Chapter 3

Mapping political violence in North and West Africa

Chapter 3 shows that political violence is very unequally distributed in North and West Africa. In order to better understand the geography of conflicts in the region, the chapter develops a new spatial indicator of violence, called the Spatial Conflict Dynamics indicator (SCDi), that examines the intensity and concentration of violent events. The indicator highlights which regions experience the most conflicts, how conflicts change geographically over time, and how military interventions affect the geography of conflicts. The analysis of the evolution of political violence is conducted at the regional level (North and West Africa) and through three case studies (Mali and Central Sahel, Lake Chad, Libya). It leverages political event data from the Armed Conflict Location and Event Data project (ACLED) that catalogues violent extremist incidents in Africa since 1997.

KEY MESSAGES

» Political violence is very unequally distributed in North and West Africa: the major hotspots are located in Nigeria, Libya, and Central Sahel.

» The new Spatial Conflict Dynamics indicator (SCDi) measures both the intensity and concentration of conflicts.

» The indicator examines which regions experience the most conflicts, how conflicts change geographically over time, and how military interventions affect the geography of conflicts

HOW TO ASSESS THE GEOGRAPHY OF VIOLENCE

Political violence is very unequally distributed in North and West Africa. While some regions such as the Lake Chad region or the Inner Niger Delta in Mali tend to experience a disproportionate number of attacks, other regions are largely devoid of violent incidents. The location of violent events in the region is also likely to change over time: before the Jihadist insurgencies developed in the 2000s, neither the Lake Chad nor the Inner Delta were known as hotspots of violence in West Africa. Understanding why, how and when a region becomes a hotspot of violence is crucial to assess the evolution of conflicts in the region.

The objective of this work is to map this changing geography of violence. To do so, the report develops a new spatial indicator of violence, called the Spatial Conflict Dynamics indicator (SCDi). The indicator examines which regions experience the most conflicts, how conflicts change geographically over time, and

how military interventions affect the geography of conflicts. Each research question is addressed using a spatial approach and involves metrics specifically designed to study the geography of conflicts in the region (Table 3.1). In order to assess the intensity of violence, the report maps the density of violent events that took place in North and West Africa since 1997. The geographical clustering or dispersion of conflicts is assessed using the average nearest neighbour analysis, a metric that provides a measure of the degree of concentration of violent incidents. The impact of military interventions on conflicts is measured using the SCDi, which incorporates both metrics.

A focus on organisations

In recent decades, the level of analysis of armed conflict has shifted from macro-, to micro-factors, to meso-factors. Until the mid-2000s,

Table 3.1

Questions, approaches and metrics for assessing the geography of violence

Research questions	Approaches	Metrics
Which regions experience the most conflicts?	Assess spatial intensity of violence over study region over time	Density analysis: number of violent events per geographical unit
How do conflicts spread geographically?	Assess spatial concentration of violence over time	Average nearest neighbour analysis: distance between each violent incident and its nearest neighbour's location
How do military interventions affect the geography of conflicts?	Assess impact of military interventions on intensity and concentration of violence	Spatial Conflict Dynamics indicator (SCDi)

large-N studies focused essentially on social inequalities, poverty, education, natural resources and commodity exports data collected at the national level. While these macro data helped characterise the context in which conflicts developed, they were not particularly well suited to explain why civil wars broke out, how alliances emerged and why civil wars were so difficult to end (Bultmann, 2018). In the late 2000s, these approaches eventually gave way to micro-level studies that focused on social interactions between insurgents (Wood, 2008) and on change during conflict (Kalyvas, 2006). One of the major contributions of micro-studies was to show that individuals had a multiplicity of motives to join armed groups. Far from being exclusively motivated by greed or grievances, they also fought for political recognition, physical protection, or to defend their property.

In recent years, a new strand of literature has argued that the meso-level, which reflects the organisation of armed groups, is best suited to understand conflict dynamics (Price, 2019). This report follows this trend by using the "organisation" as its main unit of analysis. Organisations are defined as political actors with a particular purpose and a distinct structure. Al-Qaeda in the Islamic Maghreb (AQIM), for example, is a formal organisation with a leader, an executive Council of Notables, a Sharia Council that governs Islamic legal matters, and several committees responsible for military affairs, finance, medical care, politics and international relations (CEP, 2019; Werenfels, 2015). As an organisation, AQIM has developed a professional media wing in charge of promoting

the doctrine of the organisation domestically and disseminating audio and video statements that claim attacks in Arabic and English (DHS, 2016).

Organisations are an intermediary unit of analysis that lie below political movements but above subgroups and individuals (Table 3.2). In Mali, for example, the rebellion comprises the Co-ordination of Azawad Movements (CMA), a coalition of several nationalist organisations, and Plateforme, a pro-government coalition of militias and other "popular" fronts. Each of these movements contains numerous organisations such as the National Movement for the Liberation of Azawad (MNLA) and High Council for the Unity of Azawad (HCUA) that maintain separate structures, and only join the movement for advancing their individual goals.

Organisations are far from homogeneous blocs, especially in North and West Africa, where factions often reflect tribal or ethnic lines. Each organisation is composed of different subgroups that often split from the main entity or merge with existing organisations. Islamist groups, for example, are quite diverse when it comes to their ethnic composition, political objectives, and military tactics. They rarely form a single entity such as a "global terrorist network" or "jihadi network" (Dowd and Raleigh, 2013). In North and West Africa, infighting can occur within each social level and among the various actors that comprise it. Violent extremist organisations can simultaneously struggle with internal rivalries while they fight against other organisations that have different goals than theirs. Some authors argue that intra-organisational alliances that bring together subgroups, factions and tribes

