EVALUATING SPATIAL CHANGES IN THE RATE OF INSURGENCY-VIOLENCE IN CENTRAL AFRICA: THE LORD'S RESISTANCE ARMY 2008-2012

by

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CAR	Central African Republic
DRC	Democratic Republic of the Congo
FARDC	Armed Forces of the Democratic Republic of the Congo
HRW	Human Rights Watch
HUMINT	Human Intelligence - Covert intelligence gathered from human sources
IDP	Internally displaced person
LRA	Lord's Resistance Army
MONUC	United Nations Organization Mission in the Democratic Republic of Congo (later renamed MONUSCO)
MONUSCO	United Nations Organization Stabilization Mission in the Democratic Republic of Congo (formerly MONUC)
NGO	Non-Government Organization
NRA	National Resistance Army
SAF	Sudanese Armed Forces
SIGINT	Signals Intelligence - Intelligence gathered from communications sources
SPLA	Southern People's Liberation Army
SSD	South Sudan
UN	United Nations
UPDF	Ugandan People's Defense Force (formerly the NRA)

ABTRACT

Understanding the geographic distribution of insurgency violence is critical for assessing where counter-insurgency and civilian protections operations are effective. It allows researchers and policymakers to detect trends in violence and propose local programs designed to quell insurgency aggression in vulnerable areas. This thesis examines the spatial distribution of armed-conflicts in Central Africa committed by the Lord's Resistance Army from 2008 to 2012 and offers a descriptive evaluation regarding the geographic fluctuation of violence throughout the region. Existing counter-insurgency programs are discussed, and additional analysis is performed on the development of a high-frequency radio network designed to facilitate information sharing between communities. Resulting geographic representations indicate a steady decline in armed-conflicts in the Democratic Republic of the Congo and South Sudan with violence becoming more prevalent in the Central African Republic. The revealed fragmentation and variance in the LRA's operations supplement a growing body of research that seeks to better understand the geographic evolution of conflict, identify why violence may increase or decrease in certain areas, and assess the capacity for civilian protection initiatives in regions afflicted with insurgency (Buhaug and Lujala 2005; Flint et. al. 2009; Kobayashi 2009).

CHAPTER 1: INTRODUCTION

Since 2002, the world has witnessed ongoing ethnic and sectarian violence across the African continent. The civil war in Sierra Leone, the mass killings in Darfur, and ongoing paramilitary violence in Democratic Republic of Congo (DRC) are three examples of African insurgencies where civilians have been specifically targeted (Johnston 2008). Although these conflicts span politically and environmentally diverse regions, there are recurring themes of civilian vulnerability. The most heavily impacted communities are often those with underdeveloped civil infrastructures including information technology and communications. This has inspired nongovernmental organizations (NGOs) and state leaders to develop initiatives meant to enhance civilian security and combat insurgency operations (Berman et. al. 2013; Mukeba 2013).

1.1 African Militancy and Counter-insurgency Directives

This thesis uses the term "Central Africa" in reference to the DRC, the Central African Republic (CAR), and South Sudan as depicted in Figure 1. Highlighted are the 24 territories that compose the study area applied in this thesis. In each territory, at least one act of violence committed by the Lord's Resistance Army (LRA) occurred between 2008 and 2012.

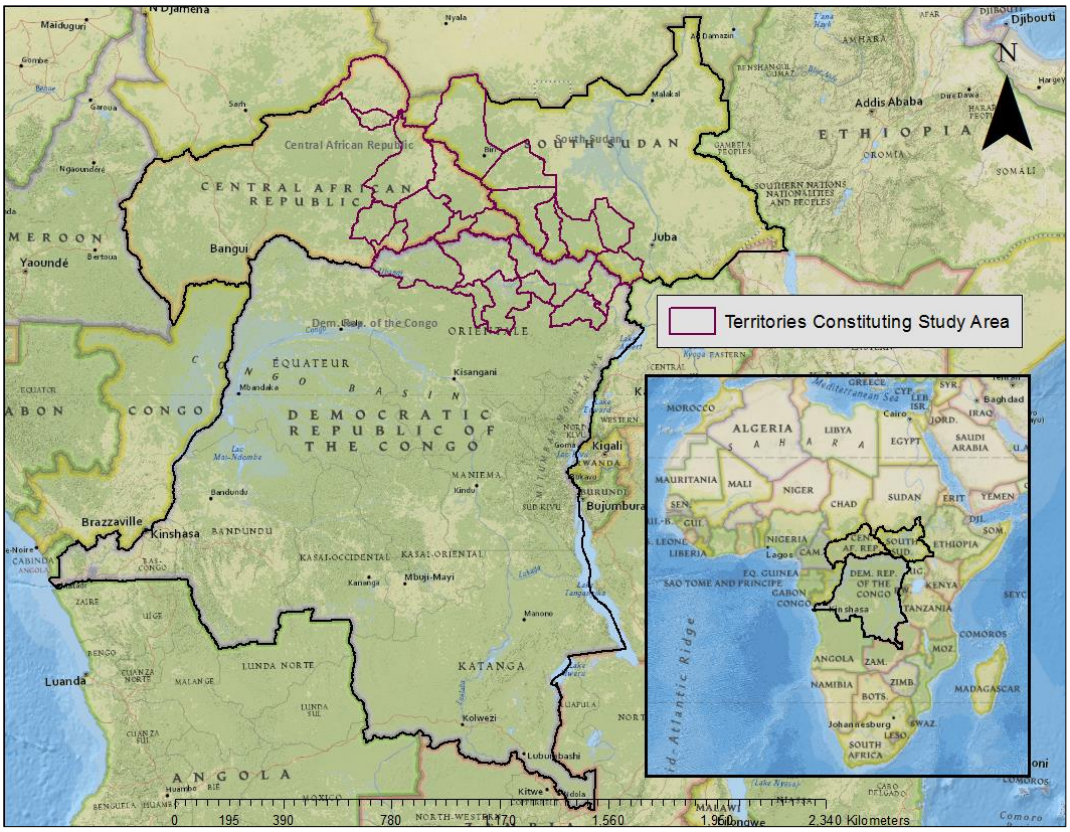

Figure 1: Dem. Rep. of Congo, Central African Republic, and South Sudan
Basemap Source: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, Increment P Corp.

While this region has a rich history of diverse tribal cultures, deep-rooted ethnic and ideological differences have grown into decades of war and insurgency -- particularly in the DRC, which is the largest country on the African continent.

Since the 1990s, conflict has escalated within several Congolese regions. It is estimated that four million people have died there since 1998 as a result of insurrection and violence (BBC 2014). Ethnic clashing in the Northeastern Ituri Region, and fighting between the Armed Forces of the Democratic Republic of the Congo (FARDC) and foreign militias in the Eastern Kivu regions, has prompted the United Nations Security Council to establish the UN Organization Peacekeeping Mission in the Congo (MONUC). This organization was renamed the United

Nations Organization Stabilization Peacekeeping Mission of the Congo (MONUSCO) in 2010 after adopting a revised mandate authorizing the use of force to ensure civilian protection (Copeland 2012).

Moctar Aboubacar, a policy writer for the Africa Center for Strategic Studies in Washington D.C., questions whether MONUSCO has been successful in stabilizing the region. In *The MONUSCO Contradiction*, he describes the mission's obligatory cooperation with the Congolese FARDC as a hindrance to success due to the military's ineffectiveness and disorganization adding that they have achieved neither cooperation nor stability in the region (Aboubacar 2013).

Copeland (2012) presents similar conclusions, carefully defining civilian protection tasks and describing three metrics by which the effectiveness of MONUSCO's mission in protecting Congolese civilians could be measured. The metrics include the rate of civilian deaths, the rate of internally displaced persons (IDPs), and the occurrence of sexual violence. Copeland offers a critical assessment of MONUSCO's peacekeeping operations citing consistently high rates of sexual violence, murders, and displacement, as evidence that the operation is failing to enforce security in the Congo (Copeland 2012). However, these assessments are based on macro-level analyses that do not recognize the variance of insurgency operations within a study area nor provide consistent metrics by which trends in violence can be accurately measured over time and across conflicts.

Research, like Copeland's and Aboubacar's, speak of African insurgency broadly and group together insurgency organizations, which in terms of religion, ethnicity, and ideology, are unrelated. Studies often fail to distinguish between the motivations behind armed-conflicts and the counter-insurgency operations tailored to combat them. In aggregating armed violence along

the Eastern and Northeastern Congolese border, such studies combine violence perpetrated by four distinct insurgency groups: the FARDC, the Democratic Forces for the Liberation of Rwanda (FDLR), the National Congress for the Defense of the People (CNDP), and the LRA. Because rates of violence persisted in these regions, despite new UN Security Council resolutions tasked with ensuring civilian protection, researchers conclude that the mission has fallen short of its goals (Copeland 2012).

1.2 Existing Research Gaps

There are recurring themes in African insurgencies including the conscription of children and the deliberate targeting of civilian populations. These have been thoroughly explored in several case studies (Aning and McIntyre 2004; Beber and Blattman 2011) with resounding calls for programs addressing civilian protection, child education, and former soldier rehabilitation. But, how do we begin assessing whether the LRA insurgency is changing; i.e., how do we model spatial and temporal changes in violence at a scale that allows us to see variance between adjacent territories?

Existing studies evaluating the impact of programs, like those headed by MONUSCO, often assess the presence of violence rather than examining which groups are committing which types of violence and where. We know that violence is ongoing along the Eastern and Northeastern Congolese border, but this border is over 2,000km long and is shared with six other countries. We do not know whether individual groups are becoming stronger or weaker, or if they are shifting their area of operations in response to political allegiances or counter-insurgency operations. Insurgents are treated as bands of rebels and little regard is paid to their ethnic, political, or ideological aspirations. Studies do not consider the difference between each group's capacity for violence and cohesion of their leadership, or their susceptibility to

dissuasion. Assessments rely on macro-level analyses, which describe violence in general. Rarely the metrics for violence extend beyond estimates of civilian deaths and IDPs.

This thesis addresses the flaws of what Fluri (2011) terms a "one-size-fits-all" approach common in African insurgency studies. By executing a spatial analysis, specific to the LRA, in greater resolution than what has been done previously, and by applying a yearly interval to the spatial observations, patterns and trends in violence are revealed indicating flux in the LRA's area of operations. This suggests external variables may be responsible for the change. Resulting observations allow for aid-workers and policy-makers to make informed decisions surrounding the logistics of humanitarian and counter-LRA specific programs, which is critical for strategically allocating military and financial resources. With quantifiable variables, the format of the study allows for researchers to make unbiased comparisons between the LRA insurgency and other regional conflicts that may also require military or UN assets.

1.3 Using Geographic Information Systems to Monitor Insurgency Violence

We know that the strength and orientation of the LRA changed from 2008 to 2012, but we struggle to determine where changes occurred, the extent of the changes, and whether particular territories improved or worsened outside of the overall trend. Also, while we know that some territories employed specific counter-insurgency and civilian protection initiatives, we do not know whether the rate of violence within those territories changed at a rate faster or slower than territories which did not employ the same initiatives.

The objective of this thesis is to leverage geographic information systems (GIS) to demonstrate how data pertaining to the spatiality of armed-conflict can be used to better understand the non-static distribution of insurgency. Using our knowledge of other forces engaged in the region, we can position better arguments on what factors might influence

insurgency behavior such as the utilization of a high-frequency radio network designed to facilitate communication between municipalities.

The remainder of this thesis is divided into four chapters. Chapter Two reviews the origin of the LRA including historical contexts and political dynamics that influence this study as well as a discussion regarding the motives behind insurgency actors and an assessment as to why isolation contributes to civilian vulnerability. This chapter describes the types of counter-insurgency programs operating and examines past research on conflict geographies. Chapter Three describes the study area, data sources, and the various metrics that are calculated and mapped. The conceptual framework is explained along with the expected outcomes. Chapter Four documents and interprets the study outcomes. Chapter Five discusses the impact of the findings, their contribution to existing research on conflict geographies, and their relevance to ongoing discussions regarding the development of counter-insurgency efforts in Central Africa. This thesis concludes by describing limitations of the methods used and by identifying future research directions in conflict geography and insurgency.

CHAPTER 2: BACKGROUND AND LITERATURE REVIEW

To understand the relationships and dynamics between the LRA and the states in which they operate, it is important to first discuss their history and the social variables that have come to influence this study. This chapter examines the Ugandan Alcholi origin of the LRA in the context of a post-colonial Central Africa inundated with violence. The factors contributing to civilian vulnerability are examined and existing counter-insurgency and civilian protection initiatives are reviewed along with past research on conflict geographies.

2.1 The LRA Militancy: From Uganda to Modern-day DRC, CAR, and South Sudan

Prime Minister Milton Obote, a descendent of the Alcholi people from Northern Uganda, suspended the constitution and declared himself President of Uganda in 1966. In 1971, he was ousted from power by a military coup led by his commander, Idi Amin. During the eight years of Amin's presidency, substantial human rights abuses were committed against the Acholi people. While the number of Ugandans murdered during these exchanges is unknown, estimates of casualties range between 100,000 and 500,000 people (LOC 1990).

In 1979, Milton Obote and other Ugandan exiles fought back into Uganda and ousted Idi Amin with the help of the Tanzanian army. Elections were held, and Obote became president for the second time in 1980. Alleging electoral fraud, the National Resistance Army (NRA), led by Yoweri Musevini, gained popularity as a resistance group and began launching attacks against the government (LOC 1990). Retaliation from Obote's security forces decimated areas that were either controlled by or sympathetic to the NRA movement. This was the beginning of the Ugandan Bush War, also known as the Ugandan Civil War, which lasted from 1981 to 1986. The war concluded in 1986 with the NRA taking control of the Ugandan government. Yoweri

Musevini was named President of Uganda, and he remains President as of this writing. Those left in the Acholi-controlled regime fled to the Sudan.

Since 1986, a number of Acholi-based rebel movements have come out of Northern Uganda to resist the Ugandan government citing mistreatment of the Acholi people by both Amin's regime and the NRA. Most notable of the resistance groups was the Holy Spirit Movement established by a medium named Alice Lakwena. The militant arm of the Holy Spirit Movement is now known as the Lord's Resistance Army (Bunting 2011). Joseph Kony assumed power of the Lord's Resistance Army in 1997, and he remains the leader of the rebel group. Like Lakwena, Kony claims to receive messages from God and is said to be fighting the Ugandan government in order to establish a new government and constitution in line with his religious philosophy (Bunting 2011; HRW 2012).

Over the next decade, the LRA continued a war of attrition against the Ugandan government. They launched attacks against the Ugandan army and even local communities in the Acholi region. The LRA quickly lost favor with the northern communities because of their forced-conscription of child soldiers and for attacking communities they accused of cooperating with the Ugandan government (Bunting 2011; Cakaj 2007). Indiscriminate killings were carried out to demonstrate to the northern populations that the government was unable to protect them if they chose to betray the LRA.

The LRA found a brief ally in the Sudanese government in Khartoum. The LRA was in a strategic, offensive position near the Southern People's Liberation Army (SPLA) -- a Sudanese rebel group based out of Southern Sudan (this region later became South Sudan following an independence referendum in 2011). The SPLA was a rival group to the Sudanese Armed Forces (SAF) who represented government interests in the north. The SAF provided the LRA with a

temporary base of operations in the south, near Juba, and the LRA received weapons, supplies, and training in exchange for guerilla-style attacks against the SPLA (Cakaj 2007). Because the Ugandan government supported the SPLA, the LRA was even more amendable to the arrangement (Cakaj 2007).

Like other insurgency groups, there are items needed to ensure the organization's longevity. These items include food, supplies, and members to fill the ranks. With Sudanese backing having deteriorated after a comprehensive peace treaty was signed between Sudan and South Sudan in 2005, the LRA increasingly relied on looting civilian-communities for food and supplies (Cakaj 2007). Weakened, the LRA signed a truce with the Ugandan government in 2006. The LRA agreed to leave Uganda and move to an area near Garamba National Park in the northeastern region of the DRC. In 2008, ongoing violence perpetrated by the LRA provoked a unified attack from the South Sudanese, Ugandan, and Congolese armies which, in turn, prompted new waves of retaliatory violence against civilians including the abduction and forced recruitment of children. It is believed that today there are between 200 and 300 members of the LRA remaining (Cakaj 2007). This is a significant decline from the 3,000+ members the army once comprised. Today, many people question whether the group still has centralized or political motives. While they have been effectively eradicated from Uganda, they remain active in the DRC, CAR, and South Sudan where looting, murder, rape, and kidnapping are still prevalent.

2.2 Area of Operations: People and Topography

The LRA's area of operations surrounds the borders between the DRC, CAR, and South Sudan. Poverty and malnutrition are prevalent within these states whose public health metrics rank among the most severe in the world. The average infant mortality rate in the region is 80 deaths per 1,000 live births. The combined literacy rate is just over 50% and the median age falls

under 20 years in all three countries. In comparison, the infant mortality rate in the United States is under 6 deaths per 1,000 live births, the literacy rate is 99%, and the median age is 37.2 years (CIA 2014). A lack of public health facilities compounded by an enormously disproportionate number of youth lacking a formal education contributes to a state of instability and civilian insecurity. Most LRA victims, whom vary in ethnicity and political alignments, share the struggles. Victims include civilians from the northern, Alcholi region in Uganda as well as the Lugbara people who live on both sides of Uganda's western border with the DRC. Christian, Islamic, and Animist tribes have also been targeted in the CAR and South Sudan. This includes members of the SPLA whose ranks contain the Sudanese Dinka.

The LRA traditionally targets rural, isolated communities along sparse countryside. These agriculturally dependent villages and hamlets are particularly vulnerable due to their lack of connectivity to other communities. Without telecommunications infrastructure, detached communities must rely on "runners" and ground transportation in order to relay messages between communities. Not only might those carrying messages be targeted by the LRA, but the slow reporting time results in a delayed military response in the event of an attack.

The region's topography consists primarily of evergreen and deciduous forests in the Northeastern DRC, and shrub-lands, grasslands and croplands in the northern area of the study in Southeastern CAR and Southwestern South Sudan. Heavily vegetated and unsettled areas are colloquially referred to as "the bush." Figure 2 is a 300m mosaic prepared by the ESA GlobCover 2009 Project Team which documents land cover types using the UN Land Cover Classification System (LCCS) (Bontemps et. al. 2011). The map provides additional context to the environment and topographical composition which influences modern development and insurgency behavior. The particularly dense forests in the DRC have hindered civilian protection

initiatives including the construction of communication infrastructure. The terrain conversely aids the LRA by providing cover and place to retreat from military forces while remaining hidden from aerial surveillance.

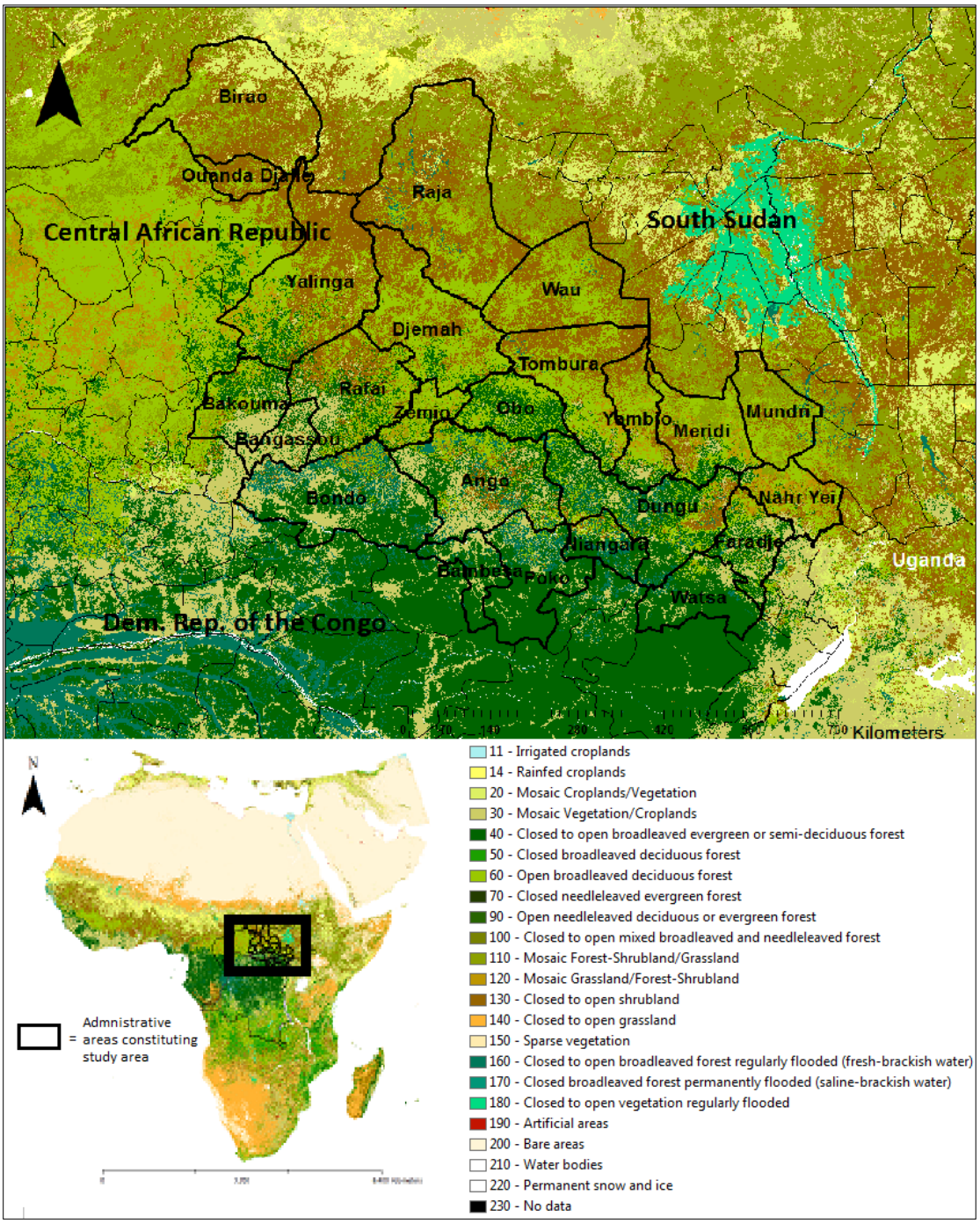

Figure 2: GlobCover 2009: 300m Mosaic Land Cover Classification
Source: *Bontemps, S., Defourny, P., Van Bogaert, E., Arino, O., Kalogirou, V., Perez, J. "Globcover 2009: Land Cover, Africa, and the Arabian." UCLouvain & ESA Team, 2011.*

Combined with a scattered population and an agriculturally-based economy where the demand for consumer goods and mobile services is low, there has been little commercial incentives to venture into these regional markets. In 2010, the Invisible Children NGO, with the Resolve NGO, attempted to help close the communication gap by expanding a network of high-frequency, short-wave radios (HF radios) with the objective of providing communities with intelligence on LRA movements. The nature of the HF radio transmission allows for broadcasts to be sent up to 3,000 kilometers leveraging the signal's ability to bounce between the ionosphere and the forest canopies around the curvature of the Earth (Ionosphere 1999). This essentially enables a radio in the town hub of Dungu to communicate with every other community in the LRA's area of operations -- a feat otherwise unachievable with existing infrastructure.

2.3 LRA Strategy

LRA members are constantly on the move as they are pursued by Ugandan and Congolese troops. It is rumored that some LRA commanders have access to satellite phones; however, they have reduced their use of satellite phones for fear of being tracked by government and military forces. The groups tend to move alongside rivers, secondary roads, and cattle paths, and they use runners to relay messages from one group to another. LRA commanders have access to GPS devices used for navigation, and they have been known to code GPS coordinates in order to organize meetings with partner groups (Cakaj 2007).

Prior to attacking a community, LRA members will often perform reconnaissance. They have been known to kidnap locals and force captives to spy on their behalf. They are most interested in whether there are Congolese or Ugandan military forces stationed near their target. If there is a nearby threat, they will typically refrain from attacking (Cakaj 2007). However, if

they are to engage a military force, they are more likely to attack the Congolese army (FARDC) than the Ugandan army (UPDF) (Cakaj 2007). While the group is averse to risk, they have on multiple occasions pretended to be opposing military groups to infiltrate communities prior to attacking (Cakaj 2007).

2.4 Notorious LRA Massacres

While LRA violence has been ongoing for over 20 years, two massacres in the DRC stand out as particularly violent and illustrative of vulnerabilities faced by at-risk communities. The importance of emphasizing these events is to illustrate the brutality of the LRA and their irregular military tactics, which include the callous and systematic execution of civilian populations. Both of these events fall within the study area and the associated casualties are included in the quantitative analysis described in Chapter Three.

