end can similarly lead to increases in intensive use and contestation of resources such as land and timber for the rebuilding of infrastructure, planting of crops, and use of pasture (Robinson & Sutherland, 2002; Unruh, 2002). Akagera National Park in Rwanda, for example, has been largely decimated by the influx of cattle following the return of refugees from Uganda and elsewhere (Hintjens, 2006). When a conflict ends, environmental considerations are often a low priority compared with the need to rebuild infrastructure and the economy, although in some cases – such as in Uganda and Mozambique – improved policy making following war actually led to greater community participation in natural resource management (Vanasselt, 2003). The lingering effects of war can also dictate where people settle. For example, the presence or absence of landmines can be a significant factor in where people choose to rebuild their communities and plant crops (Oppong & Kalipeni, 2005).

As the above examples demonstrate, the impact of a conflict on a region's physical environment is location-specific and depends on a multitude of inter-related factors. Landscapes that are shaped or otherwise materially affected by formal or informal defensive strategies to achieve recognizable social, political or cultural goals have been called “landscapes of defense.” (Gold & Revill, 1999). After a conflict has ended, the memory of war often remains imprinted on the landscape in ways that can prolong fear among inhabitants and reinforce divisions among impacted populations, as has been the case for post-war Guatemala, where model villages and clandestine graves

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