Map 3.1

Victims of political violence in North and West Africa, 1997-2019
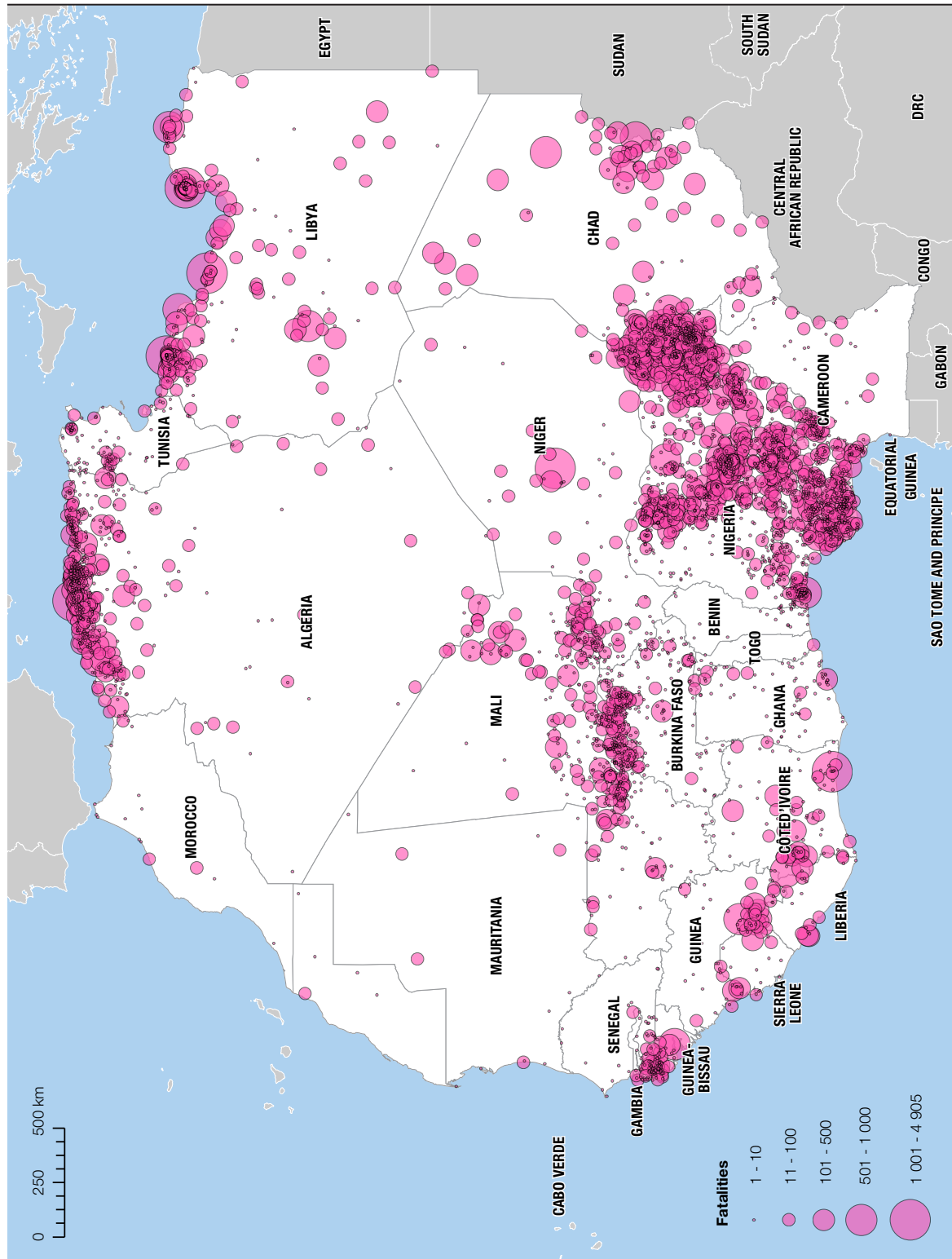
Source: Authors based on ACLED data 2019a.

Table 3.2

Four social levels of analysis

Level	Definition	Example in Mali
Movements	Movements are a collective effort by people working toward a common objective	Jihadist movement
Organisations	Organisations are discrete institutions or associations that have a particular political purpose; they are made up of members and have administrative and functional structures	Jama'at Nusrat al Islam wal Muslimeen (JNIM)
Subgroups	Subgroups are collective subcomponents of organisations; they usually perform different functions under the direction of the overall organisation	Katiba Serma
Individuals	Individuals are single human beings	Abu Jalil al Fulani

are different from inter-organisational alliances that tie several different organisations under a common umbrella (Bencherif and Campana, 2017). The same idea is true for fragmentation across organisations operating under different names and intra-group factionalism that occurs within each organisation (Dowd, 2015). These questions are particularly relevant in North and West Africa, where the distinctions between a movement and an organisation can be rather blurry. For example, the MNLA calls itself a 'movement' because it results from the fusion of several rebel groups but it is also an organisation with its own leadership hierarchy, political and military wings, public relations and social media office, and flag (Lecocq and Klute, 2019).

Regional and local analyses

The analysis of the evolution of political violence in North and West Africa is conducted at the regional and local levels. The study examines the major trends of violence in the region, including Algeria, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Libya, Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, Sierra Leone, Togo and Tunisia (Map 3.1). This rather large geographical scope reflects both the origins and mobility patterns of violent organisations, who tend to conduct their attacks across the Sahel and the Sahara instead of being contained within a single country or region.

In the region, the geographic distribution of the 138 000 victims of violence between 1997 and 2019 is quite uneven (Walther, 2017). This means that political violence occurs in a number of specific sub-regions rather than on nationwide scales. There are three main geographic zones or "hotspots" of violence:

- The main geography of conflict is in Nigeria. However, this is composed of three distinct conflicts in the country: the jihadist insurgency led by Boko Haram in the Lake Chad region, the acts of violence carried out by the armed groups in the Niger Delta against the federal government and the oil companies, and communal violence between pastoral herders and farmers in the Middle Belt. Taken together, these conflicts accounted for 30% of the violent events and half (49%) of the victims in the overall region since 1997.