The first series of events described are known as the Christmas Massacres. This series of killings occurred from December 24th, 2008 to January 17, 2009. In 24 days, 865 civilians were murdered and 160 children were abducted (HRW 2009). The LRA had coordinated attacks across three major communities in the Haut-Uele district located in the Orientale Province in Northeastern DRC. The communities were Doruma, Duru, and Faradje.

One of the first villages attacked was Batande -- a small hamlet in Doruma with a population of approximately 100 people. Ugandan soldiers, responding to the LRA attack, arrived at the village three days after the violence began. They found that the LRA had murdered 82 people leaving less than 20 survivors. Soldiers learned that residents had gathered for a Christmas celebration before the LRA attacked them by surprise. LRA members gathered residents, marched them into the woods, and then killed them (HRW 2009). LRA members ate the food that had been prepared for the celebration and stayed overnight in the village.

The next day, LRA members traveled to the nearby town of Nagengwa and killed 30 people. Then, they traveled to Mabando where they killed another 50. The LRA traveled to nine more villages killing people as they went (HRW 2009). Meanwhile, similar attacks were happening in Duru and Faradje, yet no villages were equipped with a way to request assistance or alert adjacent communities. The map in Figure 3 depicts Northeastern DRC around the Garamba National Park, which borders modern-day South Sudan. Shown in the map are the three major communities, which sustained iterative LRA attacks over the 24-day period.

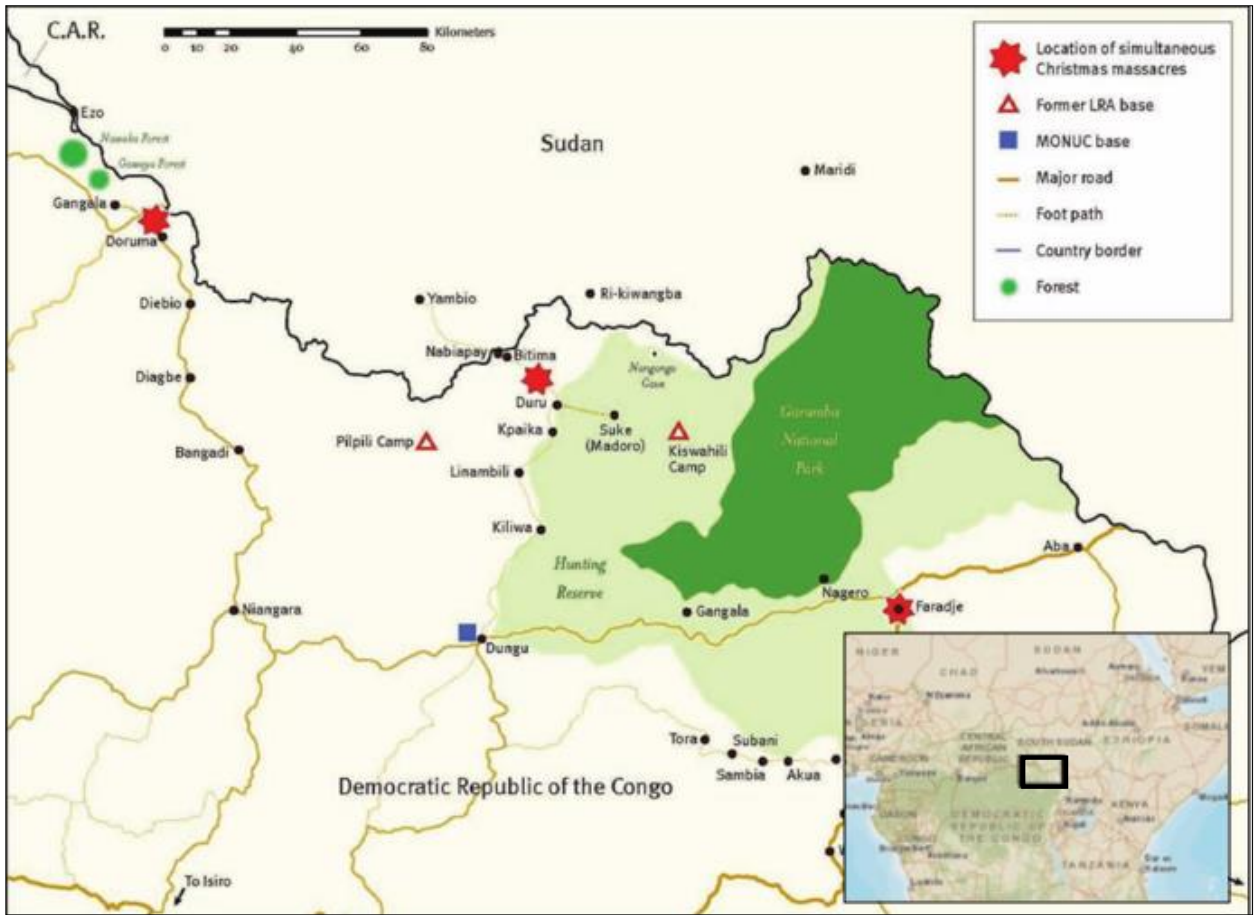

Figure 3: Locations of Christmas Massacres (HRW 2009)

Source: Human Rights Watch. "The Christmas Massacres: LRA Attacks on Civilians in Northern Congo." (16 Feb 2009). Map inset added for context.

The second series of events are known as the Makomba Massacres. These occurred between December 14th, 2009 and December 17th, 2009. The LRA attacked 10 villages in the Makomba area again located in the Haut-Uele district, DRC. They killed 321 civilians and abducted 250 others, including 80 children (HRW 2010). The map shown in Figure 4 traces the LRA's four-day route making note of the villages they attacked.

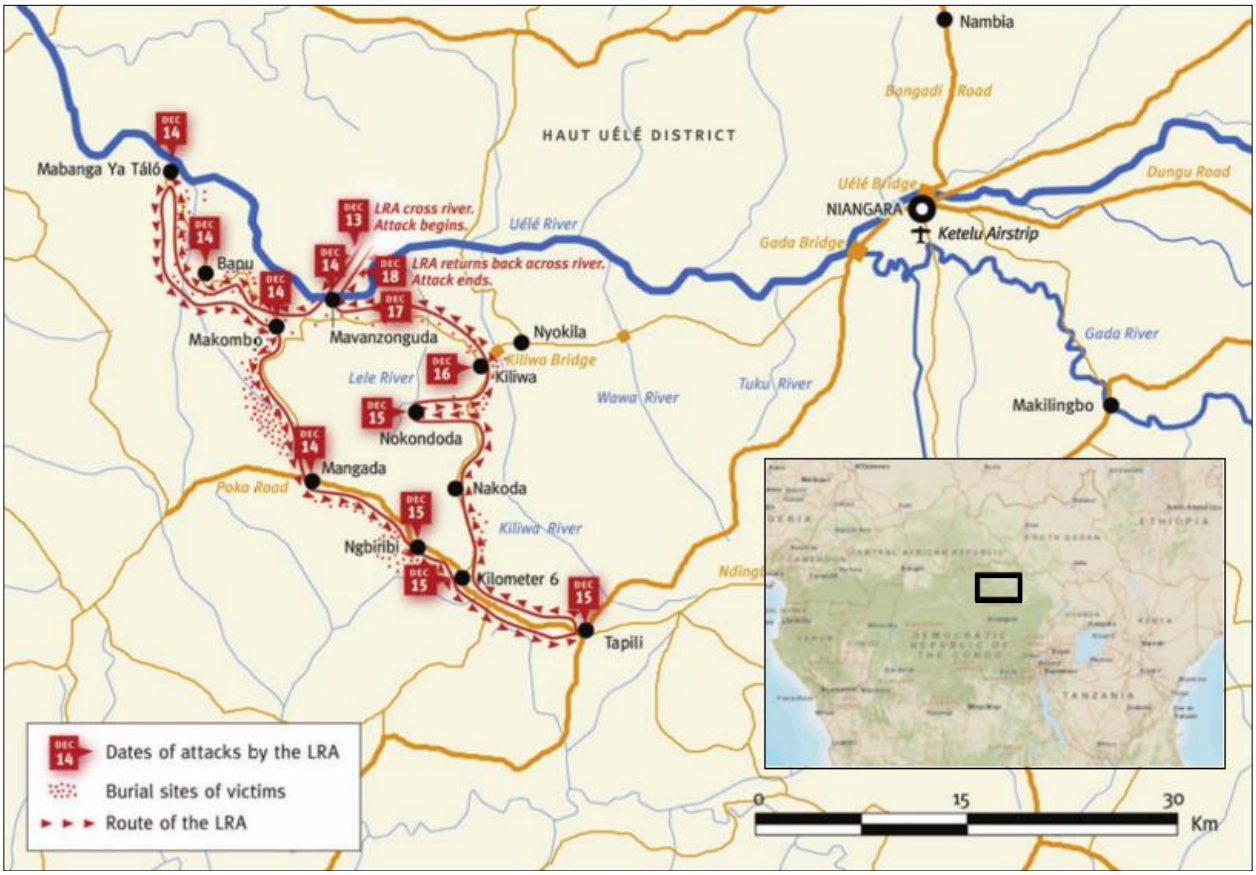

Figure 4: Map of Makomba Massacre (HRW 2010)
Source: Human Rights Watch. "Trail of Death: LRA Atrocities in Northeastern Congo." (28 March 2010.) Map inset added for context.

Abducted civilians were ordered to march 20km a day through the bush carrying looted items and supplies. Civilians who could not keep up were killed. Congolese and Ugandan

soldiers stationed in Haut-Uele were alerted to the incident on December 16th – two days after the violence started. When soldiers arrived on December 18th, the LRA was gone (HRW 2010). MONUSCO was tipped off to the event in late December; however, it took two months for MONUSCO and the UN to obtain the complete details of the attack. When the UN did receive preliminary reports of the massacre, they assigned the intelligence a grade of "D" on a scale of "A" to "F" indicating a low confidence in credibility (Poole 2013).

The Human Rights Watch (HRW), an international NGO based out of New York City, estimates that, since the LRA's inception in 1987, over 20,000 civilians have been abducted, and tens of thousands have been murdered (HRW 2012. According to records compiled by two NGOs based in the United States, the Invisible Children and Resolve, the LRA are responsible for 2,681 murders between 2008 and 2012. These killings demonstrate the enormity of the LRA's crimes and a serious lack of counter-insurgency intelligence.

An aggravating factor in these events is the remoteness of communities and the distance to counter-insurgency operations headed by state military forces. When the LRA attacks a small village or hamlet, it takes several days or weeks for the army, state, or media to be made aware. This has prompted organizations and NGOs to explore ways to strategically intervene by tracking the movements of LRA members, developing local programs to convince LRA members to leave the group, and by networking at-risk communities using radio and cellular communications. Together, these efforts should allow counter-insurgency actors to respond to LRA attacks quickly, alert nearby communities to LRA operations, and slowly break down the LRA disposition by reducing the success of their operations while increasing the risk.

2.5 Counter-insurgency Programs

Since 2008, there have been numerous efforts to curb LRA violence. Under U.S. President George Bush, the U.S. agreed to provide financial and logistical support to the Ugandan government in their pursuit of the LRA. In 2010, under President Obama, 100 military advisors were sent to region in order to assist Ugandan and Congolese military forces in tracking the LRA. Other efforts include an arrest warrant placed on Joseph Kony by the International Criminal Court (ICC), and a five-million dollar bounty for Kony's arrest offered by the U.S. (Baguma 2012). Included in the ICC's charges against Kony is the extensive use of children in warfare – a trend that is particularly prevalent in Sub-Saharan Africa where over half of the population is under the age of 18 (Anning and McIntyre 2004).

In *From Youth Rebellion to Child Abduction: The Anatomy of Recruitment in Sierra Leone*, researchers Prof. Emmanuel Aning and Angela McIntyre analyzed child soldiering in Sierra Leone. They described a 10-year civil war where both military and non-state actors had compelling incentives to develop strategies of mobilizing youth for their causes (Aning and McIntyre 2004). In the case of Sierra Leone, the civil war was preceded with economic despair, lack of economic opportunities, and a failing education system. The disadvantaged and uneducated have become prime targets for recruitment due to the ease at which they can be manipulated (Aning and McIntyre 2004). Their study draws many parallels with the LRA's recruiting and forced-conscription of children in Central Africa. Aning and McIntyre suggest that in order to combat the recruitment of children in warfare, youth-oriented initiatives must be considered an active component of the peace process, and access to education must be emphasized when working with former combatants. (Aning and McIntyre 2004; Beber and Plattman 2011).

In their 2011 study, *The Logic of Child Soldiering and Coercion*, Beber and Plattman argue that education-based, intervention programs that target youth susceptible to LRA influence can teach youth about the LRA including how to escape if captured. (Beber and Plattman 2011). Education is critical considering the methods by which children become soldiers in the first place. While many are abducted and forced to commit violent acts against their own community or family, others are tricked or convinced that life as soldier is prestigious, prosperous, and easy (Riddell 2009).

With LRA members dispersed and without a centralized command point, there has been a surge in information campaigns to reach and educate LRA members and to convince them to leave the organization. The Enough Project, an American NGO based out of Washington D.C., promotes the use of FM radio broadcasts encouraging LRA defection. They suggest that these messages should target junior- and mid-level officers (Cakaj 2010). LRA members should be made to feel that opportunities, such as resuming studies in vocational training, exist elsewhere (Cakaj 2010).

Beber and Plattman (2011) cite evidence that the LRA have been known to halt abductions in some areas after local children were exposed to FM radiobroadcasts offering amnesty to LRA members. Senior LRA leaders feared that these community broadcasts would catch on with LRA youth and trigger mass desertion among lower-ranking members that do not otherwise have access to FM radios (Beber and Plattman 2011; Cakaj 2010). Leaflet distribution and helicopter-mounted speakers flown over LRA areas have also been used in encouraging defection among LRA members. In 2012, 25 Ugandan members defected from the LRA with 21 of them stating they had seen or heard these messages (Poole 2013; Vanvider 2013). With a declining roster of active LRA members, this represents a substantial reduction.

The HRW recommends continuing to improve communication infrastructure and building cellular phone towers as a means of combating the LRA citing both physical and ideological benefits. More towers imply an expansion of mobile phone coverage in LRA-affected areas, which may result in more intelligence sharing and increased coordination between communities (HRW 2012). The Pyramid Research group, a consulting firm specializing in telecommunications and emerging markets, released a study in 2009 analyzing changes in mobile phone access in neighboring Uganda. They estimate that, in 2002, the percentage of Ugandans with access to mobile communications services was 1.9%. In 2009, that number had risen to 39%. The firm predicts that 70.7% of Ugandans will be using mobile services in 2014 (Baker 2009). Nearby countries like the DRC, South Sudan, and CAR are expected to experience similar growth (Estefan 2012). In fact, at the time of writing, some communities in the CAR, including Obo, Mboki, and Rafai, as well as some communities in the DRC, including Dungu and Faradje, have already constructed cellular towers. However, existing service is limited and does not yet extend to the many villages and hamlets, which surround the more populated community-centers (Poole 2013).

While the construction of a cellular communication network is slowly expanding, the Invisible Children and Resolve have taken measures to repurpose an existing network of high-frequency (HF), short-wave radios maintained by local Catholic churches. The churches have long used the HF radios for logistical purposes, although they are increasingly being used to defend against the LRA. In an interview, Sean Poole, the Counter-LRA Program Director at the Invisible Children, explained how the radio network functions as a complex security reporting apparatus. There are currently 38 radios composing an “early warning” network with 17 additional radios slated for installation by the first quarter of 2014.

The purpose of the HF radios is to report LRA sightings and attacks to UN and military forces as well as alert nearby communities of the LRA's presence. This allows citizens there to take precautionary measures. With the aid of radios, communication can occur faster than other methods such as sending runners or vehicles that risk being targeted by LRA members (Poole 2013).

The map in Figure 5 represents the approximate location of HF radios in use between 2008 and 2012. Points on the map have been inflated and staggered in order to shield radios' actual location. The geocoordinates of the HF radios are considered confidential due to their sensitive nature and public concerns that having an HF radio could result in a community being specifically targeted by the LRA. The HF radios and the territories in which they are located are discussed further in Chapter 3, Methodology.

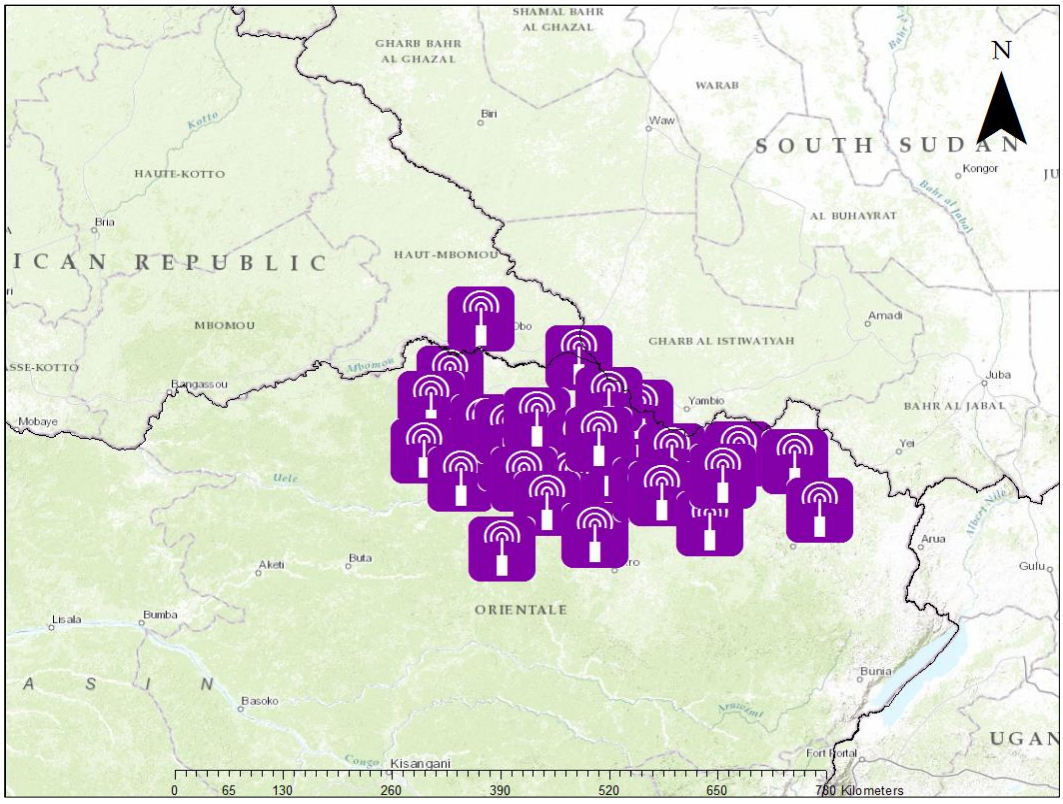

Figure 5: Generalized HF Radios 2010-2012 indicating approximate location

The Human Rights Watch supports efforts to ensure HF radios are available for all communities within the LRA's area of operations (HRW 2012). For isolated communities, these radios may serve as the only means of telecommunication. LRA encampments can be as close as 10-12km away. Even after the LRA leaves the vicinity, there is still a chance that they will return. If they do, the radios offer an avenue by which that information can be relayed to government, military organization, or UN personnel (Poole 2013).

With the assistance of the radios, LRA attacks are geographically identified with GPS coordinates and logged in a central database known as the LRA Crisis Tracker. Leveraging this geographically referenced information, the LRA area of operations is more clearly delineated which allows for education-based programs to be tailored for specific regions. Affected regions have also become candidates for economic and commercial investments, including telecommunications, due to the LRA's preference in attacking isolated communities. Overall, the information gathered in the HF radio communication network offers a picture not previously available. It remains the primary means of intelligence gathering information used by the African Unions (AU), the United Nations, Ugandan military forces, and the United States (Poole 2013).

2.6 Conflict Geographies and Theories of Communication and Insurgencies

There have been numerous studies discussing conflict geographies involving various types of African insurgency over the last 10 years. In a 2008 paper on insurgent violence in Liberia and Sierra Leone, Patrick Johnston argued that a military's effectiveness is a direct result of their hierarchical organization, which is determined by geographic and technological factors (Johnston 2008). His conclusions provide insights on the tactics armed groups will use given a defined set of circumstances and technological limitations. He argues that a military member's preferences and strategies will vary relative to the cost of defection (Johnston 2008). Classifying

insurgency groups as unitary or multidivisional, he concludes that unitary insurgencies are more effective on the battlefield, and more reliable in negotiations due to their centralization and ability to control their members. Conversely, multi-divisional insurgencies are more fragmented with members dispersed with many small sub-divisions of authority, although a centralized leadership does exist (Johnston 2008).

There is a close parallel with Johnston's description of multi-divisional insurgencies and the modern-day LRA. Since leaving Uganda, the group is widely dispersed with operations across three countries. They are scattered more today than ever before, and they currently have the fewest number of members in their history. The fragmented nature of the group negotiations difficult, and a peace treaty is nearly impossible to broker as many groups are scattered, undisciplined, and unregulated (Johnston 2008). However, it also renders them less effective in their overall threat to the Ugandan government whose overthrow had been their original mandate.

The lack of available communication has an effect on the LRA's ability to regulate and coordinate amongst their members. While this thesis advocates for the development of communication infrastructure as a civilian protection initiative, there are those who suggest that introducing communication technology, like cellular communications, may empower and allow new organizational models for insurgency organizations, i.e. a better functioning "networked insurgency" (Arquilla et. al. 1999; Andreas 2002; Muckian 2006). For insurgencies and non-state guerilla groups, mobile communications provide a platform by which attacks can be executed in an organized fashion while remaining flexible and reactive to counterinsurgency efforts (Blakely 2005; Cordesman 2005; Leahy 2005)

In the context of the wars in Iraq and Afghanistan, reactions by Al-Qaida and the Taliban to the development of communication infrastructure have been observed. There are reports of the groups attacking or threatening cell phone towers in some areas, while demanding that services are improved in other areas. These seemingly contradictive behaviors reflect their perceived security in their surroundings, i.e. whether they felt locals would share intelligence or provide tips to coalition forces or police (Shapiro and Weidman 2012).

Wireless communication channels enable the general population to easily share information about insurgent activity -- oftentimes anonymously thereby reducing the fear of reprisal attacks (Shapiro and Weidman 2012; Trofimov 2010). Instead of having a single intelligence, counter-insurgency effort, the entire population can be employed in collective intelligence gathering – a concept for which Emeritus Professor of UC Santa Barbara, Michael Goodchild, coined the term "citizens as sensors" (Goodchild 2007). In *The New Digital Age*, Eric Schmidt, the executive chairman of Google, discusses the future of multi-dimensional conflict in an era where information is distributed and accessed freely. He argues that a connected and informed public has a greater potential to mobilize against injustice (Schmidt and Cohen 2013).

To engage civilians in Iraq, the Coalition Provisional Authority, the interim transitional government from 2003 to 2004, budgeted $10 million USD for billboard, print, radio, and television advertising instructing civilians how to leverage the National Tips Hotline to report information and expand the intelligence profile on local insurgencies (Semble 2006). These efforts have multiplied the channels by which civilians can share information and participate in security building.

There are few works that quantitatively assess the effects of introducing civilian protection initiatives, including communications development, in war-affected areas. However,

in *Talking About Killing: Cell Phones, Collective Action, and Insurgent Violence in Iraq*, published by Profs. Jacob Shapiro and Nils Weidman, improvements in communication are explored to assess their impact on the production of violence in Iraq (Shapiro and Weidman 2012). While acknowledging that introducing cell phone coverage can make it easier for insurgents to coordinate attacks, their findings suggest that new coverage in areas where Iraqi insurgencies are ongoing creates more opportunities for "passive signals intelligence". This includes information gathered from people and telecommunications that can be shared with counter-insurgency forces (Shapiro and Weidman 2012). One of their key conclusions suggests that the "provision of information" by non-combatants is the most critical element. In an open-communication environment, civilians experience only a minimal risk to safety for cooperating with government and counter-insurgency forces. These information-sharing efforts have a substantial effect on local conflict (Shapiro and Weidman 2012).

In a working paper titled *Modest, Secure and Informed: Successful Development in Conflict Zones*, the garnering of civilian support in information gathering is referred to as part of a "hearts and minds" model (Berman et al 2013). This model describes a three-sided, game theoretical decision making process between non-combatants, governments, and rebel forces. Berman et al. (2013) model is searching for an optimum ratio of conditions that encourages information-sharing by non-combatants without fear of retribution or of being identified. Similar models have been in place in Iraq where coalition forces appeal to civilians to "fight the war in secret" and provide information on insurgents (Berman et. al. 2013; Miles 2004). The model predicts that with the expansion of mobile technology, and a tilt of the equilibrium by which civilians are willing to participate, there should be a reduction in violence in rebel-active areas (Berman et. al. 2013). This "hearts and minds" method corresponds well with the LRA's strategy

in Central Africa where tactics of intimidation and fear are used to dissuade locals from participating in anti-LRA efforts. Logic presented in these studies suggests that, given the proper conditions, civilians will participate in information sharing.

Research conducted by Shapiro and Weidman in *Is the Phone Mightier than the Sword? Cell Phones and Insurgent Violence in Iraq* suggests that the introduction of new mobile coverage indeed reduces the rate of violence relative to overall trends (Shapiro and Weidman 2011). Using a 50% significant threshold, they found that activating a new cell phone tower predicted .896 fewer attacks per 100,000 people, per district, per month. Conceding that they could only speculate whether the decrease was because new coverage allowed civilians to inform on insurgents, or if the new coverage enabled enhanced coalition intelligence gathering efforts, the decline in the rate of insurgent attacks was clear (Shapiro and Weidman 2012).

2.7 Use of GIS in Insurgency Studies

GIS is increasingly being used to explain the spatial dynamics of insurgency and civil war by identifying variables that vary in space and at scales consistent with armed-conflicts and conflict-zones (Buhaug and Lujala 2005). Buhaug and Lujala (2005) argue that conflict-specific variables are dependent on the scale of measurement and that country-level geographical variables often omit specific features of terrain, natural resources, and subsets of ethnic diversity, which might otherwise correlate with increased risks of conflict. This holds especially true in regions experiencing simultaneous conflicts that may be ethnically unrelated, yet motivated by distinct geographic variables.

Most civil wars and insurgencies are isolated to certain parts of the country due to either a concentrated group of people identifying with a particular ethnicity, religion, or ideology, and conflicts often extend from territorial disputes or ownership of natural resources within their

region (Buhaug and Lujala 2005). Typically, commonly used metrics are measured at the national level despite substantial deviations between statistics aggregated by country versus those that are specific to particular conflict zones. This is often due to a lack of available data at the zonal level.

In 2005, Buhaug and Lujala examined the suitability of country-level statistics in place of data collected at levels specific to conflict zones. They classified individual conflicts as stationary points with a fixed radius accounting for a total of 252 civil conflicts occurring between 1946 and 2001. Next, they separately coded individual countries and individual conflict zones by land-cover types (e.g. mountains or forest) and by whether they contained "lootable" items such as gemstones, coca, cannabis, or opium. After conducting multivariate regression analysis on the geographic variables, they reaffirmed their notion that the scale of measurement does affect the significance levels associated with the presence of land-cover types and lootable items specific to individual conflict-zones. The correlations were less significant when using country-level aggregates (Buahug and Lujala 2005).

Other GIS studies (Cederman et. al. 2007) focus solely on the sub-national divisions of ethnicity and whether these are a driving force behind certain conflicts. Cederman et al. (2007) essentially lay the foundation for country-level analysis by applying a spatially enabled disaggregated approach using polygonal feature classes to correspond with ethnic sub-divisions (i.e. boundaries). Arguing that this can then be used to better identify whether ethnic groups are participating as collective actors in various conflicts and civil wars, Cederman et. al. underwent the arduous process of digitizing a series Soviet-era ethnic classification maps known as the Atlas Narodov Mira (Cederman et. al. 2007). By layering the digitized maps with rasterized representations of population densities, they propose creating a series of ethno-linguistic

fractionalization indices (ELFs) to be used in future GIS projects. Completed, the digitization project yields greater quantitative facts regarding the "micro-level" mechanisms that influence the emergency and evolution of ethnic conflicts and insurgency (Cederman et. al. 2007).

Knowing that environmental features and international relationships are influencing individual conflicts, Flint et. al. (2009) argue that focused spatial considerations are needed to understand how actors behave. This can be achieved by documenting each actor's physical position and by defining their role in geographic and community contexts while recognizing where individual groups lie in the "social terrains" of conflict and in their relationships to other entities (Flint et. al. 2009; Tuathail 2010). These fundamentals must be incorporated in future studies to include disaggregated spatial analysis at a scale that lends specific insights to these theories, which is necessary to avoid losing the particularities of specific conflicts (Flint et. al. 2009; Fluri 2011; Tuathail 2010).

In line with the suggestions outlined in this section, this thesis offers an integrated examination of the LRA insurgency in a geographic framework that acknowledges external influences and derives patterns of insurgency behavior (Chapter 3, Section 3.3.3). Spatial observations address disjuncture in examining insurgencies as static operations. Accordingly, all findings will be provided to the Invisible Children NGO and made available to other organizations working to assess the possible impacts of counter-insurgency initiatives and improve civilian security.

CHAPTER 3: METHODOLOGY

This chapter will review LRA-active areas, discuss the data sources being used to capture metrics of violence, and it will provide a conceptual framework for conducting a descriptive analysis of change in the rates of violence given the introduction of radios over time.

3.1 Study Area and Areal Units of Analysis

This study takes place north of the Great Lakes region in Central Africa and encompasses the borders between the DRC, CAR, and South Sudan. The level of analysis selected in this study represents a "territory-level" analysis because this was the most granular level of administration for which boundary and population data were available for all three countries.

Each country applies different terminology in referring to this level of administrative area. These areas are known as "counties" in South Sudan, "territories" in the DRC, and "sub-prefectures" in the CAR. This study uses the term "territories" in reference to all three.

Territories were included in the study if they sustained one or more LRA armed-conflicts between 2008 and 2012. Territories without any conflicts were considered outside of the area of operations and were excluded from the analysis. Administrative boundaries for these areas were downloaded from www.diva-gis.org in shapefile format. The map shown in Figure 6 outlines each of the 24 territories demonstrating the LRA area of operations from 2008 to 2012.

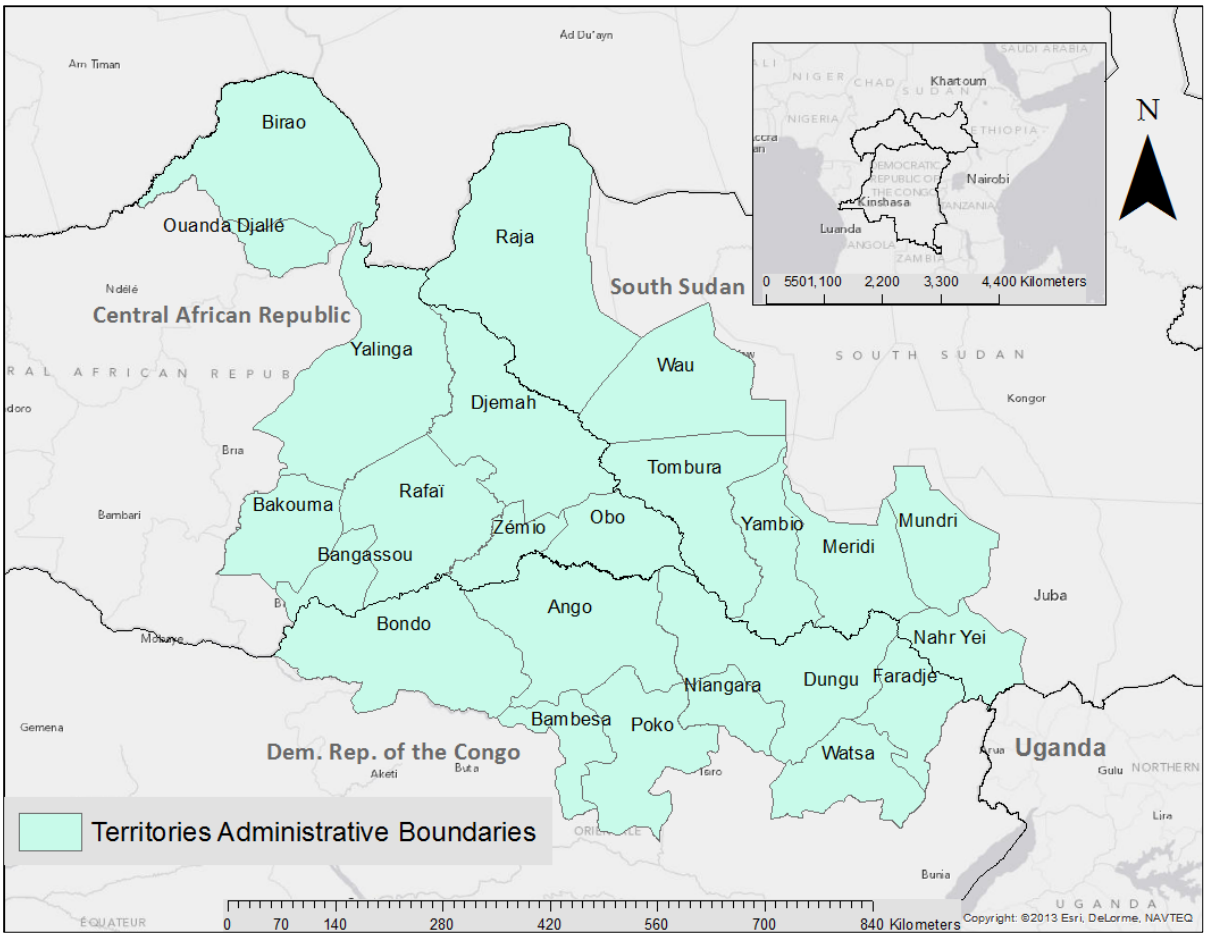

Figure 6: Map representing Administrative Boundaries in the DRC, CAR, and South Sudan comprising the LRA's area of operations 2008-2012.

Population data were acquired from www.geohive.com, www.citypopulation.de, and the World Gazetteer at www.archive.js. While there are many villages and hamlets of varying populations within each territory, data at these resolutions were unavailable. The territory-level population estimates were used to normalize each category of violence. Table 1 describes the total area and population estimates for each territory.

Table 1: Territory Areas and Population Estimates

Country	Territory	Area (km²)	Population
SSD	Raja	56,643	54,340
	Wau	28,853	151,320
	Nahr Yei	12,955	201,443
	Meridi	19,523	82,461
	Mundri	16,361	82,290
	Tombura	27,592	55,365
	Yambio	15,671	152,257
DRC	Ango	34,303	8,675
	Bambesa	9,750	15,483
	Bondo	37,139	18,576
	Poko	22,711	9,592
	Dungu	33,804	23,726
	Faradje	13,303	25,000
	Niangara	8,750	13,977
	Watsa	16,317	33,385
CAR	Djemah	33,923	1,835
	Obo	14,391	36,029
	Zémio	8,039	16,812
	Yalinga	43,856	5,175
	Bakouma	16,348	20,975
	Bangassou	8,019	66,515
	Rafaï	28,714	13,962
	Birao	40,349	48,367
	Ouanda Djallé	6,595	3,888

3.1.1 Modifiable Areal Unit Problem (MAUP)

Because this analysis is performed at a territory level delineated by administrative boundaries whose area and population vary widely, there is a clear risk of the areal units introducing bias in the results. Table 2 shows the variance between territories.

Table 2: Territory Areas and Population: Mean, Max, and Min.

	Area ($km^{2)}$	Population
Mean	23,080	47,560
Max	56,643	201,443
Min	6,595	1,835

The MAUP problem will potentially impact the rate changes calculated by territory along with the comparative changes as represented by the Difference-in-Differences statistical method (Abadie 2005) descriptive analysis (Section 3.7). Territories are a composition of many small villages and hamlets – many of which lie beyond the LRA's area of operations. However, because at least one or more armed-conflict occurred within the jurisdictional area, the entire territory is included in the analysis. This means a territory could have a small community impacted by the LRA while every other municipality in the region is unaffected. To reduce the MAUP associated with the spatial distribution, more analysis would need to be completed at additional scales. Preferably, a provincial, municipal or other type of zonal level analysis would be used to offer more general or granular pictures of insurgency variance to validate any findings. However, for this thesis administrative and population data at other resolutions were unavailable. This would constitute a next step for future research.

In the Difference-in-Differences descriptive analysis, only four distinct territories are identified as having HF radios in 2012 even though a total of 28 HF radios existed by that year. At other scales, the number of distinct areas containing radios could increase or decrease. Aggregating radios by territory implies that other municipalities within the same territory are affected by the HF radios' presence. Similarly, there may be municipalities in adjacent territories that are impacted by an HF radio across the border despite there being no HF radio within their

own jurisdiction. These are examples of errors that may be attributable to the delineation of territories without accounting for the extent of an HF radio's expected reach.

3.2 Data Sources, Variables, and Metrics

Two datasets are applied in this thesis: armed-conflict event data and HF radio locations.

3.2.1 Armed-Conflict Event Data

The Invisible Children and Resolve are two NGOs that maintain an online database of LRA attacks and sightings known as the LRA Crisis Tracker. The Crisis Tracker is a browser-based GIS developed by the sales marketing firm, Salesforce, and it allows LRA conflict data to be available to users through a geographically-enabled web interface (Ungeleider 2011). Incidents involving the LRA, including attacks, kidnappings, lootings, sightings, or even member-defections, are logged in the database. While some information is redacted from the public version of the database (e.g. victim names or other sensitive data pertaining to the movement of high-profile LRA members), the Crisis Tracker database is readily available for download in .XLS format.

The information included in the armed-conflict database is collected from a variety of sources. Sources include HF radio transmissions, UN and media outlets, military forces, NGOs, and other first-hand accounts and interviews such as those conducted by the Human Rights Watch. The complete data sourcing process by which the information is collected, verified, and catalogued in the Crisis Tracker database, can be found in Table 7 in Appendix A. This table was extracted from a codebook prepared by the Invisible Children and the Resolve.

In its raw form, the dataset contains 95 columns that describe the conflict data. These fields include the date of the event, the event's GPS coordinates, description, community,

verification level, and a detailed disaggregation of casualties and victims including violence indicators like fatalities, rapes, and abductions as well as victim sex and age.

At the time of download (02 June 2013), 2,392 records were in the table. Records missing GPS coordinates (23) were removed from the dataset. Of the records that remained, SQL was used to retain only those events that included violence against civilians. Violence against civilians is defined in this study as any LRA attack that resulted in injury to a civilian. Injury includes physical harm, death, sexual assault, and abduction. LRA sightings and looting were not included in this study unless the event included direct harm to a civilian.

Of the 2,369 records obtained, 1,132 of them met these criteria, i.e. each of the 1,132 records constitutes an "armed-conflict". The number of civilian murders and civilian abductions were then logged in separate tables. For example, if a single armed-conflict resulted in five murders and seven abductions, the record in the Armed-conflict table would receive a value of one, the record in the Civilian Murders table would receive a value of five, and the record in the Civilian Abductions table would receive a value of seven. If an armed-conflict resulted in only injury to a civilian, and no one was killed or abducted, then the Armed-Conflict table would receive a value of 1, and the other tables would receive a value of 0.

The map shown in Figure 7 shows the location of all 1,132 armed-conflicts committed by the LRA between 2008 and 2012.

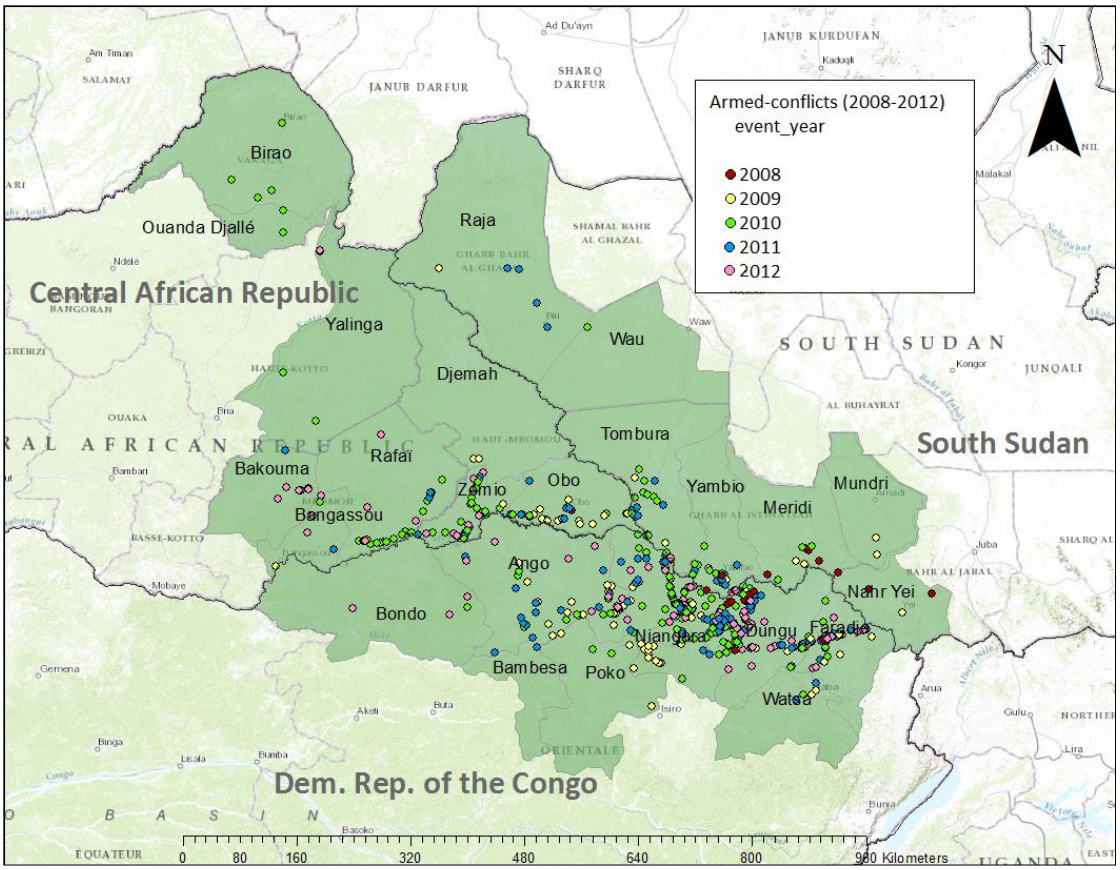

Figure 7: Map of LRA Armed-Conflicts 2008-2012

3.2.2 Civilian Protection Program Data: High-frequency Radio Locations

One objective of this thesis is to identify variance in rate changes between territories, which either do or do not employ HF radios. Data describing the locations of the HF radio installations were provided by the Invisible Children in table format. Data fields for the 38 radios included country, community, GPS coordinates, and the date of installation. Of the 38 radios, two radios were expired, and either were installed after 2012 or were still undergoing construction. The non-operational radios' expiration dates were unclear, so they were excluded from the analysis leaving 28 radios accounted for in this thesis. Due to the sensitivity surrounding the radios' geographic coordinates, the exact locations of radios have been omitted

from any maps included in this thesis. The radio data are instead aggregated in the attribute values for the territories in which they are located. As a result, two categories of territories were identified: a sample group that included those territories that contained HF radios, and a control group that included those territories that did not.

3.2.3 Data Strengths, Assumptions, and Limitations

Data included in this study were obtained from disparate sources using different collection methods with varying levels of confidence and accuracy. The armed-conflict data is derived from first-hand accounts and other primary sources. This presents two challenges. First, GPS coordinates were used to georeference the data, but the coordinates themselves carry an inherent source of error. When recorded, many of the GPS coordinates assigned to the conflict reflect the coordinates of the nearest municipality or other verified landmark. It is not feasible for all counter-insurgency forces to rely on handheld receivers to log each location as would otherwise be expected in higher-resolution applications. However, this does not present a substantial concern in this thesis due to the territory-level scale being used. Second, it is possible that witnesses or reporters of LRA violence have exaggerated certain accounts. It is difficult to corroborate every attack, and duplicate or inaccurate reporting of events has been known to occur. Conversely, there may be additional acts of violence that are unaccounted for just as there may be acts of violence included in this study wrongly attributed to the LRA. This is especially feasible due to numerous reports of rogue military units and other paramilitary organizations committing crimes against civilians (Menondji 2013). Still, the LRA Crisis Tracker database remains the best source of primary conflict data pertaining to the LRA, and this thesis is assured in the collection, entry, and validation of data as outlined in Appendix A, Table 7, *Armed Conflict Data Collection Method* (Resolve and the Invisible Children 2012).

Regional population counts are difficult to estimate and may be another source of error in this thesis. The incorporated population data were obtained from three different sources and the same population counts were used for all five years. In reality, there are a large number of IDPs whose location may vary year to year according to political climates and their proximity to other communities or even insurgencies. While estimates of IDPs are a common metric in describing the impact of military conflict, they are extremely difficult to quantify and therefore have not been incorporated into this thesis. Instead, the population estimates acquired for each territory remained unchanged so the rate of change could be calculated while maintaining a consistent level of precision across each year-to-year transition.

3.3 Methodology-framework

A high-level methodology-framework followed in this study is shown in Figure 8. The methodology involved a series of steps for data acquisition, preparation, and processing that are discussed in detail in Section 3.3.1. The flowchart also outlines the executed exploratory methods (Section 3.4) before identifying suitable approaches for qualitatively assessing the spatial distribution of violence. These approaches include aggregating summaries of violence by country (Section 3.5), calculating annual rates of change by territory (Section 3.6), and calculating comparative changes as represented by a Difference-in-Differences descriptive analysis at the territory-level (Section 3.7)(Abadie 2005).

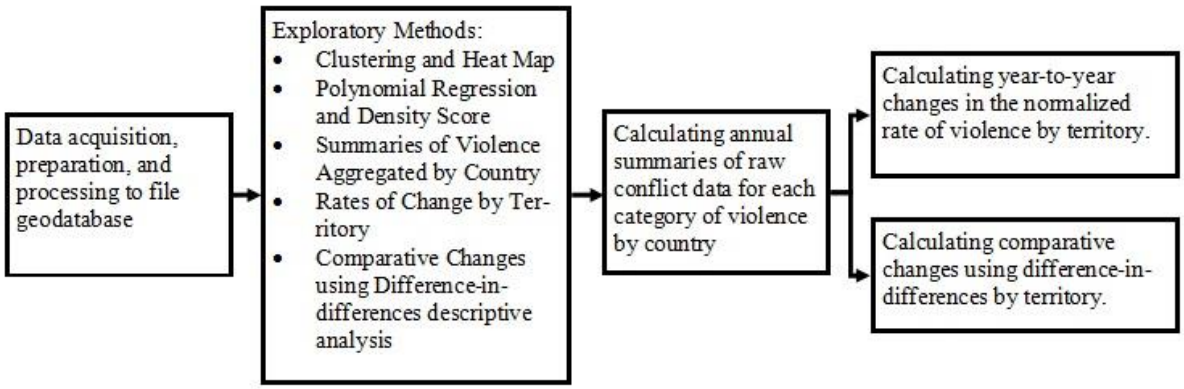

Figure 8: High-level Methodology-Framework.

3.3.1 Data preparation within ArcGIS

Data used in this study were imported and geo-referenced using ArcCatalog. All data were projected to the WGS 1984 UTM Zone 35N coordinate system (SRID 32635) as this encompasses the overwhelming majority of the study area and allowed SQL calculations to be executed in metric units. ArcMap Modelbuilder was used to align feature topology, execute spatial joins, and export cartographic representations.

Each datasets was imported to a single file geodatabase as feature classes using ArcCatalog. Individual feature classes representing the country-level administrative areas of the DRC, CAR, and South Sudan were joined to create a single layer of countries. Similarly, the individual feature classes representing the territory-level administrative areas were joined to create a single layer of territories. The process of acquiring and preparing the data is described in Figure 9.

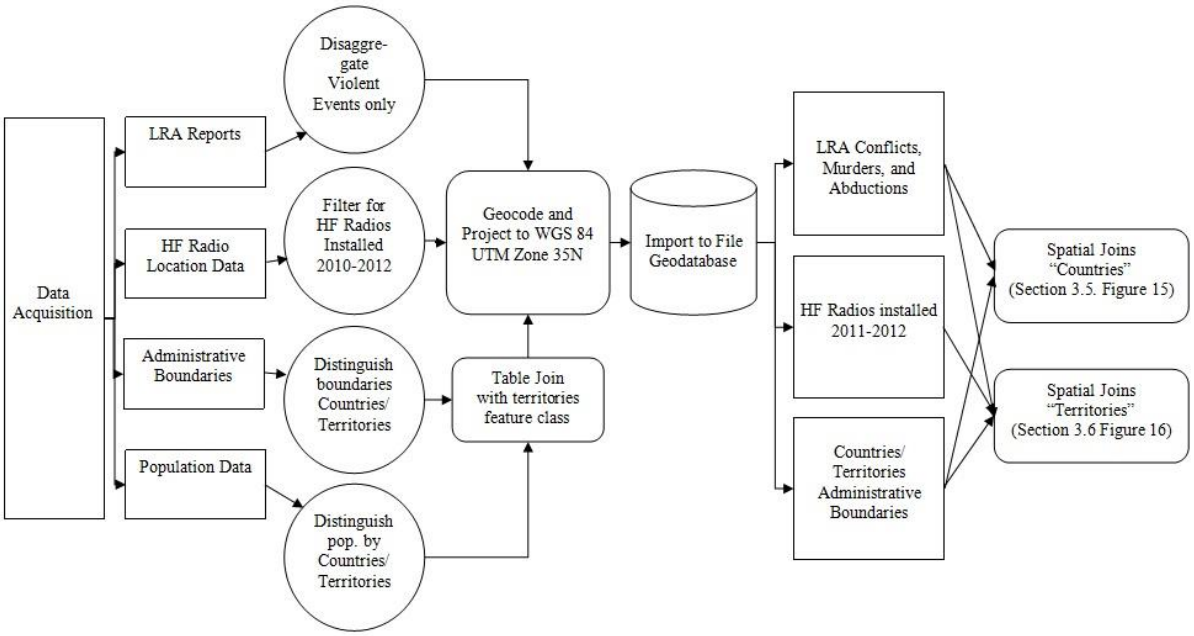

Figure 9. Data acquisition, preparation, and integration workflow

Armed conflicts

Armed-conflicts were imported to the file geodatabase, after the acquired GPS coordinates were geocoded. These data were spatially joined with the "Territories" and "Countries" feature classes and data for each category of violence (i.e. number of armed-conflicts, civilian murders, and civilian abductions) were aggregated by region (i.e. territory or country). Having executed the spatial joins, the annual raw counts of violence were known for each category of violence for each territory and each country from 2008 to 2012.