- The second geographic epicentre of violence is located north of the Sahara. In Libya, tensions related to the fall of Colonel Gaddafi in 2011, as well as fighting between Islamic militias and pro-government forces during the civil war, have resulted in 19 000 deaths since 1997 or 14% of the overall number of victims. In neighbouring Algeria, a large proportion of the 13 000 deaths reported there are due to the civil war that took place between the government and Islamist groups until the early 2000s.

- The third hotspot of violence has been located in the central part of the West African Sahel, which comprises eastern Mauritania, much of Mali, the north of Burkina Faso, and the west of Niger. In this region, civil wars, rebellions and clashes with groups affiliated

Box 3.1

The Chadian Civil War (1998-2002, 2005-10)

The first Chadian Civil War began when an armed rebellion by the Movement for Democracy and Justice in Chad (MDJT) erupted in 1998. With the help of France, the government of President Idriss Déby Itno was able to quell the rebellion and a peace treaty was signed in 2002. Political opposition to Déby's repressive policies and perceived lack of legitimacy has steadily grown and led armed political and rebel factions to emerge since the 1990's (Ploch, 2008). Idriss Déby Itno originally seized power in a coup against Hissène Habré in 1990 and has ruled Chad since then. Although Déby implemented Chad's first multi-party, democratic election in its history in 1996, he has gradually concentrated and consolidated power within his Beri (Zaghawa) ethnic group, while also repressing opposition through various mechanisms (Debos and Tubiana, 2017; Eizenga, 2018). The Beri constitute 3% of the population but occupy the majority of government positions, and this political patronage has antagonised other groups.

In 2005, Déby abolished term limits, allowing him to run indefinitely for re-election (Debos and Tubiana, 2017). Just prior to winning election for his fourth term in 2011, his party, the Mouvement Patriotique du Salut (MPS), captured a majority in the National Assembly legislature and was accused of cheating and rigging the election. A national dialogue between presidential and opposition parties ensued, with superficial reforms passed (Eizenga, 2018). These concessions included establishing an electoral commission (CEN), representation for opposition political parties, municipal elections, and a biometric census and electoral lists (Eizenga, 2018). Steadily escalating opposition toward Déby and his party has grown in Chad due to a fiscal crisis over oil prices, a crackdown a civil liberties, and repeatedly derailed elections (Debos and Tubiana, 2017).

The second war began in 2005 with a series of raids in the east of Chad on strategic government positions by the Movement for Democracy and Justice in Chad (MDJT). Various Sudanese rebel groups have backed Chadian rebel groups throughout their campaigns. Other militias and rebel groups joined the MDJT's offensives, including the Rally for Democracy and Liberty (RDL) and the United Front for Democratic Change (FUC), a coalition of eight rebel groups). In 2006, Déby announced a state of emergency, while in 2007 in Sirte, Libya the major rebel groups in eastern Chad signed a peace agreement. In early 2008, rebel forces advanced on the capital in an unsuccessful coup attempt.

The French military has supported Déby through numerous coup attempts (Eizenga, 2018; Massey and May, 2006). The United States likewise considers Chad a critical geo-strategic partner in the regional war on terror. In 2007, the UN Security Council passed Revolution 1778 that established a multinational presence called the UN Mission in the Central African Republic and Chad (MINURCAT) (UN Security Council, 2007). A number of anti-regime civil society groups have formed to protest Déby's authoritarian and repressive policies, including Ça Suffit, IYINA, and "Trop c'est Trop" (Debos and Tubiana, 2017).

Source: Matthew Pflaum.

with Al-Qaeda and the Islamic State (IS) are responsible for the bulk of violent events and fatalities. Violence has shifted over time. In Chad, the 7 600 victims reported since 1997 result from the civil wars that ended in 2010 (Box 3.1) and the current insurgency led by Boko Haram in the Lake Chad region. In Mali, the northern Tuareg rebellion of the late 2000s, communal violence, and the more recent civil war have killed almost 7 000 people. In Niger, over 3 000 people have died because of the Tuareg rebellions of the late 2000s, the Islamist insurgency that developed from Mali since 2012, and the Boko Haram insurgency in the far east of the country. In Burkina Faso, the development of Islamist terrorism in the north of the country has led to a rapid increase in the number of violent events and victims.

Table 3.3

Number of violent events and fatalities per country, 1997-2019

Country	Number of events	Number of fatalities	Major conflicts
Nigeria	9 017	67 512	Boko Haram insurgency (2009-), Middle Belt communal violence, Niger Delta insurgency (2003-)
Libya	6 369	19 048	First Libyan Civil War (2011), Second Libyan Civil War (2014-)
Algeria	2 758	13 460	Algerian Civil War (1991-2002)
Chad	658	7 642	Chadian Civil War (1998-2002, 2005-10), Boko Haram insurgency (2014-)
Cameroon	1 793	6 879	Boko Haram insurgency (2013-)
Mali	2 211	6 845	Tuareg rebellion (2007-09), Malian Civil War (2012-)
Côte d'Ivoire	979	3 822	First Ivorian Civil War (2002-07), Second Ivorian Civil War (2010-11)
Niger	623	3 265	Tuareg rebellion (2007-09), Islamist insurgency (2012-), Boko Haram insurgency (2013-)
Guinea	420	2 767	Sierra Leone-Liberia conflict (2000-03), Guinea clashes (2013)
Burkina Faso	697	1 716	Islamist insurgency (2016-)
Senegal	443	1 403	Casamance conflict (1982-2014)
Liberia	(824)*	(1 168)*	Second Liberian Civil War (1999-2003)
Guinea-Bissau	135	946	Guinea-Bissau Civil War (1997-99)
Tunisia	621	615	Tunisian Revolution (2010-11), Islamist insurgency (2015-)
Ghana	286	491	No major conflict
Sierra Leone	(2 195)*	(143)*	Sierra Leone Civil War (1991-2002)
Mauritania	59	129	No major conflict
Morocco	111	119	No major conflict
Gambia	64	97	No major conflict
Benin	53	83	No major conflict
Togo	44	57	No major conflict
Total	**30 360**	**138 207**	

Note: *The number of events and fatalities for Sierra Leone and Liberia are underreported.