HF Radio Locations

HF radio location data were imported to the file geodatabase, after the acquired GPS coordinates were geocoded. While the actual geocoordinates of the HF radios are not indicated in this thesis, their use was considered in conjunction with a polynomial regression analysis described in Section 3.4.2. However, as indicated in the workflow, the HF radio locations were

limited to a spatial join with the "Territories" feature class where they were absorbed into the attribute values of the territories in which they were located.

Population

Population data were imported to the file geodatabase and joined with the "Territories" feature class. The ArcMap Field Calculator was used to normalize the conflict data by calculating the rate of violence per 1,000 people in each territory. Conflict data were normalized for the three categories of violence in each year.

3.4 Explored methods

Three methodological directions were initially explored: Clustering and Heat Map analysis, Polynomial Regression and Density Score, and Annual Rates of Change and Comparative Changes using Difference-in-Differences. Attempts and limitations of the clustering and polynomial regression methods are presented before introducing, in detail, the qualitative analysis of the spatial distribution of violence, which is represented as summaries of violence by country, annual rates of change by territory, and as comparative changes represented by Difference-in-Differences.

3.4.1 Clustering and Heat Map Analysis

Clustering methods were explored to show where armed-conflicts are concentrated and whether there is evidence of heavy clustering. In a heavily clustered environment, there is the potential to identify predictor variables that can be used to explain the highs and lows of the data. Six kernel density maps were created to produce rasterized surfaces indicating concentrations of LRA activity. Figures 9-13 reflects the kernel density of armed-conflicts in 2008, 2009, 2010, 2011, and 2012 respectively. Figure 14 reflects the kernel density with all years considered.

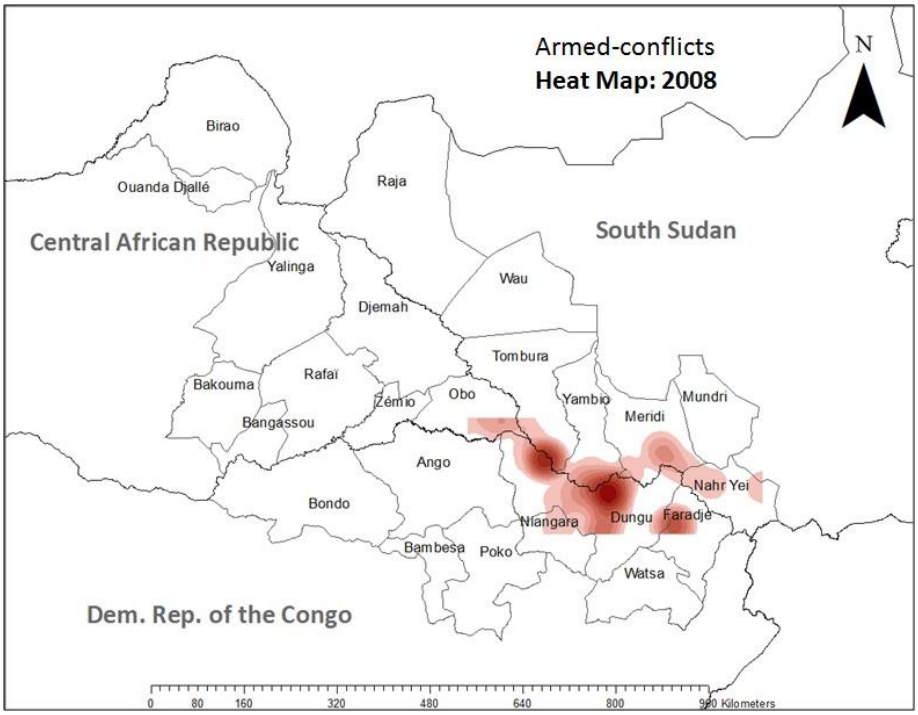

Figure 9: Armed-conflicts Heat Map: 2008

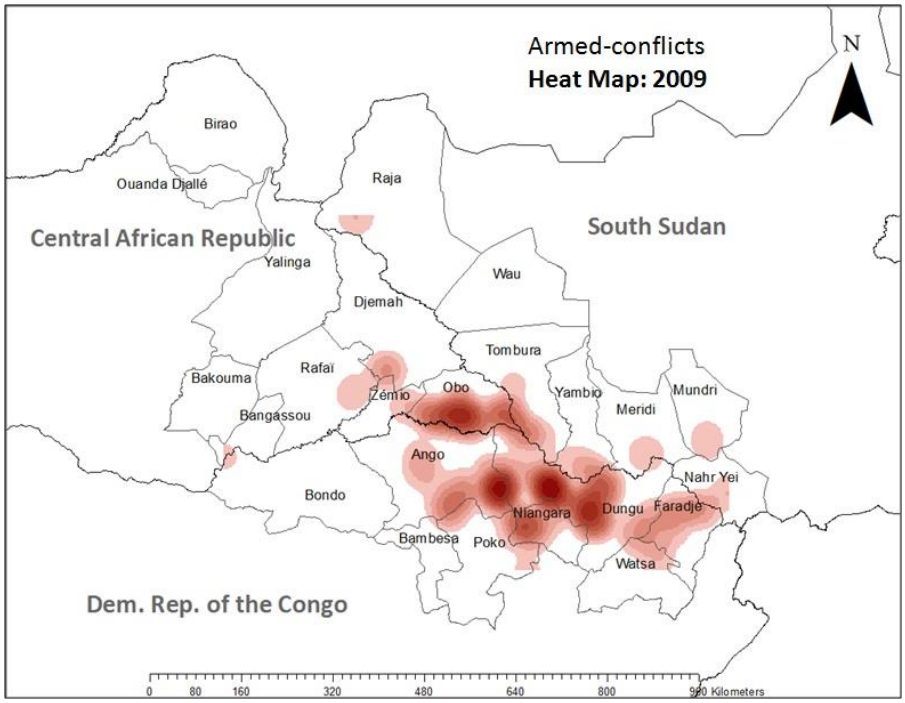

Figure 10: Armed-conflicts Heat Map: 2009

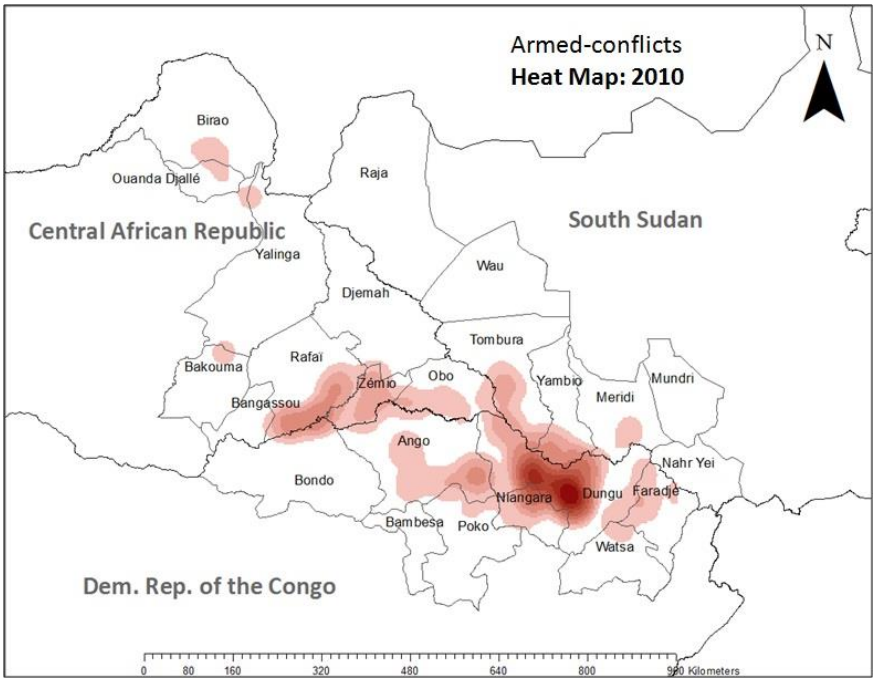

Figure 11: Armed-conflicts Heat Map: 2010

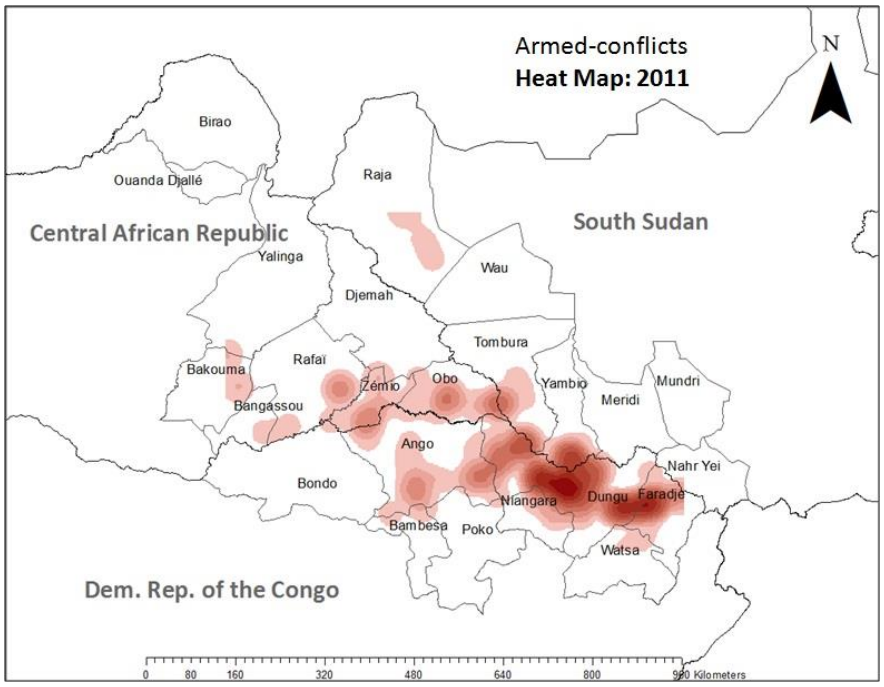

Figure 12: Armed-conflicts Heat Map: 2011

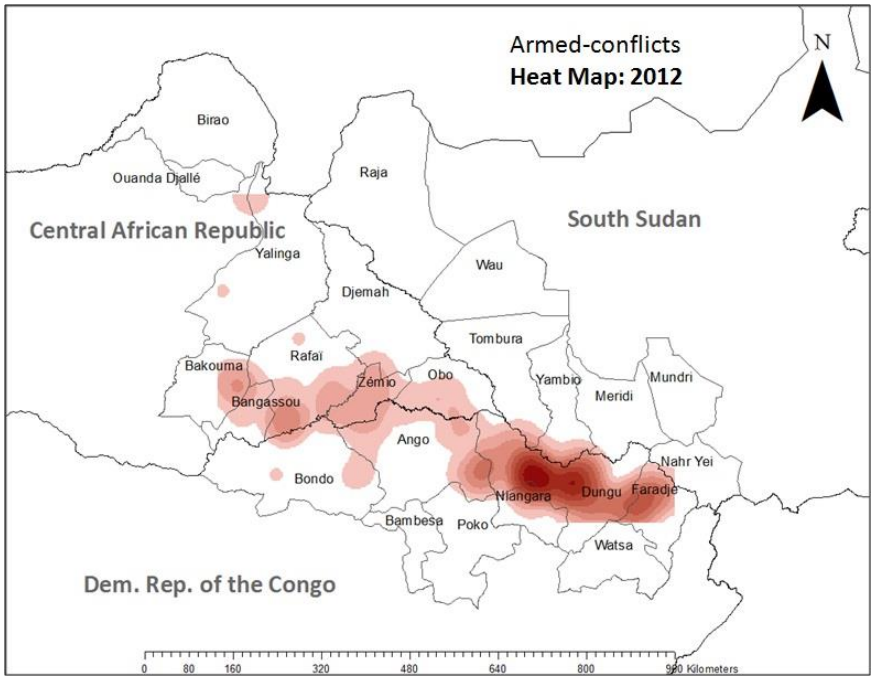

Figure 13: Armed-conflicts Heat Map: 2012

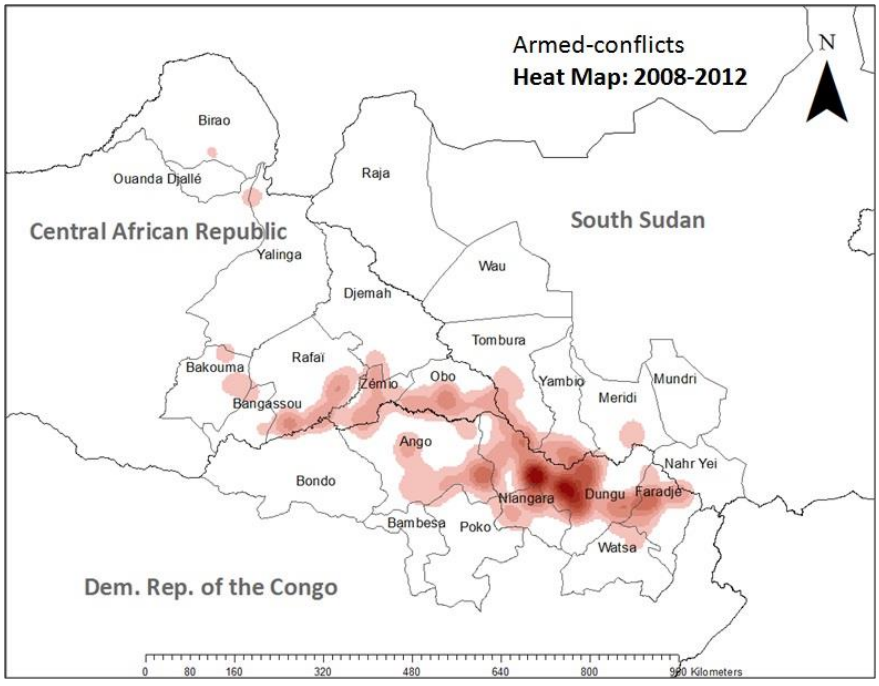

Figure 14: Armed-conflicts Heat Map: 2008-2012

While the maps demonstrate how the concentration and extent of the LRA's operations has changed with time, the changes are relative and are dependent upon the total number of

armed-conflicts each year. This complicates our ability to quantify changes in density for each year-to-year transition. This method would be increasingly viable in the presence of a more robust collection of predictor variables enabling other regression techniques.

3.4.2 Polynomial Regression and Density Score

This approach began with coding each armed-conflict event with the ID of the nearest HF radio installation. Armed-conflicts were only coded to a nearby HF radio if that radio was in existence at the time the armed-conflict occurred. Then, the distance between the armed conflict event and the nearest HF radio was calculated in meters. Armed-conflicts events were classified as being in Tier 1 or Tier 2 of the nearest radio. An event was classified as Tier 1 if it occurred within 40 km of a HF radio and classified as Tier 2 if its distance was greater than 40km. The furthest any event was to a radio was 954km. Because the year of the earliest HF radio installation date is 2010, only armed-conflicts occurring after that point in time could be included in this analysis. Of the 547 armed-conflicts meeting this criterion, 270 were in Tier 1, and 277 were in Tier 2.

A value, termed in this thesis as “Density Score”, was then calculated for each armed-conflict using spatial SQL. The variable was designed to be indicative of the density of violence surrounding each individual point feature (i.e. armed-conflict event) within a temporal window. A radius of 15 km and a temporal window of +/- 15 days were selected. Once calculated, the Density Score value for each armed-conflict represented how many other conflicts occurred within 15 km and within 15 days. Armed-conflicts that occurred nearby and in close succession with other conflicts were assigned the highest scores. Calculating the Density Score in this manner allowed for testing at different radii (e.g. 20km or 50km) and varying windows of time

(e.g. +/- 30 days, or +/- 45 days) while maintaining the same units of reference (events per km^2 per day).

The goal was to aggregate all armed-conflicts by the two tiers of the HF radio installation nearest to them and assign each Tier a mean density score value. Then, the mean density score for both tiers of the HF radio installation would be plotted over the course of three years: 2010, 2011, and 2012. The expectation was that the mean density score for armed-conflicts in Tier 1, i.e. the mean density score for armed-conflicts occurring within 40 km of a radio installation, would decline over time at a rate different than the mean density score for armed-conflicts in Tier 2. Polynomial regression would be applied to offer trend analysis by tier with the expectation that armed-conflicts would initially peak following the placement of an HF radio installation before tapering off as more time passed. Further, it was the expectation that Tier 1 would see a larger decline in violence.

Upon coding the Density Score for each armed-conflict, it was discovered that an optimal and meaningful proximity distance and temporal window could not be found. There was little variance in the calculated density score values, and in order to increase the variance, the spatial and temporal windows would needed to have been extended which is counter-intuitive considering the density score is meant to capture clusters of events occurring nearby and in close succession.

Compounding this problem was the low number of HF radios and their limited expanse. For example, three HF radios were installed in 2010. Yet, only a very low ratio of armed-conflicts occurred within 40 km of these three radios. To assume density score values for armed-conflicts occurring far from the HF radio installation would omit other external variables such as local counter-insurgency initiatives or rival forces. Tier values could be modified to only account

for armed-conflicts nearer to the HF radios' location, however, upon mapping every armed-conflict back to an individual HF radio, the results were found to be lopsided as 24 out of 28 HF radios had fewer than 50 armed-conflicts map back to them with some HF radios having none. While the total number of armed-conflicts classified as Tier 1 or Tier 2 is close to being equal, when examining individual radio locations, the number of armed-conflicts within each radio's respective tiers varied widely. This method was abandoned in favor of a more general spatial distribution model that aggregated armed-conflicts and HF radio locations by country and territory.

3.4.3 Spatial Distribution of Violence: Summaries of Violence Aggregated by Country, Rates of Change by Territory, and Comparative Changes using Difference-in-Differences

In light of the challenges associated with these statistical methods**,** this study takes a qualitative approach by calculating changes in the distribution of violence over time. First, violence is aggregated by country to indicate annual trends in the raw counts of violence from 2008 to 2012; this country-level analysis is discussed in Section 3.5. Then, in-depth analysis is completed by utilizing administrative data for individual territories. By classifying relative rates of change over time by territory, the resulting level of analysis is compliant with the scales called for in prior studies (Bahaug and Lujala 2005; Cederman et. al. 2007; Flint et. al. 2009; Tuathail 2010) to detect sub-national trends in insurgency. This territory-level analysis is described in Section 3.6. Finally, with an objective to analyze the impact of installing HF radios in LRA-active territories, a Difference-in-Differences descriptive analysis was applied. This approach was chosen because it has the advantage of measuring the variation in the rates of change between distinct groups of territories (e.g. a sample group and a control group) while controlling for an overall, global trend. The inspiration for this method came from Shapiro and Weidman's

study (2012) in which they quantitatively assessed the rate of change in insurgent violence in Iraq in relation to the installation of cell phone towers and the expansion of mobile infrastructure. They employed a Difference-in-Differences statistical approach to calculate the variance between the rates of insurgent attack in the 180 days preceding a cell phone tower installation and the rates of insurgent violence in the 180 days immediately following the tower's installation (Shapiro and Weidman 2012).

While limitations of this study, specifically the low number of territories in which HF radios were located, prevented a Difference-in-Differences statistical method from being completed, an analysis of comparative changes represented by the Difference-in-Differences model is able to describe the changes between the two groups of territories without denoting statistical significance. The Difference-in-Differences descriptive analysis is discussed in detail in Section 3.7.

3.5 Summaries of Violence Aggregated by Country

Conflict data spatially joined with the "Countries" feature class were aggregated by three categories of violence: armed-conflicts, civilian murders, and civilian abductions. Values representing summary totals of violence were coded as attributed values in the "Countries" feature class and were separated by year. The summary values were exported in table format and used to create line graphs plotting annual summaries of violence for each country from 2008 to 2012. The background analysis at the national level helps provide context for the in-depth territory-level analyses that follow in Sections 3.6 and 3.7, which describe sub-national trends in violence. The detailed flowchart for the country-level process is shown in Figure 15.

Figure 15: Aggregating categories of violence by Country and exporting line graphs

3.6 Annual Rates of Change in the Spatial Distribution of Violence by Territory

With conflict data spatially joined with the "Territories" feature class, Modelbuilder was used to generate 15 new territory feature classes. Each new feature class represented one category of violence in a given year (e.g. Armed-conflicts_2008, Civilian-murders_2008, etc.). Each feature class contained values indicating the normalized rate of violence for each year. Tables 3, 4, and 5 show the normalized rates of violence by territory for each category.

Table 3: Armed-Conflicts by Territory, 2008-2012: Normalized by Population

Country	*Territory_Name*	2008	2009	2010	2011	2012
SSD	Raja	0.00	0.04	0.00	0.07	0.00
	Wau	0.00	0.00	0.01	0.00	0.00
	Nahr Yew	0.01	0.01	0.00	0.00	0.00
	Meridi	0.05	0.02	0.05	0.00	0.00
	Mundri	0.00	0.02	0.00	0.00	0.00
	Tombura	0.05	0.16	0.25	0.16	0.02
	Yambio	0.02	0.02	0.10	0.10	0.00
DRC	Ango	0.00	4.15	3.69	2.54	1.84
	Bambesa	0.00	0.00	0.00	0.06	0.00
	Bondo	0.00	0.00	0.05	0.00	0.16
	Poko	0.00	0.42	0.21	0.00	0.00
	Dungu	1.39	3.08	8.64	5.02	4.34
	Faradje	0.20	0.44	0.36	0.96	0.80
	Niangara	0.07	1.22	1.86	0.36	0.43
	Watsa	0.00	0.06	0.03	0.06	0.00
CAR	Djemah	0.00	2.18	0.00	0.00	0.00
	Obo	0.08	1.05	0.31	0.39	0.14
	Zémio	0.00	0.12	1.19	0.65	0.71
	Yalinga	0.00	0.00	0.77	0.00	0.58
	Bakouma	0.00	0.00	0.10	0.19	0.29
	Bangassou	0.00	0.02	0.03	0.02	0.05
	Rafaï	0.00	0.14	3.08	0.43	1.22
	Birao	0.00	0.00	0.10	0.00	0.00

Table 4: Civilian Murders, 2008-2012: Normalized by Population

Country	*Territory*	2008	2009	2010	2011	2012
SSD	Raja	0.00	0.04	0.00	0.00	0.00
	Wau	0.00	0.00	0.01	0.00	0.00
	Nahr Yei	0.02	0.04	0.00	0.00	0.00
	Meridi	0.07	0.10	0.06	0.00	0.00
	Mundri	0.00	0.07	0.00	0.00	0.00
	Tombura	0.56	0.11	0.31	0.22	0.00
	Yambio	0.21	0.02	0.14	0.09	0.00
DRC	Ango	0.00	6.46	13.83	1.38	0.12
	Bambesa	0.00	0.00	0.00	0.00	0.00
	Bondo	0.00	0.00	0.11	0.00	0.00
	Poko	0.00	0.10	0.00	0.00	0.00
	Dungu	21.07	12.90	10.96	3.54	0.34
	Faradje	7.36	2.00	0.08	0.36	0.12
	Niangara	1.43	25.76	7.15	0.29	0.07
	Watsa	0.00	3.00	0.00	0.03	0.00
CAR	Djemah	0.00	14.17	0.00	0.00	0.00
	Obo	0.17	2.39	0.36	0.11	0.08
	Zémio	0.00	0.24	2.91	0.18	0.42
	Yalinga	0.00	0.00	1.55	0.00	0.00
	Bakouma	0.00	0.00	0.38	0.05	0.38
	Bangassou	0.00	0.03	0.08	0.00	0.03
	Rafaï	0.00	0.14	4.08	0.57	1.15
	Birao	0.00	0.00	0.02	0.00	0.00
	Ouanda Djallé	0.00	0.00	0.51	0.00	0.00

Table 5: Civilian Abductions, 2008-2012: Normalized by Population

Country	*Territory*	2008	2009	2010	2011	2012
SSD	Raja	0.00	0.24	0.00	0.20	0.00
	Wau	0.00	0.00	0.02	0.00	0.00
	Nahr Yei	0.12	0.03	0.00	0.00	0.00
	Meridi	0.10	0.07	0.04	0.00	0.00
	Mundri	0.00	0.11	0.00	0.00	0.00
	Tombura	1.26	0.56	0.65	0.33	0.00
	Yambio	0.36	0.03	0.28	0.14	0.00
DRC	Ango	0.00	49.34	16.83	13.03	3.34
	Bambesa	0.00	0.00	0.00	0.32	0.00
	Bondo	0.00	0.00	0.16	0.00	0.97
	Poko	0.00	1.77	0.63	0.00	0.00
	Dungu	15.26	10.83	11.93	8.35	7.63
	Faradje	7.60	0.76	0.84	2.48	2.16
	Niangara	0.00	18.60	8.30	1.36	0.79
	Watsa	0.00	0.60	0.06	0.06	0.00
CAR	Djemah	0.00	15.26	0.00	0.00	0.00
	Obo	3.69	3.03	0.75	0.80	0.14
	Zémio	0.00	0.48	3.39	4.82	1.96
	Yalinga	0.00	0.00	29.18	0.00	5.02
	Bakouma	0.00	0.00	1.05	2.57	3.24
	Bangassou	0.00	0.02	0.44	0.09	0.78
	Rafaï	0.00	2.72	19.48	0.93	2.44
	Birao	0.00	0.00	0.76	0.00	0.00
	Ouanda Djallé	0.00	0.00	22.63	0.00	0.00

Next, feature classes for the same category of violence were joined from one year to the next using a table join and a common ObjectID (Territory_Name); Armed-conflicts_2008 was joined with Armed-conflicts_2009, and Armed-conflicts_2009 was joined with Armed-conflicts_2010, etc. The table joins allowed for the calculation of rate changes for each year-to-year transition (i.e. 2008-2009, 2009-2010, 2010-2011, and 2011-2012). The rate change was calculated for the three categories of violence (i.e. armed-conflicts, civilian murders, and civilian abductions) for each of the 24 territories. Geographic representations of the rate changes were generated in a series of maps.