Source: Calculations by the authors based on ACLED data 2019a. The dataset, which starts in 1997, only partially covers the Sierra Leone Civil War (1991-2002) and the Second Liberian Civil War (1999-2003).

Outside of these three main hotspots, the largest number of events and victims is observed on the Gulf of Guinea, where several related conflicts have taken place in Côte d'Ivoire, Sierra Leone, Liberia and Guinea from the early 1990s to the mid-2000s.

The report draws on this understanding of the geography of conflict to focus on three case studies where violent organisations: (1) have developed particularly rapidly since the late 1990s, (2) have extended beyond state boundaries, (3) have caused a significant number of violent events and fatalities, and (4) have led external powers to intervene militarily. As shown on Map 3.2, these cases are the Mali insurgency and its

consequences in Central Sahel (since 2012), the Lake Chad region insurgency (since 2009), and the First and Second Libyan Civil War (since 2011). In Mali and Central Sahel, the conflict opposes the governments of Mali, Mauritania, Niger and Burkina Faso and their international allies to a number of secessionist rebels and Jihadist organisations such as AQIM, ISGS and other groups. In the Lake Chad region, the conflict opposes the governments of Nigeria, Niger, Chad and Cameroon, organised into a Multinational Joint Task Force (MNJTF), to the Jihadist organisation Boko Haram and its splinter group. In Libya, the conflict initially opposed Colonel Gaddafi's forces to revolutionary militias before

Map 3.2
Location of case studies
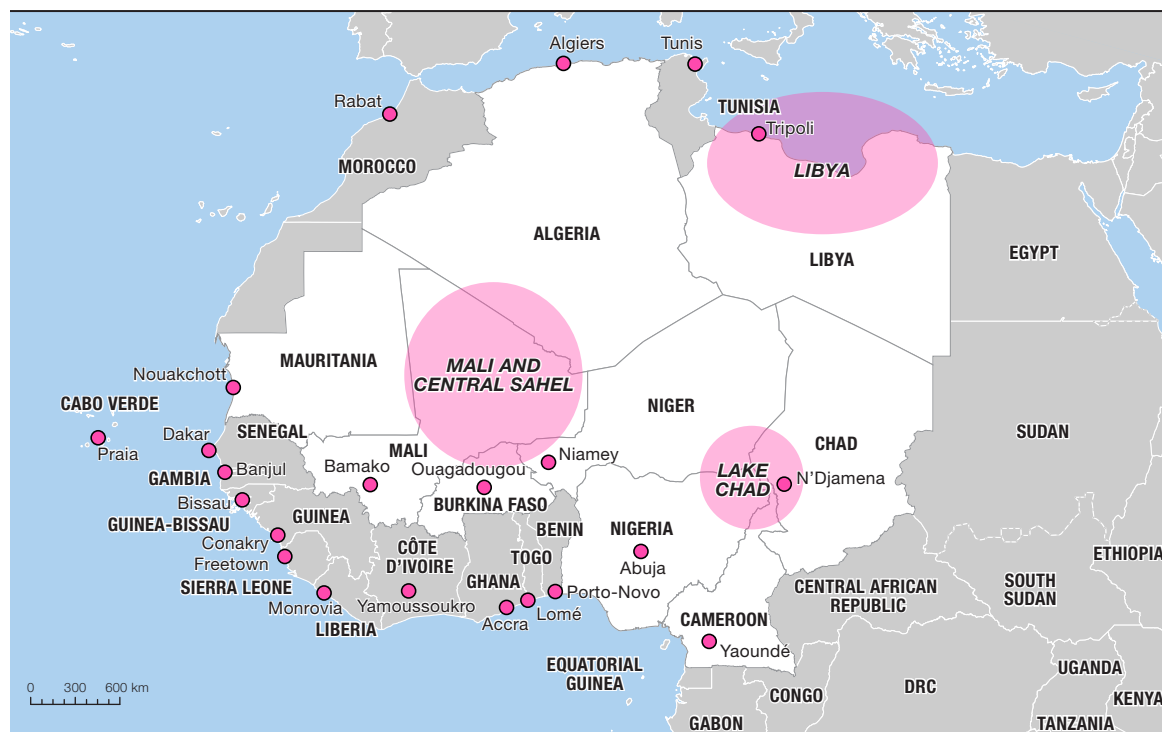
degenerating into a military struggle between competing governments, each supported by numerous militias, the IS or Al-Qaeda.

In additional to the exploration of the three case studies, the report also uses spatial metrics to identify trends of violence at the subnational level. The choice to consider subnational data is motivated by the fact that much of the political violence observed in the region has localised roots that would be difficult to understand at the regional or national level. For this reason, the new spatial indicator developed in this report (the SCDi) is calculated at a small scale by dividing all of North and West Africa into a 50 by 50 kilometres grid containing 6 540 individual "cells" or "regions" (Map 3.3 and Box 3.2).

A disaggregated dataset

The report leverages political event data from the Armed Conflict Location and Event Data project (ACLED) that catalogues violent extremist incidents in Africa since 1997 (ACLED, 2019a). Compared with other databases such as the

Worldwide Incident Tracking System (WITS), the Global Terrorism Database (GTD), or UCDP PRIO Armed Conflict dataset, ACLED provides detailed and georeferenced information on actors in conflict without imposing a threshold on the number of fatalities recorded for each event (Raleigh et al., 2010). From January 1997 to June 2019, the ACLED dataset provides detailed information on 30 360 events involving 2 551 unique organisations and 138 207 fatalities.

The study uses the actors listed in the ACLED dataset to identify the organisations involved in political violence in the region (Table 3.4). The dataset distinguishes between eight categories of actors (Box 3.3) based on their goals and structure and, where possible, on their "spatial dimension and relationships to communities" (ACLED, 2019b: 19).