The process of calculating the annual rates of change by territory is illustrated in Figure 16. Included in this figure are the additional steps taken to compare changes between the sample group of territories and the control group as represented by the Difference-in-Differences descriptive analysis discussed in Section 3.7.

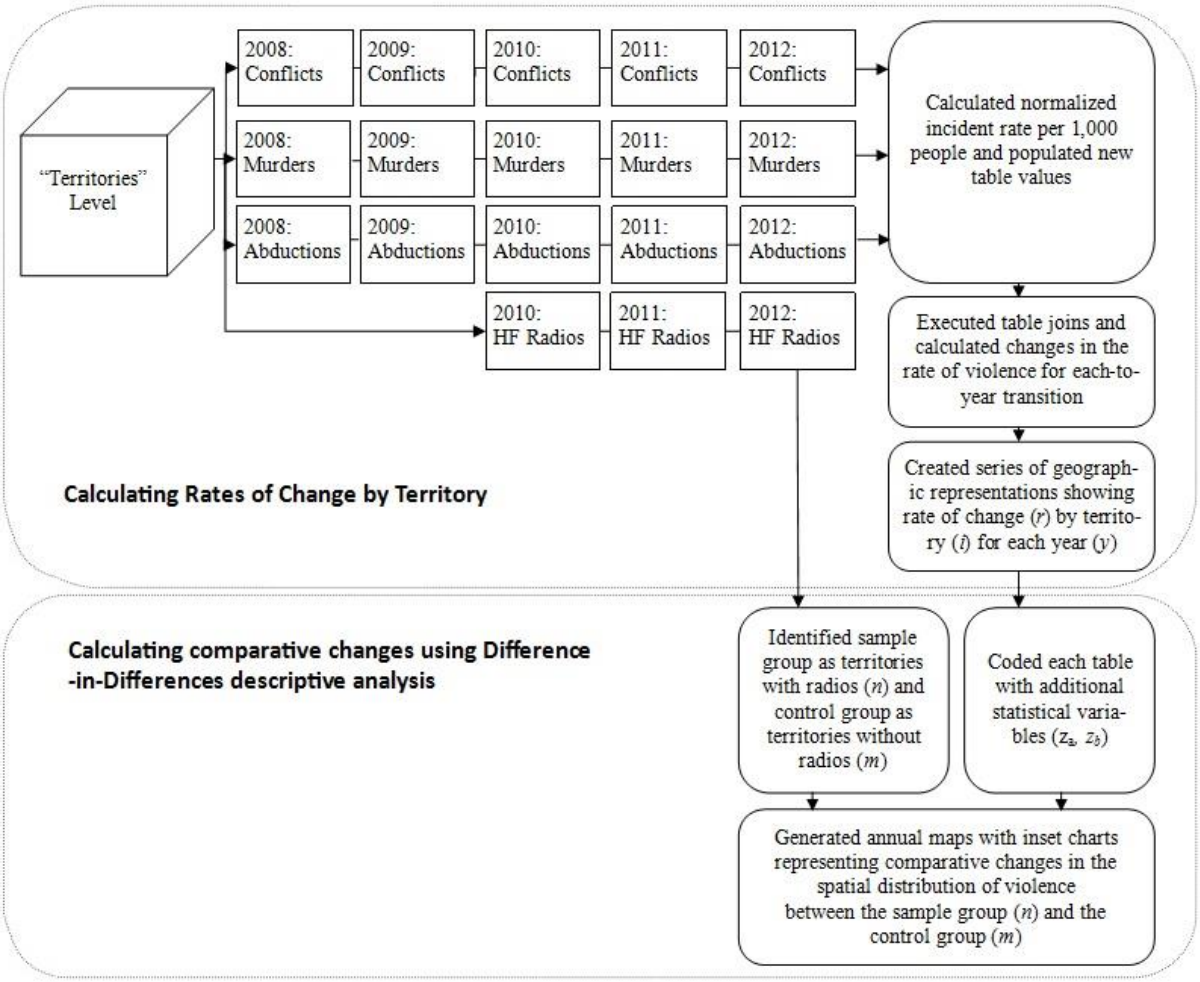

Figure 16: Calculating rates of change by territory and comparative changes from Difference-in-Differences

3.7 Comparative Changes Represented by a Difference-in-Differences Descriptive Analysis

After the rate changes were coded to each feature class, the territories were divided into two groups: the first group is the sample (*n*), which is composed of territories in which HF radios are located. The second group is the control (*m*), which is composed of territories without HF radios. HF radios were aggregated by territory and each territory was coded as either having or not having one or more HF radios. The mean rate of change for the control group was then

subtracted from the mean rate of change for the sample group. In Figure 17 is a conceptualization of this method, illustrating comparative changes between a sample group and a control group.

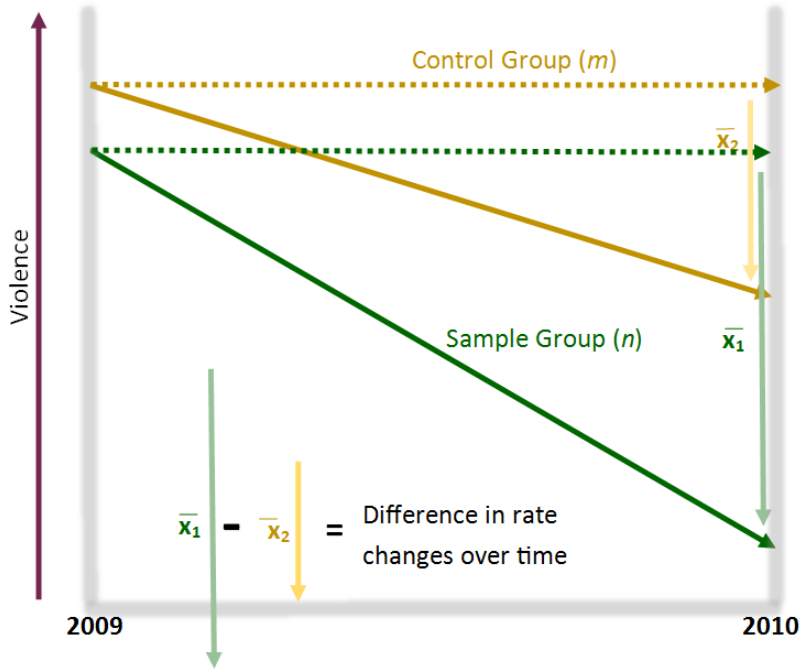

Figure 17: Conceptualizing comparative changes between territory groups

The comparative changes between the two groups are calculated using Equation 1, which is based on the Difference-in-Differences statistical method (Abadie 2005). In Table 6 are listed the variables used in this analysis with associated assumptions and limitations. In the calculations/statistics, territories were only included in each year-to-year iteration if they sustained one or more conflicts during the designated period (e.g. 2008 to 2009). Resulting values indicate how the rate of violence in territories with HF radios changed in comparison to territories without HF radios. The detailed flowchart for this approach is included in Figure 16. Due to the low *n*, the significance at local scale of the true Difference-in-Differences statistical analysis could not be established or validated. Therefore, the numerical results derived from this

method are shown in chapter four and described qualitatively focusing on a comparative description of the results. The discussion in Chapter 5 outlines possible venues in which these results could be further analyzed given the possibility of being validated in their significance or impact as discussed in Section 5.3.1.

Equation 1: Comparative Changes ($\bar{x}_1$ - $\bar{x}_2$)

$$\left(\bar{x}_1 - \bar{x}_2\right) = \left[\frac{\sum_{i=territory}^{n}\left(\left(r_{y+1} - r_y\right)_i\left(z_{ai}\right)\right)}{n}\right] - \left[\frac{\sum_{i=territory}^{n}\left(\left(r_{y+1} - r_y\right)_i\left(z_{bi}\right)\right)}{m}\right]$$

Table 6: Variables referenced in the analysis of comparative changes

Variable	Description	Assumptions	Limitations
i	Territory	The territory sustained at least one armed-conflict for each year-to-year interval.	Territories vary widely in area and population.
r	Rate of change	Rate of each assumes each territory's population is static through each year-to-year transition.	The rate of change is calculated for armed-conflict, civilian murders, and abductions. It does not consider other forms of looting or harassment.
y	Year	Annual interval provides a summary of violence over the course of a year.	Interval does not account for spikes or drops in violence that can occur weekly or monthly.
n	Number of territories in sample group	All HF radios locations are known.	Territories are not weighted by how many radios they contain.
m	Number of territories in control group	Territories in control group are not affected by HF radios in adjacent territories.	Some territories in the control group very seldom experience violence compared to territories in the sample group.
z_a	Indicator = 1 if HF radios are present, 0 if not	If an HF radio is present in a territory, it is being used.	Does not account for how long a radio has been present.
z_b	Indicator = 0 if HF radios are present, 1 if not	""	""

3.8 Expected Outcome

Understanding that the number of LRA members has been declining, there is an expectation that there will be an equal decline in the rate of armed-conflicts, murders, and

abductions over time. Unilateral military operations in the Congo are thought to have decreased violence in the areas surrounding the Dungu territory in particular. However, this military push from the east combined with new uprisings and political instability in the CAR means that the LRA may find refuge along the southern border of the CAR (Ronan 2012). It is also predicted that there will be a greater decrease in the number of civilian murders and abductions than overall armed-conflicts. The rationale for this is in the LRA's dwindling numbers. Many believe that the organization is in "survival mode" and the majority of their activities now involve looting and intimidation rather than systematic murder (DeLaurentis 2012).

It is predicted that territories in which civilian-protection programs are prevalent will experience a greater decline in incidents than territories without them. While this thesis examines the use of high-frequency radios, it does not consider the effects of leaflet distribution, FM broadcasts, or the location and strength of counter-insurgency forces. It is assumed that military operations are happening in areas with a heavy concentration of LRA attacks; however, those data are not factored into this analysis. This analysis will simply provide a geographic context for the rate changes along with a proposed method to compare rate changes between territories. Readers can use this information and incorporate their own understanding of counter-insurgency efforts and make an assessment as to the possible impact of programs like the high-frequency radio network discussed here.

CHAPTER 4: RESULTS

This chapter documents the spatial distribution of violence and demonstrates change over time for each category of violence. Results of the distribution of violence are shown by countries and by territories.

Aggregate summaries of violence by country are expressed by three plots representing the raw annual volume of conflicts from 2008 to 2012. These are described in Section 4.1. Calculating the annual rates of change in violence at the territory-level produced fifteen maps that are separated into five groups with three maps per group. The five groups include a baseline (Section 4.2.1) and one group for each year-to-year interval (Section 4.2.2). The three maps within each group represent the change in the rate of violence for each category. With the exception of the baseline maps, the figures do not depict the actual annual rates of violence. The calculated annual rate of violence for each category can be found in section 3.6 in Tables 3-5, and the raw counts of violent events can be found in Appendix B, Tables 8-10: *Raw Counts by Territory*. Calculating the comparative changes using Difference-in-Differences produced four maps that are described in Section 4.3.

4.1 Summaries of Violence Aggregated by Country

A summary of the raw number of armed-conflicts occurring from 2008 to 2012 is shown in Figure 18. The year 2008 marks the lowest levels of LRA attacks in the five-year span; only 55 attacks occurred during this period. However, violence increased significantly in 2009 and again in 2010 with attacks becoming increasingly prevalent in the DRC; The LRA launched 399 attacks in 2010 that resulted in civilian injury, and 276 of those attacks occurred in the DRC. After 2010, the number of armed-conflicts tapered off with 2012 marking the lowest overall levels in the study. This decline coincides with MONUSCO's adoption of Security Council

Resolution 1925 in 2010, which authorized the use of force to ensure civilian protection. Notable, however, is the slight upswing in armed-conflicts in the CAR in 2012. Here, the LRA launched 10 more attacks than in 2011.

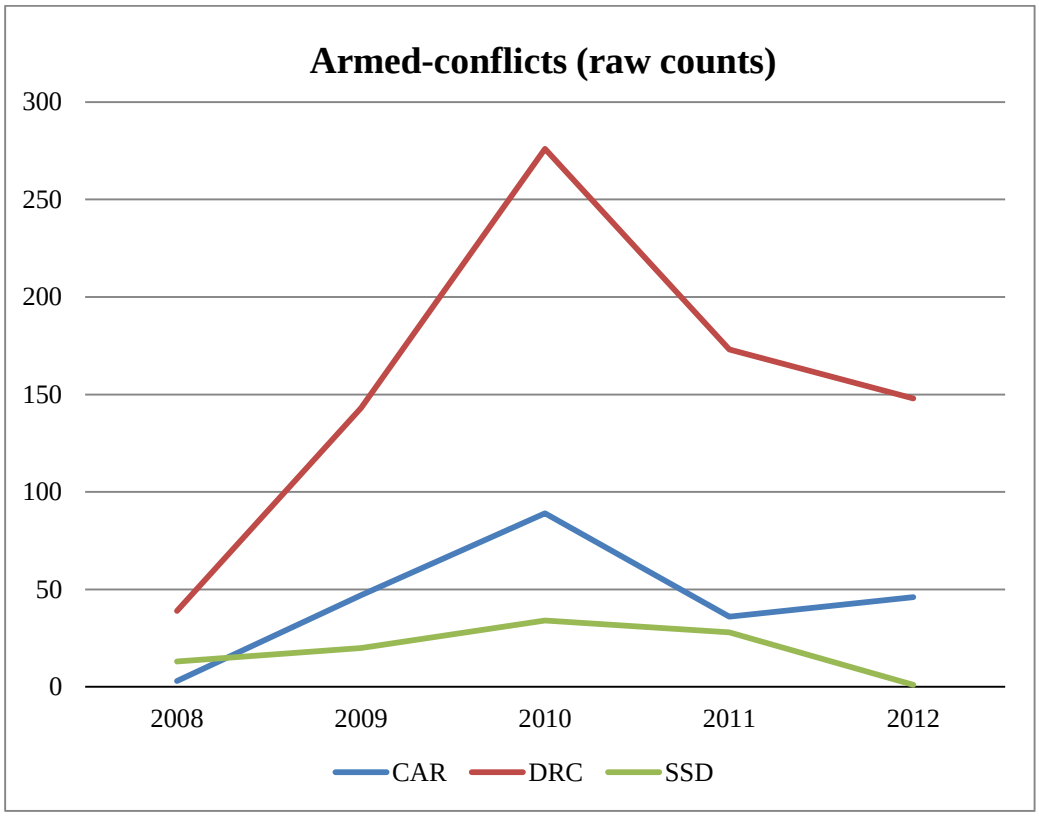

Figure 18: Trends of Armed-conflicts by Country (raw counts)

Analogously, the plot in Figures 19 provides additional context to the changing landscape of LRA violence. While the overall number of armed-conflicts steadily declined after peaking in 2010, the number of civilian-murders declined even more substantially. Although LRA killed 49 civilians in 2012, this is 96 percent fewer civilian than they killed in 2010 and over 99 percent fewer than in 2009. In fact, the ratio of civilian murders to armed-conflicts in 2009 was 4.89 while the same ratio in 2012 was 0.25. This decrease implies that LRA attacks are yielding far fewer casualties than before.

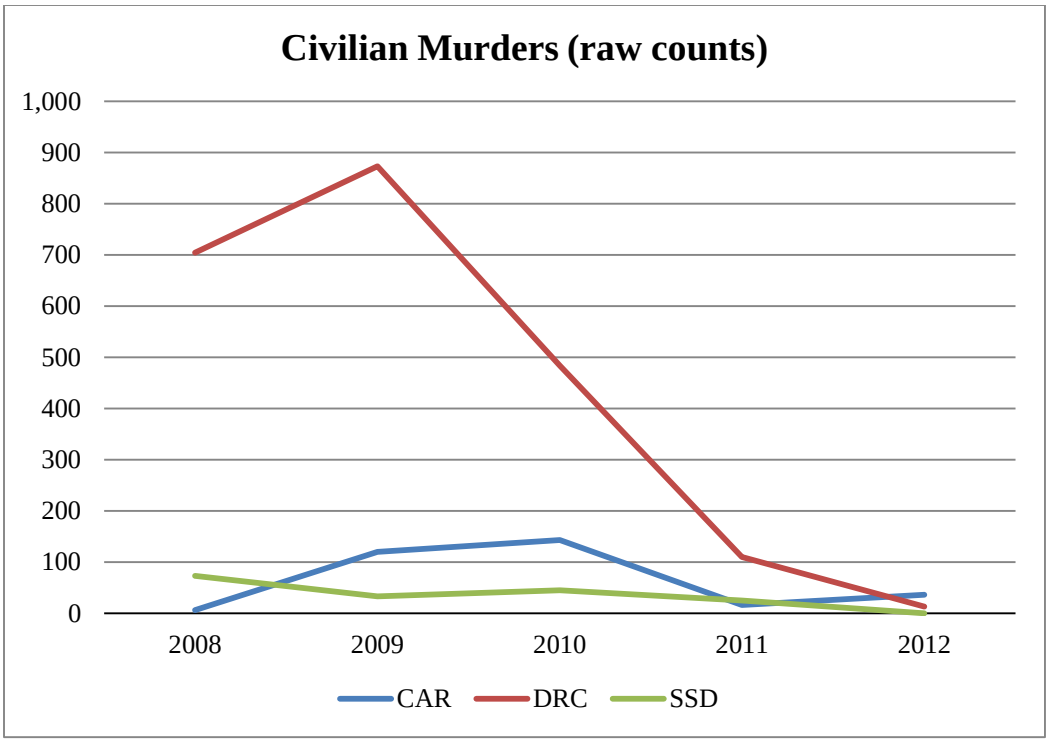

Figure 19: Trends of Civilian Murders by Country (raw counts)

The total number of civilian abductions is also declining but with slightly more variance by country (Figure 20). While the overall number of abductions declined after peaking in 2010, there was a slight increase in 2012 in the CAR with abductions becoming more prevalent in the southern territories crowding the Congolese border. This trend is similar to those shown in Figures 18 and 19. The plot in Figure 20 also shows how the total number of civilian abductions in CAR (218) is 75 fewer than those that occurred in the DRC (293) despite there being three times as many armed-conflicts in the DRC during the same temporal period. A comparatively higher percentage of abductions in the CAR supports the theory that the LRA is fleeing pursuing forces in the DRC and is capitalizing on regional instability in the CAR to replenish their ranks via forced conscription strategies.

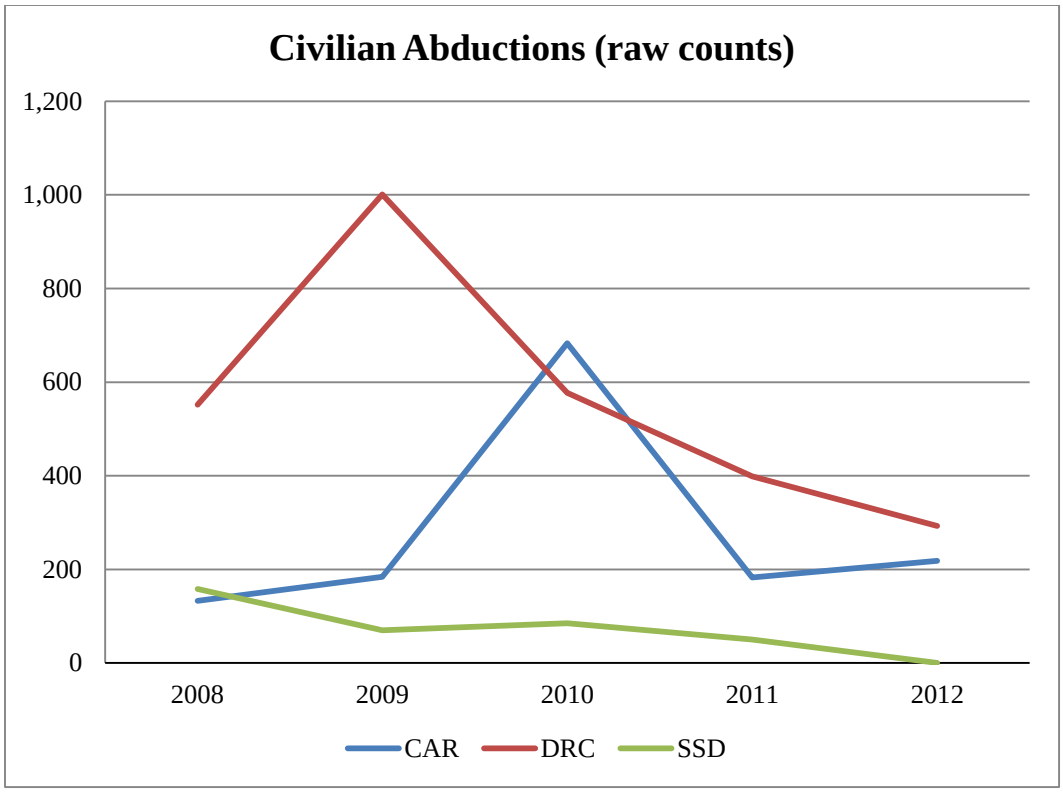

Figure 20: Trends of Civilian Abductions by Country (raw counts)

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4.2 Annual Rates of Change in the Spatial Distribution of Violence by Territory

The baseline maps (Section 4.2.1) are represented by the rate of violence in each territory, i.e. the number armed-conflicts, civilian murders, and civilian abductions per 1,000 people. The interval rate change maps (Section 4.2.2) are represented by the increase or decrease in the rate of violence from one year to the next. Also logged in each interval map are the "global mean change", the "greatest increase", and the "greatest decrease." The "global mean change" reflects the average rate change across the study area, while the "greatest decrease" and the "greatest increase" indicate which territories experienced maximum variance from one year to the next. An assessment is made of each territory to reveal whether the rate of violence, murders, or abductions in that territory is worsening or getting better than the overall trend. It should be

noted that territories were only factored into the global mean change if they sustained one or more armed-conflicts within the two-year span captured by the map. For example, if a territory sustained zero armed-conflicts in 2011 and 2012, then it was not included in the 2011 to 2012 analysis because it was outside of the LRA's area of operations during that timeframe.

Reconciling this information provides us with the ability to identify spikes and reductions in violence and make evaluations regarding the potential causes behind the variance in a geographic context. Potential causes include changes in political leadership as well as the implementation of counter-insurgency and civilian-protection initiatives discussed in chapter two.

4.2.1 Baseline Distributions by Category of Violence

2008 Baseline: Armed-conflicts

In 2008, the baseline distribution of armed-conflicts (Figure 21) was concentrated in the northeastern region of the DRC and the southwestern region of South Sudan. Across all territories where the LRA was active, the mean rate of armed-conflicts per 1,000 people was 0.24. Beginning Christmas Day 2008, the LRA attacked numerous villages across three communities within Dungu and Faradje in close succession. This was in conjunction with the Christmas Day Massacres discussed in section 2.4, explaining why the highest rates of armed-conflicts are in Dungu and Faradje.

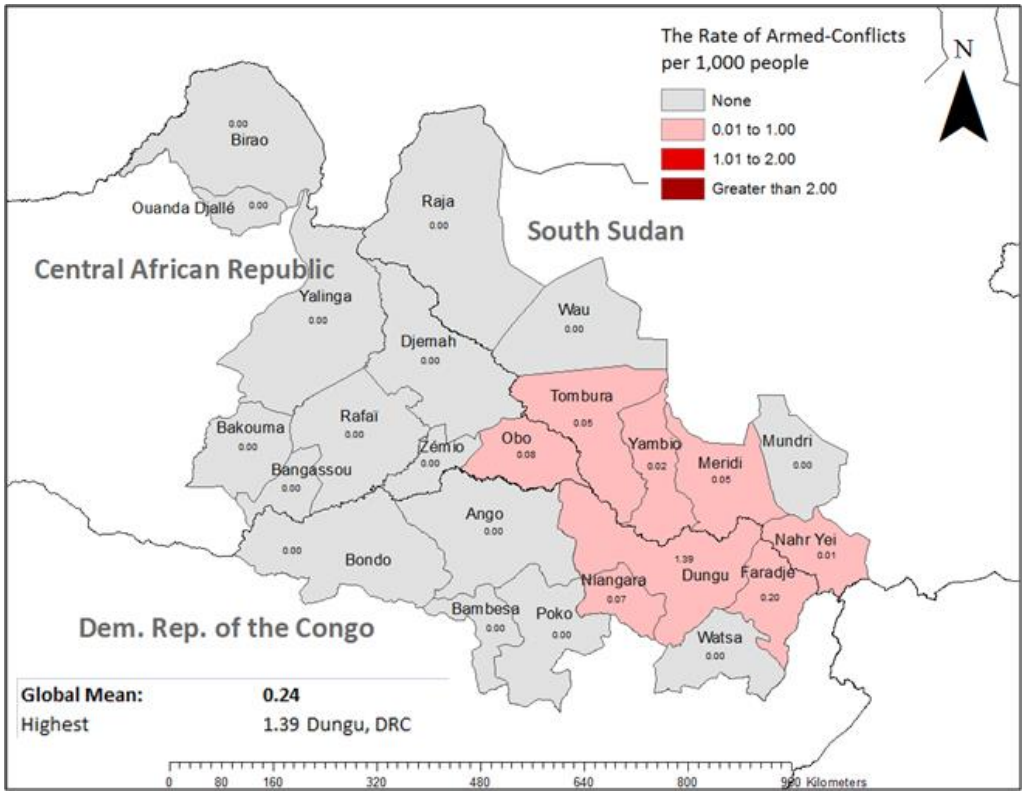

Figure 21: The Rate of Armed-conflicts in 2008

2008 Baseline: Civilian murders

In 2008, the average rate of civilian murders in LRA-active territories was 3.86 murders per 1,000 people (Figure 22). The Christmas Day massacres that took place during this time caused the rate in that territory to spike to 21.07 making Dungu the deadliest of all territories (HRW 2009).

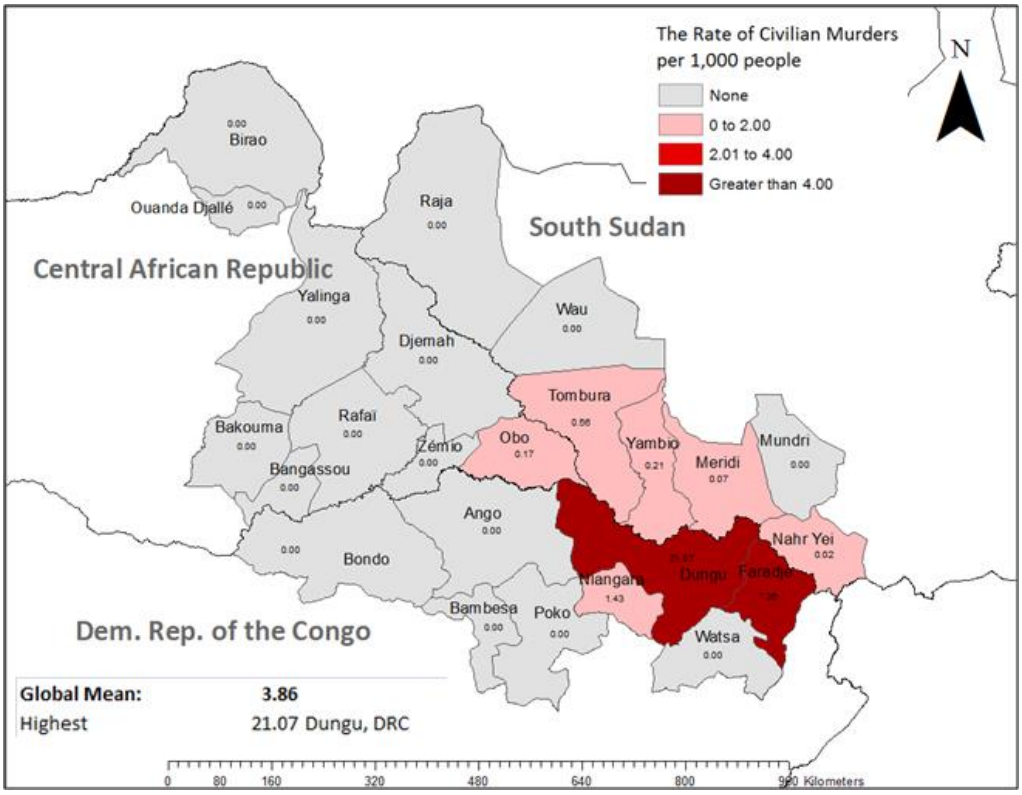

Figure 22: The Rate of Civilian Murders in 2008

2008 Baseline: Civilian Abductions

In 2008, the baseline rates of civilian abductions (Figure 23) had a pattern similar to the rates of armed-conflicts and civilian murders. The mean rate of abductions across the area of operations was 4.06 abductions per 1,000 people. The highest rates were in Dungu and Faradje measuring 15.26 and 7.60 respectively making the two territories again the most dangerous in 2008. Also evident is the alarming number of murders and abductions that occurred during each armed-conflict. For example, the rate of armed-conflict in Dungu was 1.39, however, the rate of murders was 21.07, and the rate of abductions was 15.26. Each armed-conflict, on average, yielded 15 civilian deaths and 10 civilian abductions.

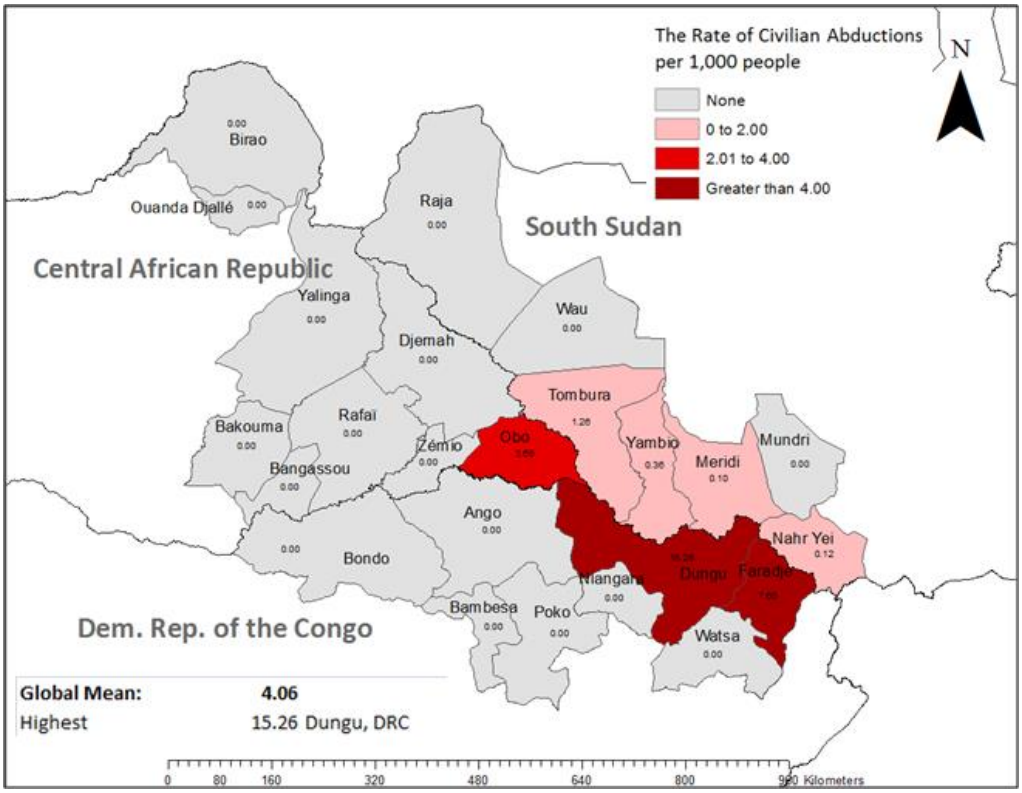

Figure 23: The Rate of Civilian Abductions in 2008

4.2.2 Interval Rate Changes by Category of Violence

2008 to 2009: Armed-conflicts

The map in Figure 24 illustrates the expansion of the LRA's area of operations from 2008 to 2009. The rate of armed-conflict increased in fourteen territories during this time, and the rate only decreased in two. The global mean, or the mean rate of change for all territories that saw violence in 2008 or 2009, was +0.66 incidents per 1,000 people. The rate of armed-conflicts increased most in Ango (+4.15)and Djemah (+2.18). Rates also increased in Niangara and Dungu, both located in the DRC. Niangara, as discussed in section 2.4, is the territory in which the Makomba massacres occurred in 2009 (HRW 2010). The Christmas Day massacres that began in 2008 carried through into January hence the elevated rates in Dungu and Faradje.

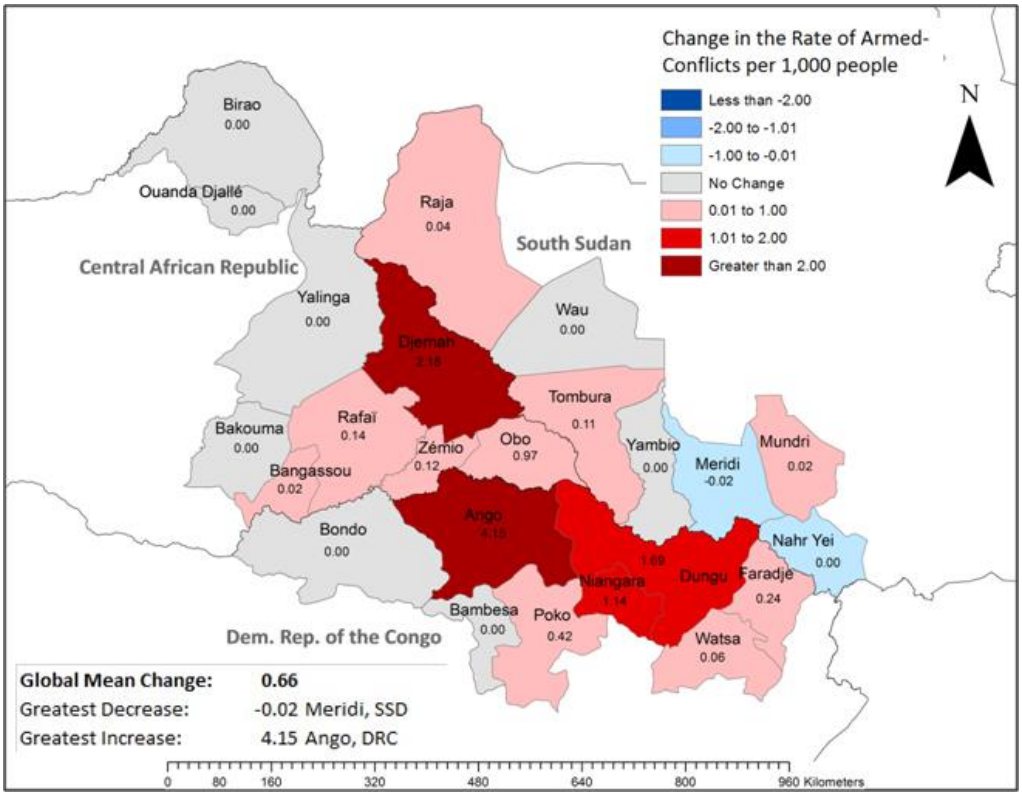

Figure 24: Change in the Rate of Armed-conflicts from 2008 to 2009

2008 to 2009: Civilian murders

The rate of civilian murders in 2009 rose dramatically in Niangara partly due to the Makomba massacres which killed 321 civilians in 10 villages over four days (Figure 25). This elevated the total rate of murder in Niangara to 25.76 murders per 1,000 people. The rate of civilian murder actually decreased in the Dungu and Faradje territories, which had traditionally been the most violent areas, despite the rate of armed-conflicts rising the same year. In these territories, individual armed-conflicts, on average, yielded fewer civilian murders than in years past.

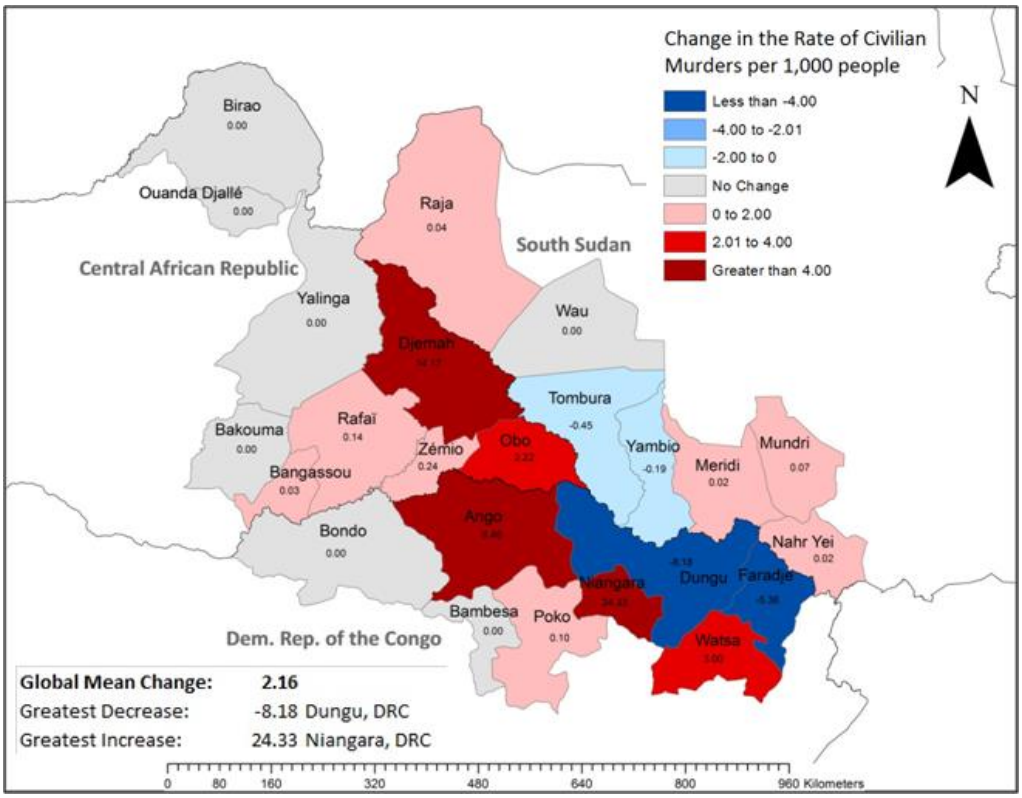

Figure 25: Change in the Rate of Civilian Murders from 2008 to 2009

2008 to 2009: Civilian Abductions

In 2009, the global mean rate of civilian abductions increased at a rate of +4.47 civilian abductions per 1,000 people (Figure 26). Driving the upward trend was increased LRA activity in Ango and a total of 428 abductions. The spike in abductions elevated the rate in Ango by +49.34. Conversely, Dungu and Faradje saw a decrease in abductions, like murders, despite a rise in the number of armed-conflicts.

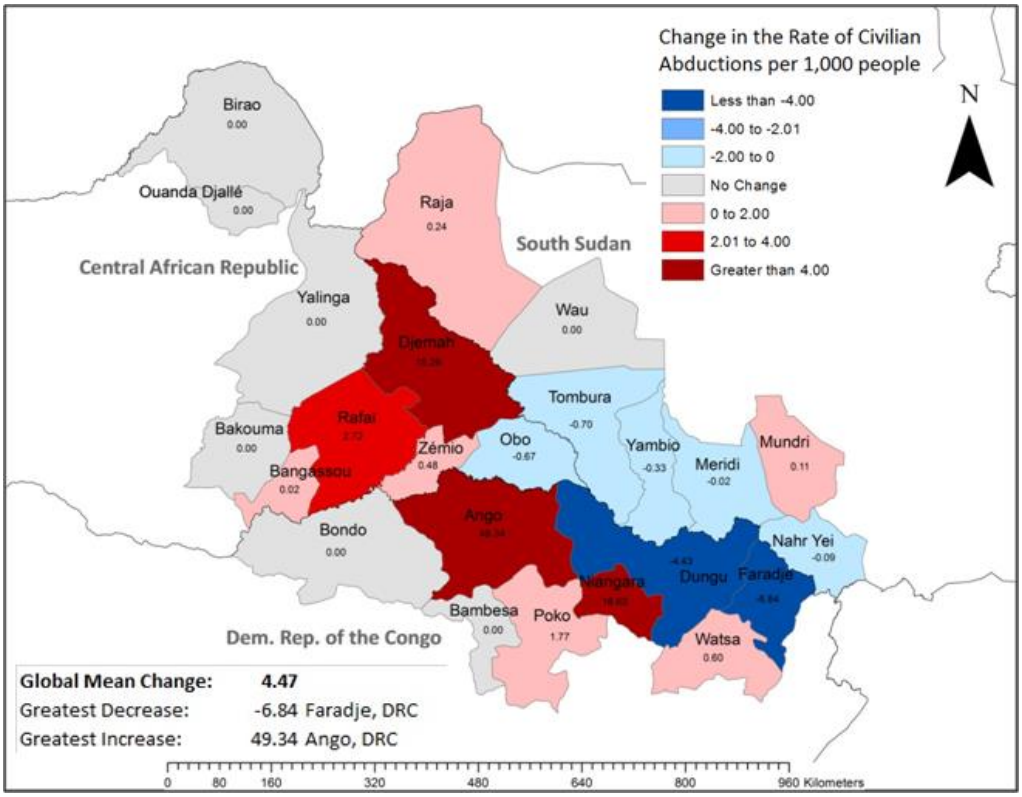

Figure 26: Change in the Rate of Civilian Abductions from 2008 to 2009

2009 to 2010: Armed-conflicts

The map in Figure 27 shows how the number of armed-conflicts peaked in 2010 with the global trend increasing by +0.36 armed-conflicts per 1,000 people. However, we do see many of the formerly violence areas improving. In fact, a separation begins to reveal itself as violence increases in South Sudan and CAR in territories which had initially seen little LRA violence. This indicates a large expansion from the original concentration of LRA activity in the Northeastern DRC. 2010 is also the first year that MONUSCO began operating with revised mandate to increase cooperation with the Congolese army and apply the use of force against LRA members. MONUSCOs forward base of operations is located in Dungu bringing more attention to the region. 2010 also marks the first year that HF radios are being used to share intelligence between communities and counter-insurgency forces.

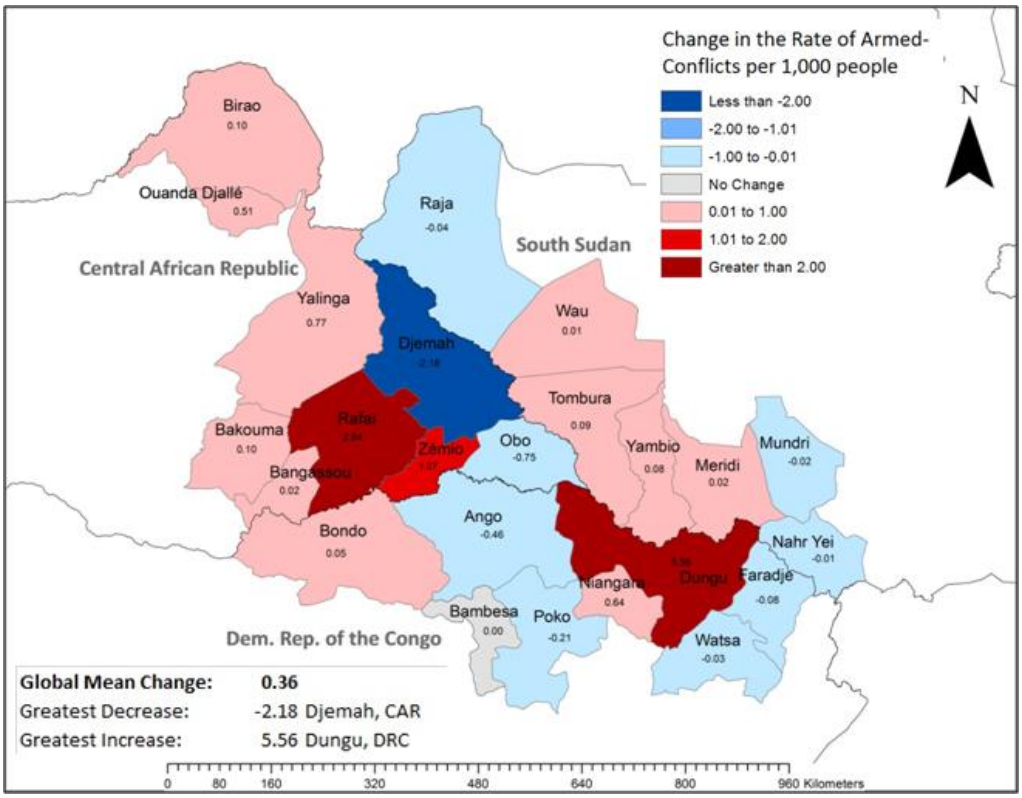

Figure 27: Change in the Rate of Armed-conflicts from 2009 to 2010

2009 to 2010: Civilian murders

The year 2010 is very significant as it marks the first year, since 2008, in which the global mean rate of civilian murders begins to decrease (Figure 28). Even though armed-conflicts in Dungu rose in 2010, the rate of civilian murders actually decreased. The same pattern occurred in Niangara. The fact that armed-conflicts are yielding fewer deaths in these territories may be attributable to the counter-insurgency initiatives based in Dungu. Conversely, the rate of armed-conflicts in Ango decreased by -0.46 while the rate of civilian murder increased by +7.38, which is indicative of a westward trending LRA insurgency.

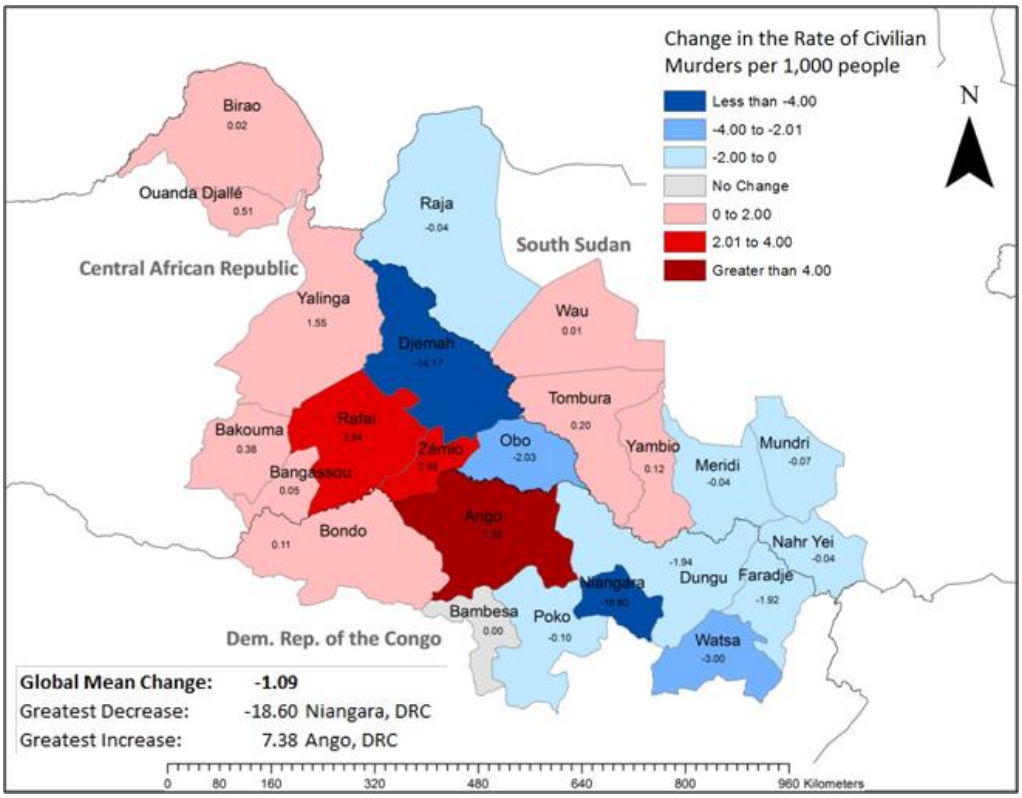

Figure 28: Change in the Rate of Civilian Murders from 2009 to 2010

2009 to 2010: Civilian Abductions

In Figure 29, the global mean rate of murders decreased across the study area while the rate of civilian abductions increased. This is due to a spike of civilian abductions occurring in the CAR. In Ango, the rate of civilian abductions decreased despite a record number of civilian murders in the same year. The decrease is misleading because there was still a high number of abductions in Ango in 2010; there was simply fewer than in 2009.