The main factor of classification in the ACLED database is the "event", which necessitates some adjustments when the data is used to map political events. For this reason, the study creates a unique name for each organisation. In the ACLED database, some government forces
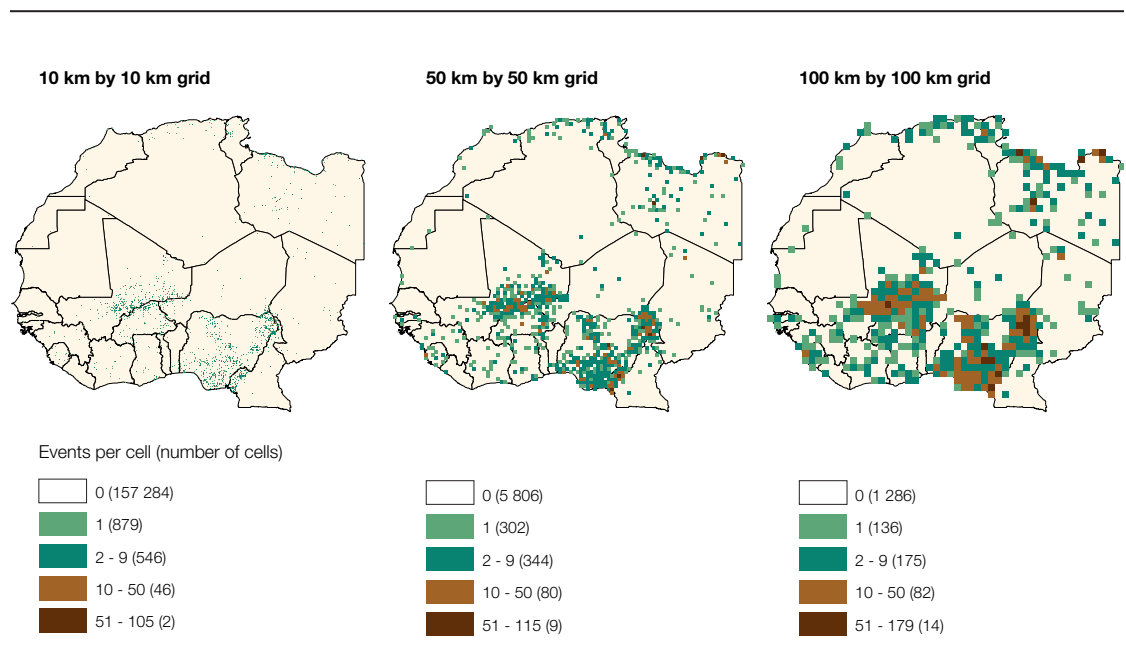
Box 3.2

Choosing the right grid for the region

The chosen grid was developed and adapted specifically to study political violence in this region: each cell in the grid is large enough to aggregate a sufficient number of violent events for meaningful analysis while still small enough to provide a localised assessment of political violence across the region.

Alternative cell sizes were explored. For example, using a much smaller grid of 10 by 10 kilometres would have potentially provided a more granular location of violent events. However, because political violence is geographically clustered in a limited number of regions, 99% of the cells would have been empty in 2018. Of the 1% of cell that would have had events within them, only 40% would have had more than one event. The indicator would not have been particularly meaningful with such small numbers of points in each cell. Alternatively, larger cells such as a 100 by 100 kilometres grid would have aggregated distant events that would not be necessarily linked to one another.

By comparison, the 50 by 50 kilometres grid provides a balanced approach to these issues, with large enough areas to encompass multiple events for the standardised metrics of the study without being so large as to necessarily group together events that are unconnected. This allows comparing the evolution of conflicts from Dakar to N'Djamena, and from Lomé to Algiers. It also provides a much more homogeneous representation of violence than existing administrative units, whose size differs enormously across countries and bioclimatic zones. Administrative regions tend to be much bigger in the sparsely populated Sahara than anywhere else, for example, which would greatly affect the density and diffusion of violent events as calculated in this report.

Map 3.3

Size of grids and number of events by cells

10 km by 10 km grid   **50 km by 50 km grid**   **100 km by 100 km grid**

Events per cell (number of cells)

10 km	50 km	100 km
0 (157 284)	0 (5 806)	0 (1 286)
1 (879)	1 (302)	1 (136)
2 - 9 (546)	2 - 9 (344)	2 - 9 (175)
10 - 50 (46)	10 - 50 (80)	10 - 50 (82)
51 - 105 (2)	51 - 115 (9)	51 - 179 (14)

Box 3.3
Categories of actors

- State forces are collective actors that exercise de facto state sovereignty over a given territory. They include military and police forces. In the particular case of Libya, competing groups that have a claim to government functions, such as the National Salvation Government, are coded as state forces.
- Rebel groups are organisations whose political agenda is to overthrow or secede from a given state. When splinter groups or factions emerge from a rebel group, they are recorded as distinct actors in the dataset.
- Political militias are organisations whose goal is to influence and impact governance, security and policy in a given state through violent means. Unlike rebel groups, political militias "are not seeking the removal of a national power, but are typically supported, armed by, or allied with a political elite and act towards a goal defined by these elites or larger political movements" (ACLED, 2019b: 22).
- Identity militias are a rather heterogeneous group of militants structured around ethnicity, religion, region, community and livelihood. Events perpetrated by identity militias are often portrayed as "communal violence" as they involve groups

embedded in local conflicts over resources and power.
- Rioters are individuals or groups of individuals engaged in disorganised violence during demonstrations. They are unarmed yet may engage in violent activities against civilians, government forces or other armed groups. Rioters are identified by their country of origin. Those affiliated with a political party or leading an event are named in the respective associated actor category.
- Protesters are peaceful and unarmed demonstrators who engage in a public event. They are identified by their country of origin. Those affiliated with a political party or leading an event are named in the respective associated actor category.
- Civilians are unarmed victims of violent events. They are identified by their country of origin.
- External forces include international organisations, foreign military forces, private security firms and independent mercenaries engaged in violent events. When military forces operate outside of their home state, they are coded as "Other".