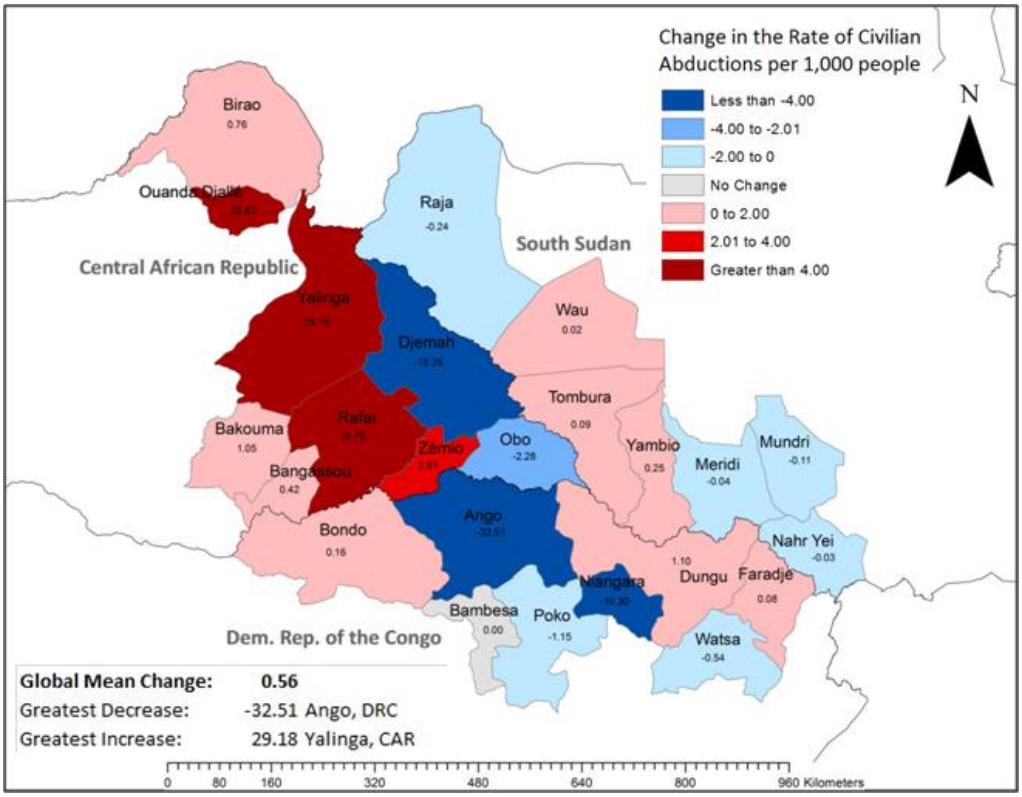

Figure 29: Change in the Rate of Civilian Abductions from 2009 to 2010

2010 to 2011: Armed-conflicts

The transition into the year 2011 is significant as this is the first year, since 2008, in which the global mean rate of armed-conflicts decreased; the mean rate of change was -0.49 armed-conflicts per 1,000 people (Figure 30). The rate of armed-conflicts decreased in fifteen territories, and the rate increased in six territories. The rate of violence in Dungu and Rafaii, the two hardest hit territories in 2010, declined by -3.62 and -2.65 respectively. In 2011, we also begin to see fragmentation in the organization with LRA violence increasing by very small amounts in only a few areas. By this time, MONUSCO had engaged increasingly with regional forces, the HF radios were widely being used in Northeastern DRC, and a series of other counter-insurgency and LRA initiatives (e.g. leaflet distribution, FM transmissions, and flyovers) were taking place.

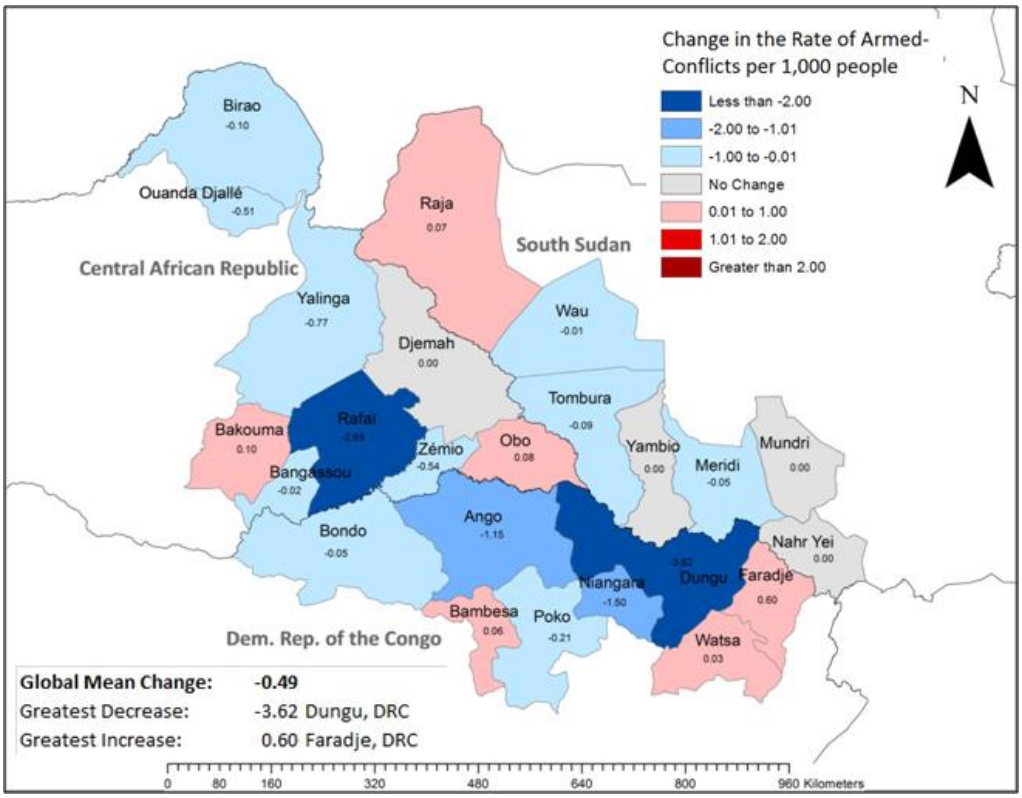

Figure 30: Change in the Rate of Armed-conflicts from 2010 to 2011

2010 to 2011: Civilian murders

The steepest decline in civilian murders occurred from 2010 to 2011 (Figure 31). Across the study area, the rate of civilian murders increased in only two territories: Faradje and Watsa. Murders declined in the other fifteen territories despite rate of armed-conflicts having increased in three of them.

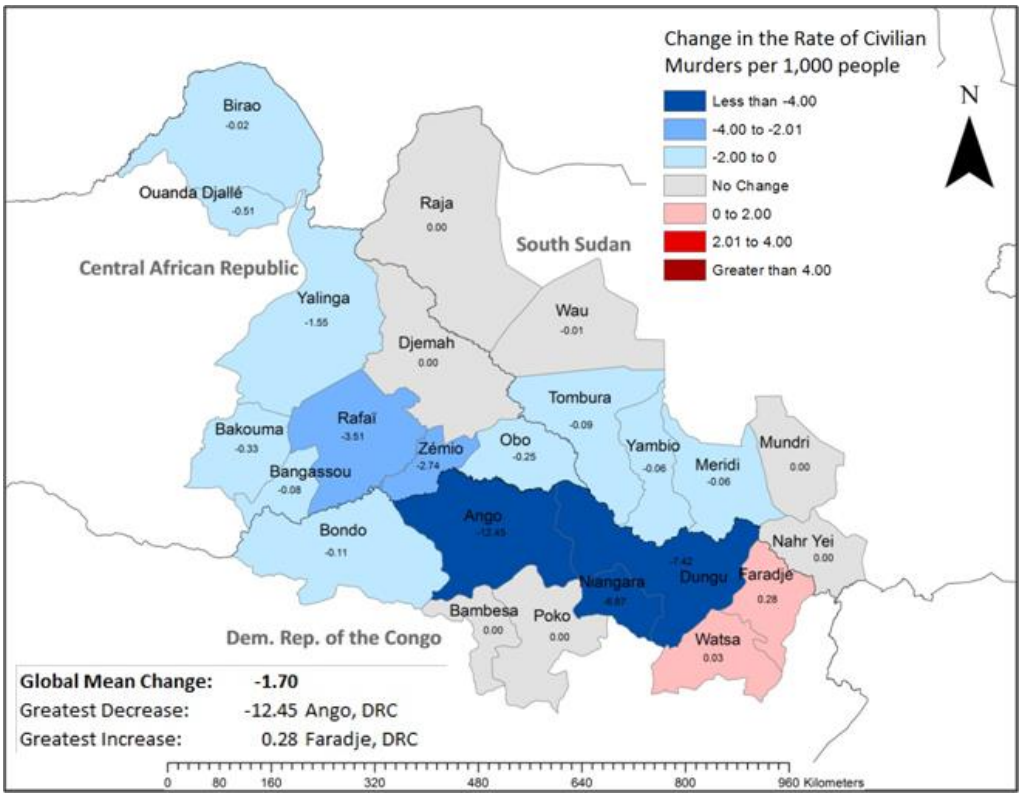

Figure 31: Change in the Rate of Civilian Murders from 2010 to 2011

2010 to 2011: Civilian Abductions

From 2010 to 2011, the overall rate of abductions dropped significantly, although abductions rose slightly in different areas throughout the map (Figure 32). Similar to the rates of armed-conflicts and civilian murder maps for same interval, there is evidence of fragmentation with disparate groups committing more abductions instead of murders. This may be the result of a reeling insurgency lacking the strength they had in 2009 and 2010.

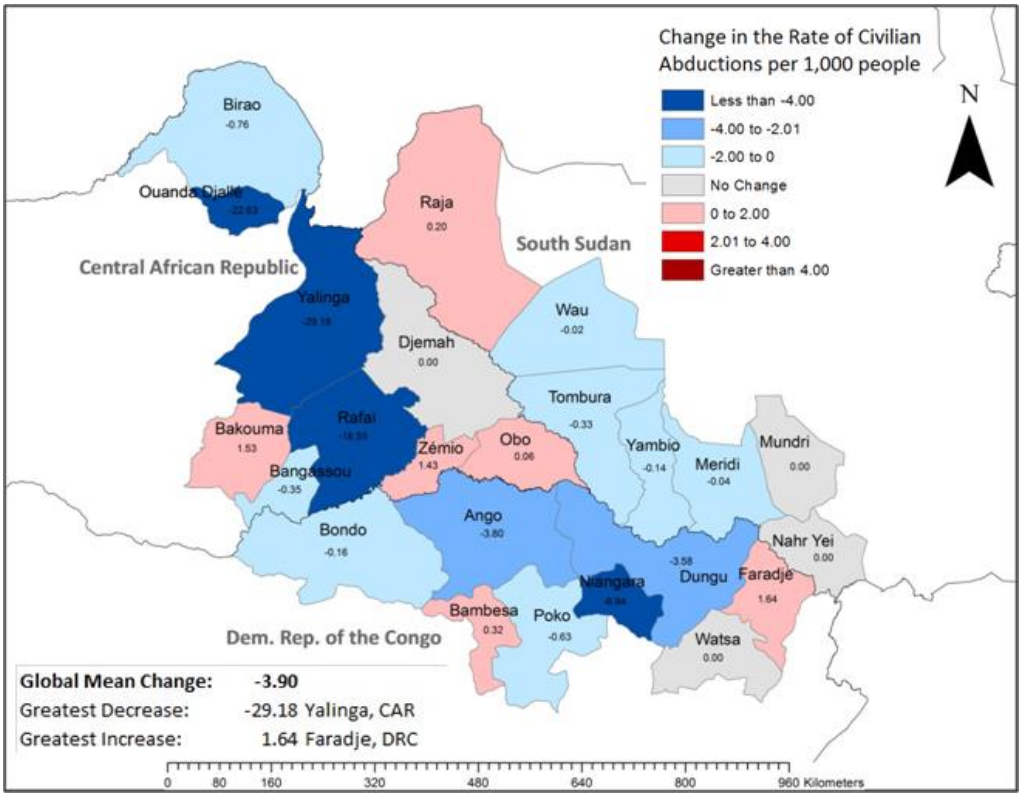

Figure 32: Change in the Rate of Civilian Abductions from 2010 to 2011

2011 to 2012: Armed-conflicts

In the transition from 2011 to 2012, the rate of armed-conflicts increased in the CAR at a rate faster than any other country indicating a clear dichotomy in the study area (Figure 33). The global mean rate of change during this period was -0.03 indicating a continuing decrease in the overall rate of LRA violence. During this time, violence nearly disappeared from South Sudan altogether. In 2012, only one LRA armed-conflict resulting in civilian injury occurred in South Sudan, and there were zero murders or abductions in the entire year. While the rate of armed-conflicts was still highest in the DRC, there is evidence of a westward trend with the rate of armed-conflicts increasing in the CAR. This trend may be attributable to MONUSCO who by this time had gained considerable ground against the LRA. It is also worth noting that, during this period, new HF radios were being installed nearly every other month.

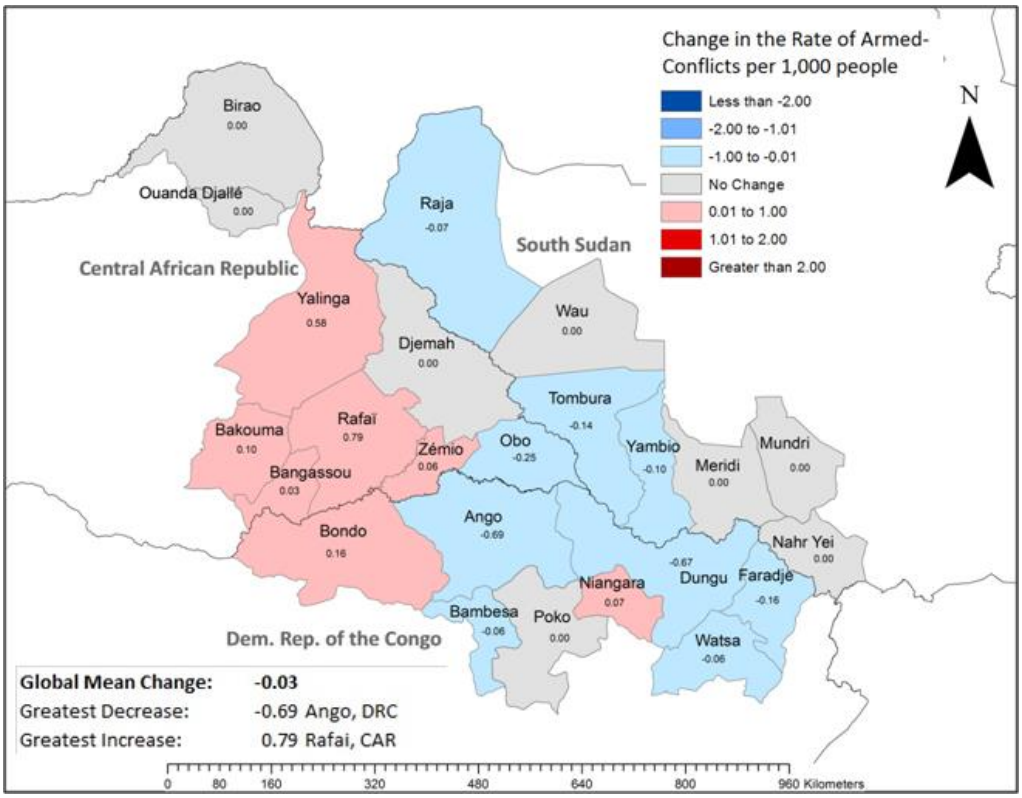

Figure 33: Change in the Rate of Armed-conflicts from 2011 to 2012

2011 to 2012: Civilian murders

In the 2011 to 2012 transition, it is clear that the rate of civilian murders rose only in the CAR (Figure 34). In 2012, 148 armed-conflicts occurred in the DRC, yet they yielded only 13 murders. At the same time, 46 armed-conflicts occurred in the CAR, however, those conflicts yielded 36 murders. This marks the first time that conflicts in the CAR resulted in a higher rate of murders than in the DRC.

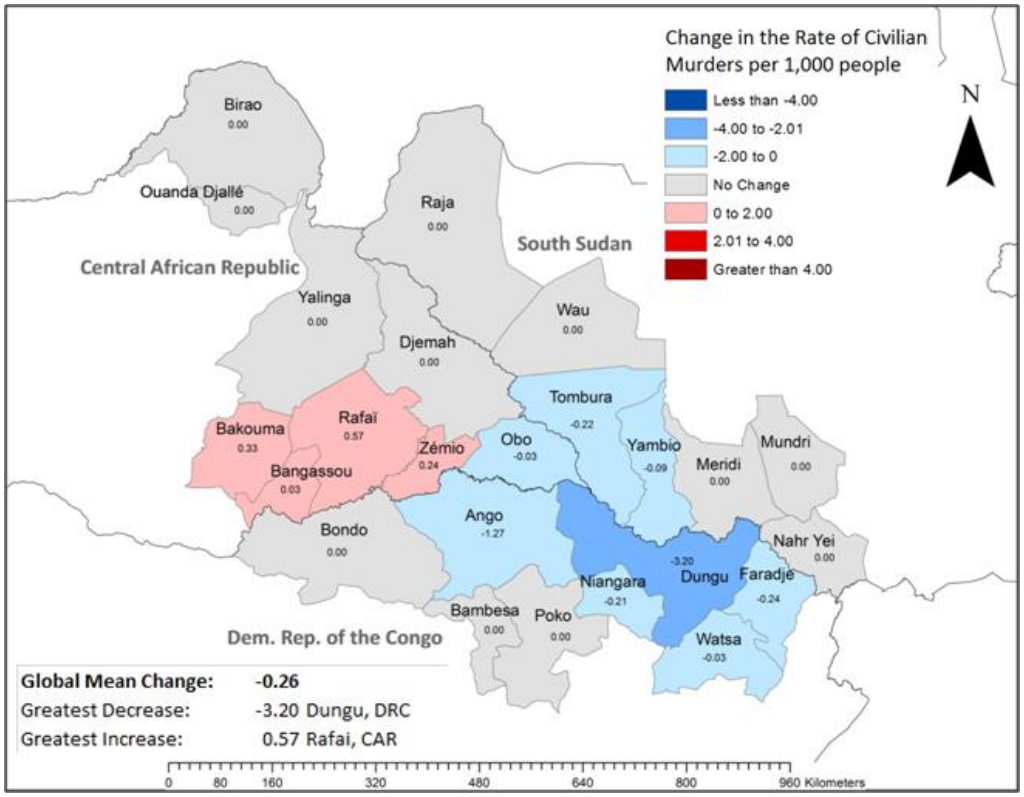

Figure 34: Change in the Rate of Civilian Murders from 2011 to 2012

2011 to 2012: Civilian Abductions

From 2011 to 2012, the rate of abductions increased in the CAR and decreased in the DRC, highlighting a greater dichotomy in the study area (Figure 35). The increase in violence in the CAR is in line with concerns that the LRA is retreating into an increasingly instable region where they are finding opportunities to replenish their ranks through the abduction and forced-conscription of children (Stearns 2013). Furthermore, the CAR territories are several hundred kilometers from MONUSCO's forward base of operations in Dungu which increases the logistical challenges associated with pursuing the LRA in a country that has not been an active participant in the anti-LRA coalition.

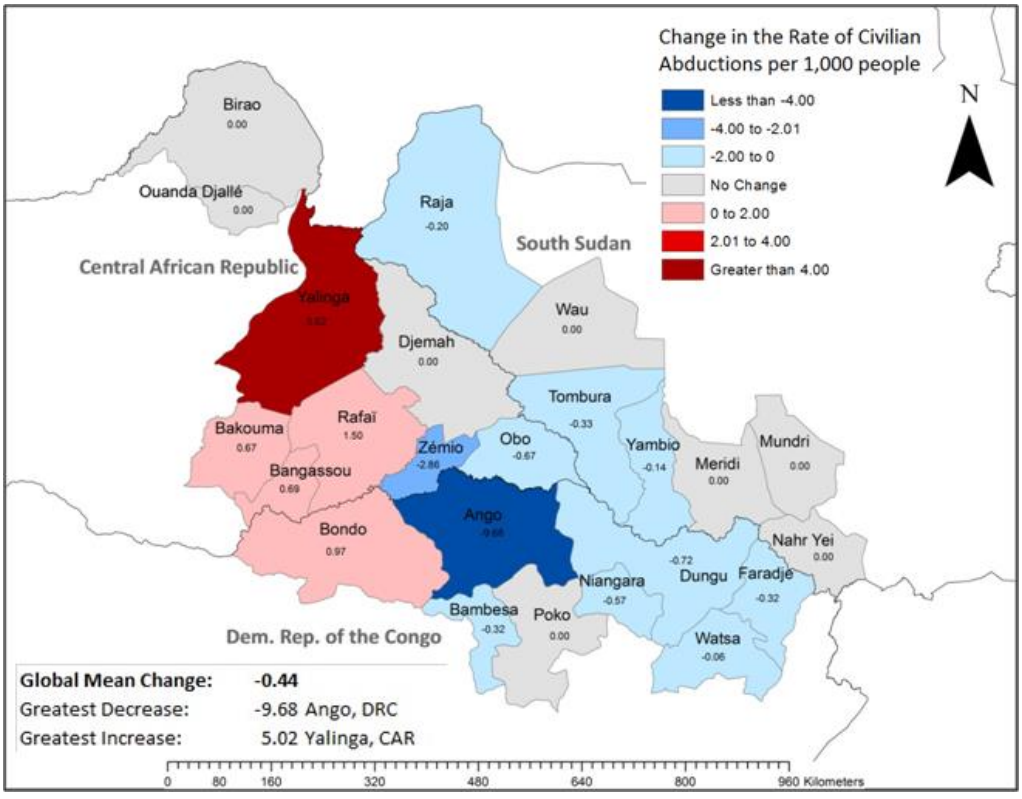

Figure 35: Change in the Rate of Civilian Abductions from 2011 to 2012

4.3 Comparative Changes Using a Difference-in-Differences Descriptive Analysis

The installation of high-frequency radios reflects one of several civilian protection methods employed in the region, and a comparative changes from Difference-in-Differences was used to compare rate changes between the groups to establish whether the presence of radios has had an impact on the rate of violence against civilians.

Representations of the comparative changes are broken into four maps -- one map for each year-to-year transition. The sample group, which includes territories with radios, is highlighted in green and is represented by $(\bar{x}_1)$ in the inset chart. The control group, which includes territories without radios, is highlighted in beige and is represented by $(\bar{x}_2)$ in the inset chart. Territories were only included in the sample group *n* and control group *m* if they sustained one or more armed-conflicts within each temporal period. For example, if a territory had no armed armed-conflicts in either 2010 or 2011, then it was not grouped into either *n* or *m* for the 2010 to 2011 analysis. Excluding territories with no armed-conflicts allowed the analysis to focus only on the changes occurring in regions where the LRA was active during each interval.

2008 to 2009: Violence Comparative Changes

In 2008 and 2009, there were no HF radios installed and herefore no sample group is highlighted in Figure 36. However, the LRA increased their activities in all three categories throughout the study area thereby increasing all rates of violence over time.