Source: ACLED 2019a.

are sometimes called differently depending on their patterns of behavior or time period. The Military Forces of Liberia, for example, are listed six times according to the regime they have served and the type of unit that was in charge of the events. The study simplifies this classification and considers the military and police forces of each country as a unique actor.

In a few cases, the code assigned to an actor can change over time if, for example, a militia is incorporated into government forces or if a rebel group successfully secedes from a state. In other cases, some actors can sometimes be listed either as a movement or as an organisation depending on the incident. For example, incidents in Mali can be attributed to the CMA or Plateforme, which would normally be considered as political

movements, and to MNLA, HCUA, which are two organisations of the larger CMA and Plateforme movements. To address this issue, the study assigns violent events to an organisation, rather than a movement, when possible.

ACLED data is used to select state and non-state actors involved in terrorism, rebellion and communal violence from 1997-2019, as well as their allies and their enemies. This rather broad definition of violence is made necessary by the fact that actors can be involved in different types of violence over time. ACLED distinguishes between violent events, demonstrations and non-violent actions, 6 types of events and 25 sub-event types. The study focusses on politically motivated violent events exclusively. The following referents are considered: battles,

Table 3.4

Number of actors by category, 1997-2019

Type	Number	Examples
State forces	339	Military forces of Algeria, police forces of Morocco, Government of Ghana
Rebels	128	Polisario Front, National Movement for the Liberation of Azawad (MNLA), Boko Haram, Al-Qaeda in the Islamic Maghreb (AQIM)
Political militias	448	Democratic Alliance of 23rd May for Change (ADC), Janjaweed, Operation Libya Dawn
Identity militias	1 065	Chaamba Ethnic Militia, Raffour Communal Militia, Dozo Militia
Rioters	3	Rioters (Chad)
Protesters	6	Protesters (Togo)
Civilians	507	Aid Workers, Ashanti Ethnic group, Chadian Association for the Promotion and Defence of Human Rights
External forces	50	Military forces of France, International Organisation of the Red Cross, United Nations Missions
Others and unknown	6	Free Karim Movement, Nigeria Petroleum Development Company
Total	**2 551**	

Source: Authors based on ACLED data 2019a.

explosion and remote violence, and violence against civilians (Table 3.5). Demonstrations and non-violent events such as agreements, arrests, disrupted weapons use, headquarters established, looting and non-violent transfer of territory are excluded from the analysis.

- A battle is "a violent interaction between two politically organised armed groups at a particular time and location" (ACLED, 2019b: 7). Battles can occur between any state and non-state actors and involve at least two armed and organised actors. Violence against civilians is categorised separately although civilians can be harmed as an indirect result from battles. This category includes events that did not cause fatalities. Battles are subdivided into three sub-event types, depending on whether non-state actors or government forces overtake territory or whether there is no territorial change.
- Explosions/remote violence are "one-sided

violent events in which the tool for engaging in conflict creates asymmetry by taking away the ability of the target to respond" (ACLED, 2019b: 9). Explosions/remote violence can be carried out using devices such as bombs, grenades, improvised explosive devices (IEDs), artillery fire or shelling, missile attacks, heavy machine gun fire, air or drone strikes, or chemical weapons.

- Violence against civilians is defined as "violent events where an organised armed group deliberately inflicts violence upon unarmed non-combatants. By definition, civilians are unarmed and cannot engage in political violence. The perpetrators of such acts include state forces and their affiliates, rebels, militias, and external/other forces" (ACLED, 2019b: 11). Violence against civilians include beating, shooting, torture, rape, mutilation, kidnapping and disappearances.

INTRODUCING A NEW SPATIAL INDICATOR

The report introduces a new geographic indicator of political violence, the SCDi, that measures whether conflicts increase or diminish in intensity and contract or spread geographically. The SCDi builds on spatial analysis, a quantitative

approach that measures the intensity, direction, and distribution of violent events over time (Box 3.4). In recent years, spatial analysis has been facilitated by the availability of disaggregated data and important advances in software such as

Table 3.5
ACLED violent event types

Event type	Sub-event type	Number of events	Number of fatalities
Battles	Armed clash	12 206	59 733
	Government regains territory	898	4 748
	Non-state actor overtakes territory	827	4 277
Explosions/remote violence	Chemical weapon	0	0
	Air/drone strike	1 487	5 564
	Suicide bomb	483	4 882
	Shelling/artillery/missile attack	725	1 176
	Remote explosive/landmine/IED	2 137	7 605
	Grenade	53	48
Violence against civilians	Sexual violence	119	887
	Attack	9 948	49 287
	Abduction/forced disappearance	1 477	0
Total		**30 360**	**138 207**

Source: Authors based on ACLED data 2019a.

Geographic Information Systems (GIS) that can store, manage, display and analyse spatial data. Today, such systems are able to integrate and link data sets from various sources to uncover previously hidden relationships between violent activities and space (Chainey and Ratcliffe, 2013; Boba Santos, 2017).

The intensity of violence

In order to study whether the intensity of conflicts tends to decrease or increase, the report maps the density of violent incidents in each 50 by 50 kilometres region (or cell). Formally, the density (d) is calculated as a count of events in a region for a defined time period divided by the measurement of the region's area. The density d has a lower limit of 0 when there are no events in a cell but no theoretical upper limit. However, the larger the time period, the more likely the density is to increase. The example below assumes identical areas (grids) of 10 square kilometres for a single time period (Figure 3.1).

It is important to note that the density d is not a measure of the location of points within the region. In the example below, both region A and

B have a density of 0.6 (6 events/10 kilometres^2) despite the fact that violent events tend to be distributed rather unequally between the two regions (Figure 3.2).

The concentration of violence

The study uses the average nearest neighbour analysis to determine if violent events are dispersed, clustered or randomly distributed throughout the study area. This metric first measures the distance between each violent incident in a region and its nearest neighbour's location. It then averages all these nearest neighbour distances. The distribution is considered clustered if the average distance is smaller than the one for a random distribution and considered dispersed otherwise.