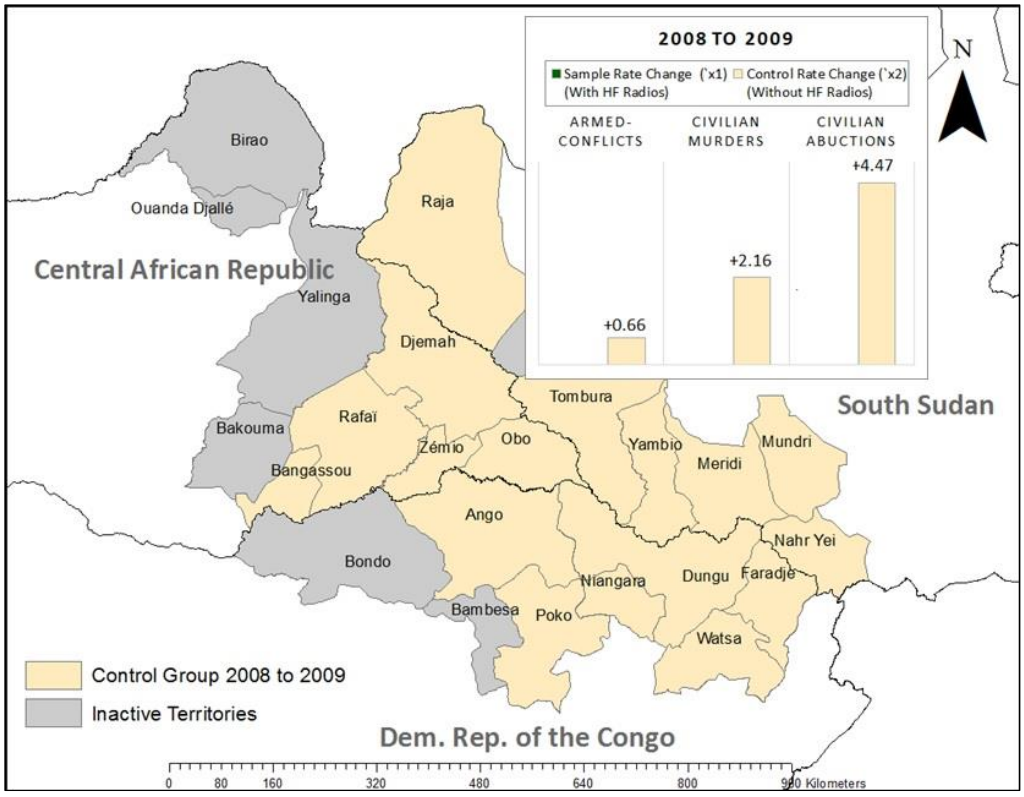

Figure 36: Comparative Changes in Violence 2008 to 2009 (no HF radios exist)

2009 to 2010: Violence Comparative Changes

In 2010, radios were installed in the Dungu and Poko territories. The mean rate change in armed-conflicts between these two territories was +2.68 while the control group was +0.13 (Figure 37). This means that violence in the sample group increased at a rate faster than the control group by +2.54 armed-conflicts per 1,000 people. This is expected because counter-insurgency initiatives, particularly the installation of the HF radios, targeted those territories with the highest rate of armed-conflicts. During this year-to-year transition, the rate of murders decreased in the sample group and the control; however the decrease in the control group was slightly greater. Conversely, the rate of abductions increased in both groups, but the increase was greater in the control group.

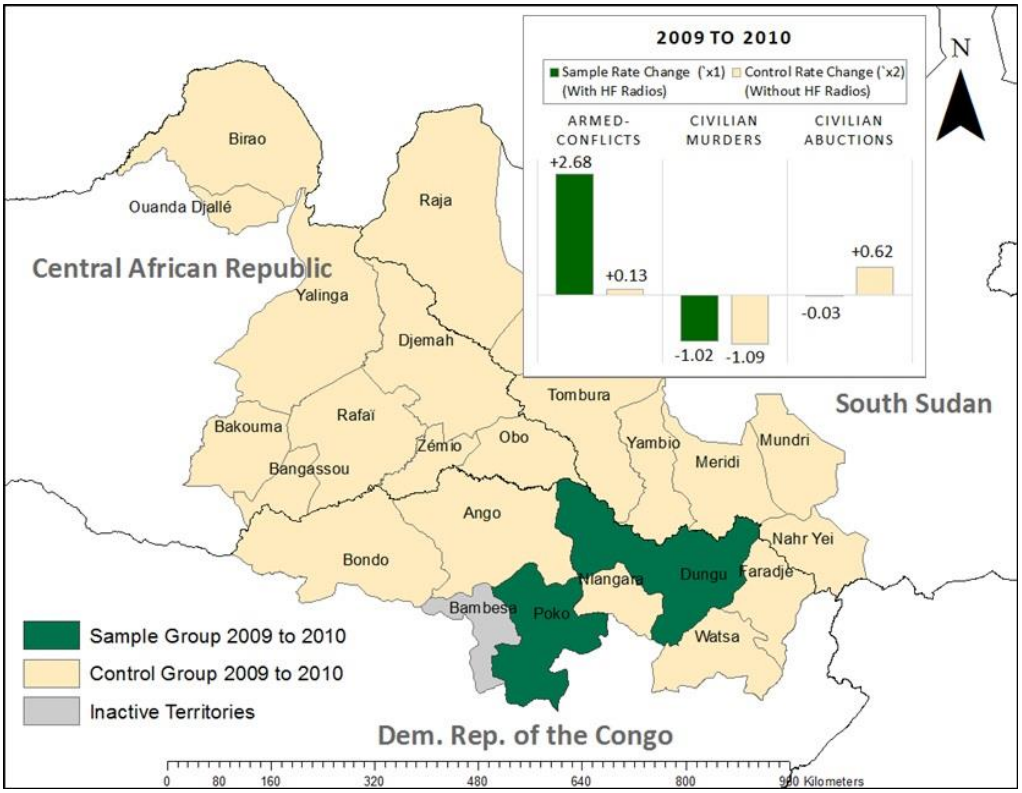

Figure 37: Comparative Changes in Violence 2009 to 2010

2010 to 2011: Violence Comparative Changes

From 2010 to 2011, the rate of armed-conflicts in territories with HF radios decreased at a greater rate than in territories without them (Figure 38). The same held true for the rate of murders. Here, the rate of civilian murders in the sample group decreased by -6.62 while the rate change in the control group was only -0.88. During this time, the rate of abductions also decreased substantially across the study area; however, the rate of decrease in the control group was greater than in the sample group.

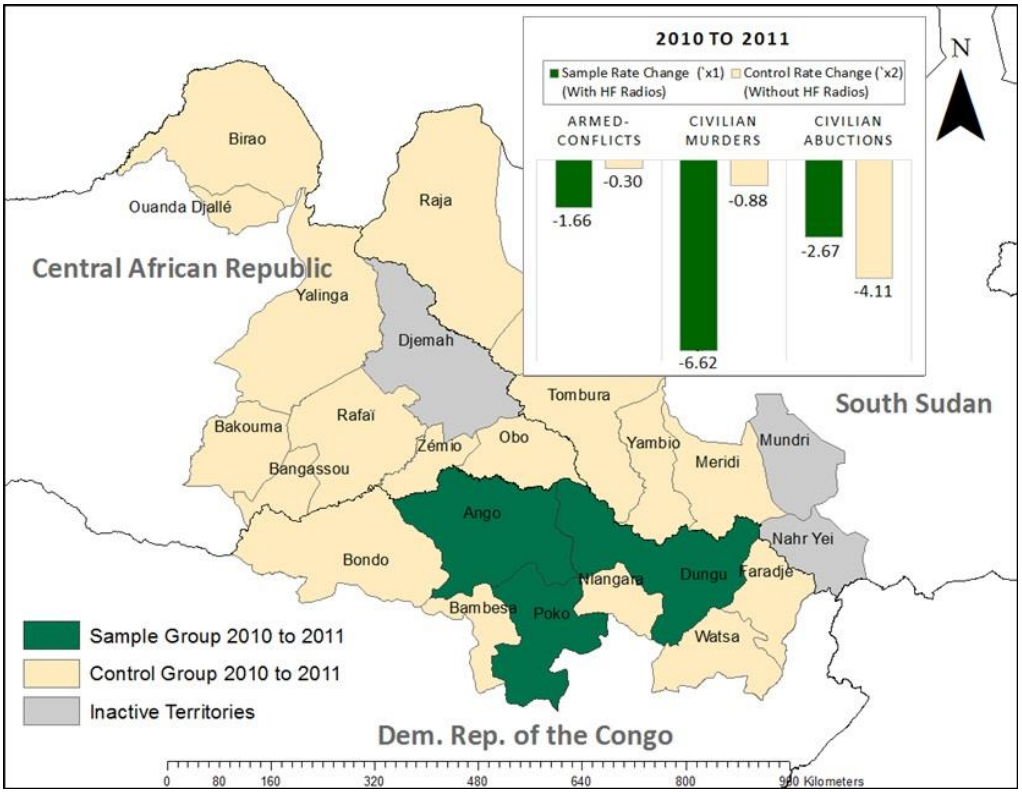

Figure 38: Comparative Changes in Violence 2010 to 2011

2011 to 2012: Violence Comparative Changes

In 2012, the rate of armed-conflicts in territories with HF radios continued to decrease more than in territories without them (Figure 39). The rate of armed-conflicts in the sample group decreased by -0.54 while the rate of armed-conflicts in the control group increased slightly by +0.09. Following this pattern, the rate of murders in the sample group decreased at a rate of -1.50 murders per 1,000 people while the control group actually increased slightly by +0.03. In line, the rate of abductions declined in the sample group by -3.69 while the control group, at +0.31 actually experienced a slight increase. Altogether, this offers evidence that violence in territories with HF radios has decreased at a rate greater than in territories without them.

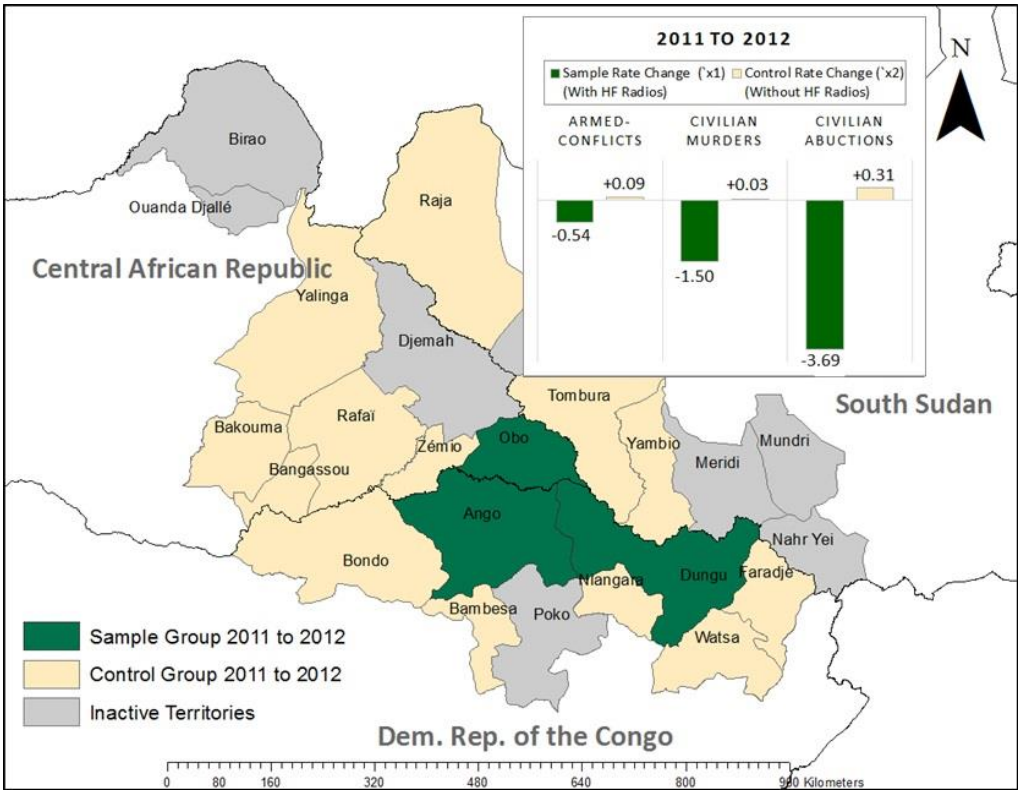

Figure 39: Comparative Changes in Violence 2011 to 2012

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Chapter Five discusses the impact of the findings, their contribution to existing research on conflict geographies, and their relevance to ongoing discussions regarding the development of counter-insurgency efforts in Central Africa. Shortcomings of the data are discussed, and several recommendations for future geographic studies in insurgency-violence are made.

5.1 Key Observations

Results in this work suggest that the LRA's area of operations has fluctuated over time in an apparent reaction to external influences. Since the number of attacks and casualties peaked in 2010, there has been a steady decline in violence committed by the group with the year 2012 marking the lowest levels of violence in the years observed.

In 2012, there were a total of 49 civilian murders. This is a 92.7 percent reduction in murders since 2010 when MONUSCO first adopted Security Council Resolution 1925. This represents a 74.8 percent reduction in CAR, a 97.3 percent reduction in the DRC, and a 100 percent reduction in South Sudan. These statistics indicate that the MONUSCO mission, along with other regional counter-insurgency and civilian-protection initiatives, have been extremely effective in reducing LRA violence in the region.

There are other spatial changes in the distribution of violence that provide telling insights to the evolution of the insurgency group. Notable is the upswing in the rate of violence, particularly abductions, in the CAR in 2012. Since 2010, MONUSCO has prioritized their mission resources in the Northeastern DRC. This includes the establishment of a 1,200 strong peacekeeping force in Haut Uele, the Northeastern Congolese district that includes the Dungu, Faradje, and Niangara territories (UN 2012). MONUSCO missions in the area have included

rehabilitating roadways, escorting civilians and humanitarian partners, and participating in leaflet distribution and FM radio broadcasts designed to convince LRA members to defect.

The increase in violence in the CAR is in line with concerns that the LRA is retreating into an increasingly instable region where they are finding opportunities to replenish their ranks through the abduction and forced-recruitment of children (Stearns 2013). Furthermore, the CAR territories are several hundred kilometers from MONUSCO's forward base of operations in Dungu, which increases the logistical challenges associated with pursuing the LRA and protecting civilians further away.

MONUSCO's base of operations is not far from the Congolese border with Sudan where, in 2012, there were no civilian murders or abductions. During this time, there was only one LRA attack that resulted in civilian injury. This is a significant achievement for a country that sustained 176 murders and 363 abductions in the four years prior. The reduction may be the result of a strengthening South Sudan and Dinka leadership following the country's independence in July 2011. However, there is the possibility of LRA resurgence following increasing instability in South Sudan in 2013 and 2014. Ethnic infighting has recently caused instability in the region, and whether LRA members will resume operations is yet to be seen.

Reviewing the analysis of comparative changes, we can qualitatively describe how the rate of violence consistently declined within the few territories composing the sample group. As expected, the fluctuation in violence for territories without radios was inconsistent; however, this study is unable to ascertain that this is due to the absence of radios. Because of the low sample size and the inability to test the model at other resolutions, the findings associated with this procedure are simply descriptive of a small number of cases.

This thesis offers an integrated examination of the LRA insurgency in a geographic framework that acknowledges external influences and derives patterns of insurgency behavior although with the intrinsic limitations imposed by the data and scale. Moreover, spatial observations address disjuncture in examining insurgencies as static operations and promote the efficiency of spatially integrated approaches. Accordingly, the spatial observations described in Chapter 4 will be provided to the Invisible Children NGO and made available to other parties interesting in assessing flux in the LRA insurgency and the possible impacts of regional counter-insurgency and civilian protection initiatives.

5.2 Contrast with Previous Studies

The diminishing of LRA attacks around Dungu suggests that MONUSCO's forward base of operations have been influential there as an anti-insurgency organization. This is contrary to previous analyses by Copeland (2012) and Aboubacar (2012) that cite ongoing violence in Northeastern Congo as MONUSCO's inability to work effectively with regional forces and protect civilians. This work does not suggest that the same counter-insurgency efforts would be successful against other paramilitary organizations in Africa, but the contrary observations suggest that the LRA area of operations has reacted to the tailored counter-insurgency strategies targeting the organization's structure, priorities, ethnic and ideological foundations.

This study stages variation in violence in social and topographic contexts specific to the LRA, discussing the challenges associated with interstate cooperation faced by coalition forces in areas like the CAR, without relying on estimates of violence perpetrated by unrelated insurgency groups. And, while this study does not provide an examination of the impact of ethno-linguistic distribution and population densities offered in past GIS conflict analyses (Buhaug and Lujala 2005; Cederman et. al. 2007), it does adhere to a scale of analysis that

allows for sub-national trends in insurgency to be detected. Understanding the non-static nature of insurgency operations better informs organizations working to improve civilian security. By adopting intelligent strategies and utilizing geospatial analyses to assess insurgency aggression, we can avert our research from blanket, generalized statements and begin developing more comprehensive profiles targeting specific organizations.

5.3 Recommendations for Future Research Directions

Since January, 2014, interethnic violence has increased in South Sudan. After counter-insurgency forces nearly eliminated the presence of LRA attacks in South Sudan, it is possible that the political instability there may provide the LRA with the opportunity to regain their footing. The LRA could potentially coordinate with one of the opposing sides and volunteer their members for guerilla attacks, like they did in 2005, in exchange for supplies. While this is unlikely, given that they are historical enemies, LRA activity in the South Sudan should be closely observed for indications of new ethnic or political alignments and for the assimilation of former-LRA members into existing South Sudanese paramilitary forces. The adoption of guerilla fighters in foreign militias is a frequent occurrence in African insurgencies when forces become disbanded or are defeated.

Ongoing studies should also continue exploring LRA violence in the CAR in the years 2013 and 2014 to see how the rate of violence has evolved. The Invisible Children and the Resolve, in coordination with UN Agencies, have committed to installing more HF radios in CAR. Therefore, a continuation of the comparative analysis may yield more significant results by leveraging the increased sample size.

5.3.1 Comparative Analysis for High-frequency Radio Distribution

A drawback of the comparative changes from Difference-in-Differences is the resolution of the data being used. Many of the benefits of having an HF radio are local and may not be adequately scaled at the territory-level. To examine the local impacts of utilizing the HF radio network a municipal-level data would need to be used. An alternative approach could be tested using a weighted analysis (Hendrix and Glaser 2007) in which the individual territories have an assigned weight based on the number of radios within them. Hendrix and Glaser (2007) employed a similar approach to measuring significant covariates of conflict by weighting data nodes and creating linear time series regressions at multiple scales of aggregation.

An option for applying a comparative analysis to this study would include using linear regression at annual intervals for each category of violence and classifying an overall trend within each zone/country. From this, we would be able to infer whether the weight (i.e. the number of radios within a zone) correlates with rate changes across any of the three categories of violence (Pers. Com. Dr. Paganelli 2014).

This approach would separate the study area into three zones/countries (e.g. the CAR, DRC, and South Sudan), aggregate the individual territories for which we already have data, combine their categorical event totals (e.g. armed-conflicts, civilian murders, and civilian abductions), and then create a series of plots to form cumulative trends representative of each category of violence. A linear trend would be created for each country for each year-to-year transition in which radios were in existence. For example, CAR, DRC, and South Sudan would each have four distinct linear trends: 2009 to 2010, 2010 to 2011, and 2011 to 2012. Each pair of years would be plotted on the X-axis while the number of events, i.e. armed-conflicts, murders, and abductions, would be plotted on the Y-axis. The cumulative trend for each country would be

indicative of the overall regional tendency (Pers. Com. Dr. Paganelli 2014). For each temporal period, we could then consider the individual territories and their relative weight, i.e. the number of radios within their area, and how the rate of change during the same year-to-year transition deviated from the cumulative trend. This effect can be displayed geographically indicating how the rate of change varies from the trend and among territories within the same country.

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APPENDIX A: ARMED-CONFLICT DATA COLLECTION METHODS

Table 7: Data collection codebook methodology

1. Data Collection	Reports are gathered from a variety of sources: • HF radio towers in DRC and CAR o Civilians report activity to HF radio tower operators o Over 30 HF radio operators call the Dungu hub twice daily to report armed-group activity o Activity is entered into a spreadsheet and then sent to data coders • UN & NGO reports • News & media outlets • Civil society contacts in local communities • Field research conducted by Resolve and Invisible Children staff
2. Database Entry	Database entry: • Reports are divided between a team of coders from both Invisible Children and Resolve. Coders determine if the source is reliable or unreliable (see section 4.2B of the codebook). Before an incident is reported, the coder reads through other incidents to check for duplicates. Verification ratings: • After an incident is categorized, each incident is given a verification rating (see section 4.2A of the codebook). • If a coder determines that an incident was potentially committed by the LRA, the incident is rated on the LRA Actor Verification Scale (see section 4.2C of the codebook).
3. Data Review	• A second data coder reviews each incident to catch human errors and duplicate reports (see section 4.1E). • IC and Resolve staff with field experience review sensitive incidents immediately and review all incidents every three months. Should these staff members feel an incident was misreported, the incident is corrected. External LRA and regional experts are consulted as necessary.
4. Data Mapping & Sharing	• After an incident is entered and approved to be mapped, it appears on the LRA Crisis Tracker website. • Data is regularly sent to UN agencies and humanitarian practitioners for comparison and collaboration.
5. Data Revamp	• As the database grows and policies are updated to reflect best practices, data coders revisit and "revamp" the data when needed.
6. Data Analysis & Reporting	• Crisis Tracker staff analyze data for trends and patterns in LRA activity. • Specific areas and provinces are also analyzed for increases or decreases in the number and type of attack. • After analysis has been completed and reviewed, it is reported in various Crisis Tracker reports that can be found on the LRA Crisis Tracker website.

Source: Resolve and the Invisible Children. "Map Methodology & Database Codebook v 1.6" ed. The Invisible Children for the LRA Crisis Tracker, 2012.

APPENDIX B: RAW COUNTS BY TERRITORY

Table 8: Armed-Conflicts - Raw Counts by Territory

Country	Territory	2008	2009	2010	2011	2012
SSD	Raja	0	2	0	4	0
	Wau	0	0	1	0	0
	Nahr Yei	3	2	0	0	0
	Meridi	4	2	4	0	0
	Mundri	0	2	0	0	0
	Tombura	3	9	14	9	1
	Yambio	3	3	15	15	0
DRC	Ango	0	36	32	22	16
	Bambesa	0	0	0	1	0
	Bondo	0	0	1	0	3
	Poko	0	4	2	0	0
	Dungu	33	73	205	119	103
	Faradje	5	11	9	24	20
	Niangara	1	17	26	5	6
	Watsa	0	2	1	2	0
CAR	Djemah	0	4	0	0	0
	Obo	3	38	11	14	5
	Zémio	0	2	20	11	12
	Yalinga	0	0	4	0	3
	Bakouma	0	0	2	4	6
	Bangassou	0	1	2	1	3
	Rafaï	0	2	43	6	17
	Birao	0	0	5	0	0
	Ouanda Djallé	0	0	2	0	0

Table 9: Civilian Murders - Raw Counts by Territory

Country	Territory	2008	2009	2010	2011	2012
SSD	Raja	0	2	0	0	0
	Wau	0	0	1	0	0
	Nahr Yei	4	8	0	0	0
	Meridi	6	8	5	0	0
	Mundri	0	6	0	0	0
	Tombura	31	6	17	12	0
	Yambio	32	3	22	13	0
DRC	Ango	0	56	120	12	1
	Bambesa	0	0	0	0	0
	Bondo	0	0	2	0	0
	Poko	0	1	0	0	0
	Dungu	500	306	260	84	8
	Faradje	184	50	2	9	3
	Niangara	20	360	100	4	1
	Watsa	0	100	0	1	0
CAR	Djemah	0	26	0	0	0
	Obo	6	86	13	4	3
	Zémio	0	4	49	3	7
	Yalinga	0	0	8	0	0
	Bakouma	0	0	8	1	8
	Bangassou	0	2	5	0	2
	Rafaï	0	2	57	8	16
	Birao	0	0	1	0	0
	Ouanda Djallé	0	0	2	0	0

Table 10: Civilian Abductions - Raw Counts by Territory

Country	Territory	2008	2009	2010	2011	2012
SSD	Raja	0	13	0	11	0
	Wau	0	0	3	0	0
	Nahr Yei	25	6	0	0	0
	Meridi	8	6	3	0	0
	Mundri	0	9	0	0	0
	Tombura	70	31	36	18	0
	Yambio	55	5	43	21	0
DRC	Ango	0	428	146	113	29
	Bambesa	0	0	0	5	0
	Bondo	0	0	3	0	18
	Poko	0	17	6	0	0
	Dungu	362	257	283	198	181
	Faradje	190	19	21	62	54
	Niangara	0	260	116	19	11
	Watsa	0	20	2	2	0
CAR	Djemah	0	28	0	0	0
	Obo	133	109	27	29	5
	Zémio	0	8	57	81	33
	Yalinga	0	0	151	0	26
	Bakouma	0	0	22	54	68
	Bangassou	0	1	29	6	52
	Rafaï	0	38	272	13	34
	Birao	0	0	37	0	0
	Ouanda Djallé	0	0	88	0	0