The average nearest neighbour ratio (ANN) determines whether the patterns of violent events exhibit clustering or dispersion. The ANN ratio is calculated as the observed average distance among a set of points in a cell divided by the expected average distance that would have been obtained if the events were distributed randomly (ESRI, 2019a). ANN ratios smaller

Figure 3.1
Density of violent events

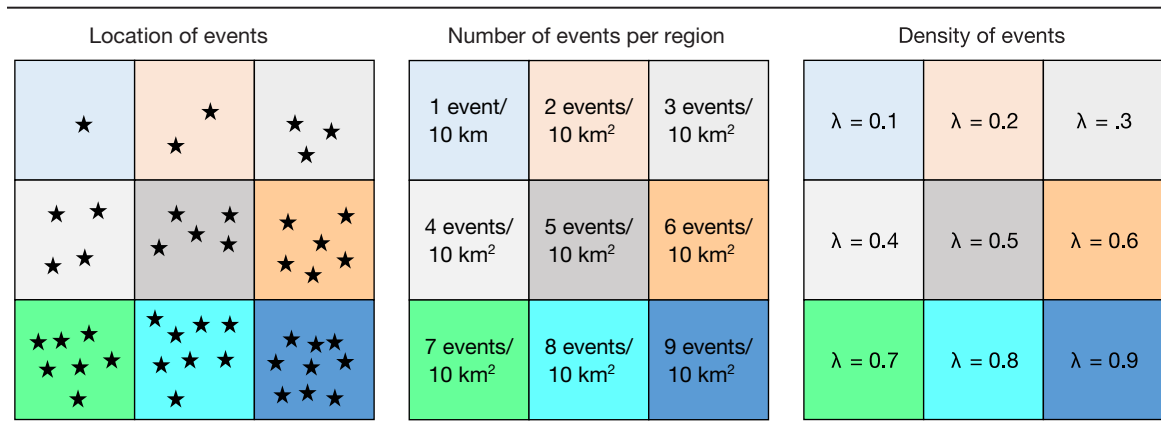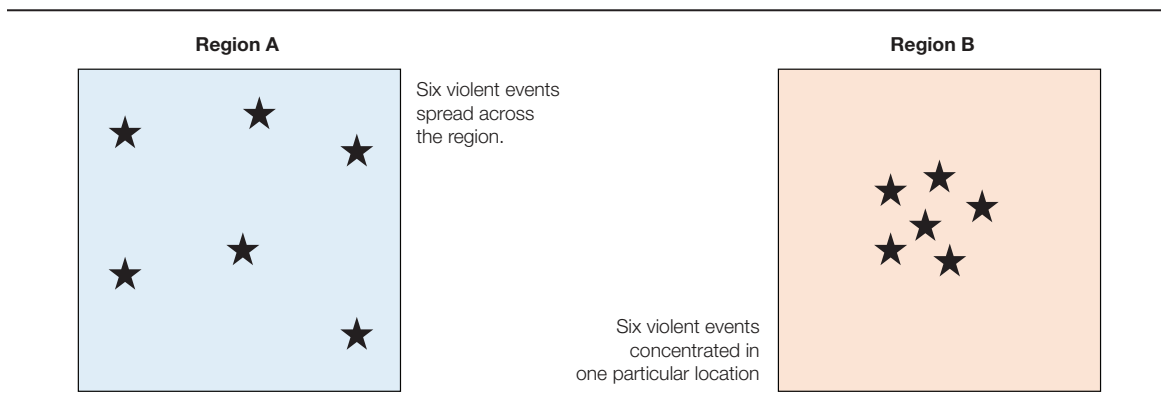| Location of events	Number of events per region			Density of events		

Figure 3.2
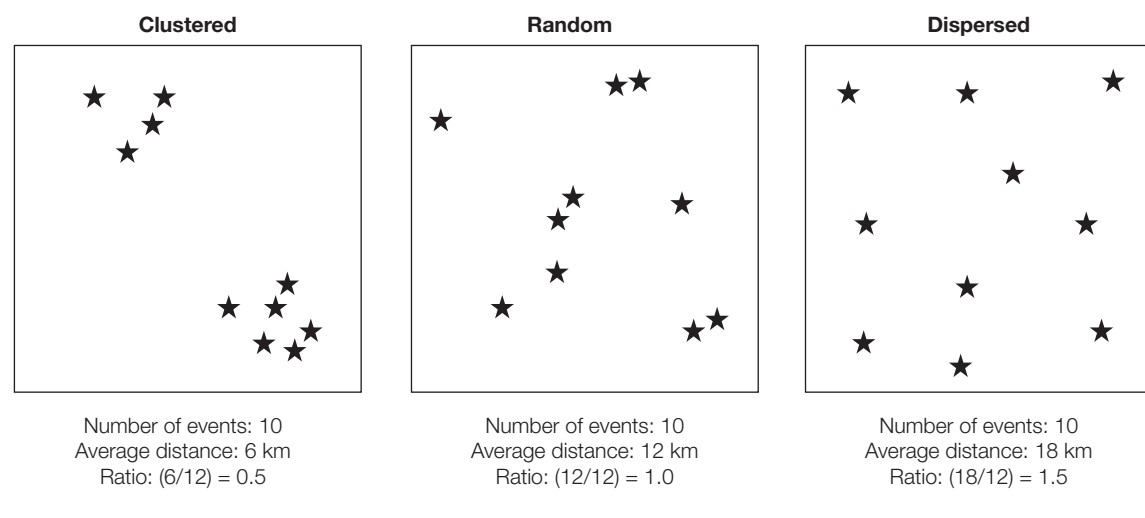Identical density but different locational pattern of violent events

than one indicate clustered events while ratios greater than one indicate dispersed events. The distribution of events on the left-hand side of Figure 3.3, for example, is clustered compared with a random distribution of the same number of events, as shown by its ratio of 0.5, while the distribution on the right-hand side is dispersed, with a ratio of 1.5.

The combined study of the spatial intensity and concentration of political violence allows to identify four typologies of conflict geography (Chapter 1). Regions where violent events tend to become less frequent and more concentrated spatially are perhaps the most common indicating that conflict is relatively localised. On the contrary, regions where violent events tend

to be more numerous and spread across the territory are the most worrying. Apart from these two extreme cases, some regions tend to experience lingering conflicts, when a low density of events is combined with a diffuse distribution. Other regions experience an increasing number of events but on a much smaller scale, suggesting that the conflict is spatially contained.

Figure 3.3

Clustered, random and dispersed events as measured by the average nearest neighbour ratio

Clustered	Random	Dispersed
Number of events: 10	Number of events: 10	Number of events: 10
Average distance: 6 km	Average distance: 12 km	Average distance: 18 km
Ratio: (6/12) = 0.5	Ratio: (12/12) = 1.0	Ratio: (18/12) = 1.5

MEASURING THE IMPACT OF MILITARY INTERVENTIONS

The study measures how military interventions affect the geography of conflict in the region. This requires the identification of interventions that have had the potential to disrupt conflicts over the last 22 years. Four main types of external actors are taken into consideration: intergovernmental organisations such as the United Nations (UN) and NATO, regional bodies such as the Economic Community of West African States (ECOWAS), nation-states on other continents such as France and the United States, and African countries (including their multinational task forces). Some of the military interventions are still ongoing or have lasted for years. Therefore, for each intervention, it was necessary to identify one or several time periods during which military operations had a direct impact on insurgents on the ground.

This is achieved by identifying when and where the military operations launched by actors in each conflict took place. For example, the Multinational Joint Task Force (MNJTF) established by Nigeria, Niger, Chad, Cameroon and Benin has conducted several operations against Boko Haram in northeastern Nigeria from January 2015 onwards (LCBC, 2018). In

order to detect changes in the geography of these conflicts, the study identifies the areas most affected by each military operation in each conflict. In northeastern Nigeria, for example, some operations have targeted the Lake Chad basin while other have focused on the Sambisa Forest near the border with Cameroon, where Boko Haram insurgents are also active.

In order to detect changes in conflict geographies that can be attributed to a military intervention, the study uses the two metrics developed as part of the SCDi. The spatial effect of military interventions is assessed by first considering the events that are connected to the cases shown by Map 3.2 and then analysing how these external shocks may have contributed to the reduction, intensification, contraction and diffusion of conflicts.

The study measures the change introduced by military interventions into the spatial structure of conflict by considering shifts in both aspects of the SCDi. Comparing the proportion of cells that are classified as high or low intensity prior to an intervention with those following an intervention allow an evaluation if conflict is being reduced or not (a key goal of any intervention),

Box 3.4
Data processing steps

The study uses several software and programming tools to process the data, implement the indicator, and visualise results. These tools primarily include the statistical software R (R Core Team, 2019) and the visualisation package ggplot2 (Wickham, 2016), ArcGIS 10.6.1 (ESRI, 2019b), and Python 2.7 (Python Software Foundation, 2019) to explore the relationships between fatalities, event type, and location. Initially, ACLED data was georeferenced in ArcMap as point locations over the 21 countries of the study region. When mapped, all the outputs used the Lambert Conformal Conic projection.

A 'fishnet' grid of 50 kilometres cells was then made in ArcGIS to cover the entire study region. Each grid cell encompasses the same amount of land area (2 500 square kilometres). The grid was overlaid onto the event locations in ArcGIS and then used to determine the two separate calculations needed for the indicator: the spatial density of events per cell and the concentration of event locations within each cell.

These calculations were completed using arcpy, a library for Python 2.7 that interacts with ArcGIS. The script, developed by the research team, primarily consists of two nested loops that performed both calculations (the spatial density and the concentration of event locations) for each cell, year, and type of event. Because the clustering calculation requires a minimum input of two points, the script also selects only the cells that contained more than one violent event within them. The resulting output for any given year is a new fishnet grid with the density and clustering measures for each cell containing two or more events. Using ArcGIS, the study used the resulting grids to map the results across the region.

and where such shifts are taking place. Similarly, comparing shifts in concentration or diffusion before and following an intervention allows an interrogation of how an intervention may be affecting the spread of violence in either direction.
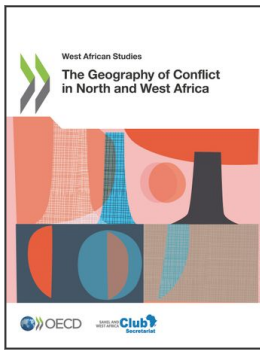
The SCDi makes it possible to take into account the great diversity of current African conflicts. By combining density and concentration, the indicator contributes to identify regions that experience the most conflicts, assess whether conflicts tend to spread across the region, and measure to what extend military interventions shape the geography of armed struggles. Assessing the spatial dynamics of conflict is crucial to inform and design security and development strategies adapted to local contexts. For example, conflicts that tends to make numerous victims in a spatially contained area call for different political responses than conflicts that have a lower than average density and a diffuse distribution of violent events.

The new indicator complements existing approaches to conflicts currently implemented in the region, such as the Violence Early-Warning System (ViEWS) project, which models how geographical, social, economic and political factors lead certain groups or individual to resort to organised violence (Hegre et al., 2019). The SCDi can also contribute to current initiatives that aim at mapping the temporal evolution of food and nutrition in the region. The relative simplicity of the new indicator would make it easy to integrate its results into the *Cadre Harmonisé* analysis, collectively managed by the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS) and other members of the RPCA (FAO, WFP, UNICEF, FEWS NET, ACF, CARE, OXFAM, Save The Children, JRC-EC, FICR, IPC-GSU…) (CILSS, 2019). This could facilitate a better understanding of the interdependence between food and political insecurity.

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