博士論文

Fission-fusion of warring parties: the case of civil wars in Africa

(紛争主体の分裂統合：アフリカの内戦を中心に)

大石　晃史

Contents

Chapter 1

Introduction

1.1 Civil war and its resolution

Human societies have suffered from violent conflicts since ancient times, ranging from minor squabbles between neighboring villages to disastrous interstate wars [1]. Especially, the last century saw the tremendous loss of human life in interstates conflicts: the World Wars, the Vietnam War, the Korean War, to name a few. Today while interstate wars as large as the World Wars are not observed, civil war, which occurs between the government of a state and internal opposition groups, is a principle source of human insecurity [2]. Fig. 1.1 shows that civil war has increased since the end of the World Wars and became much more frequent than interstate war. This is partly because of the increase of collapsed states in Africa and Asia [3]. After the World Wars, many former colonies achieved independence because of the change of international norms. However, many of them soon lapsed into autocracy, failed in economic policy, but temporally survived with the external support in the context of the Cold War. The collapse of such fragile states precipitated civil war, but civil war frequently resulted in another fragile government. As a result, the countries were trapped in the poverty and conflict [4].

Though most of civil wars erupt in developing countries, this does not mean that civil war is irrelevant for developed countries. For example, conflict-torn countries can be a breeding ground for terrorism and disease. The September 11 attacks in 2001 by Al-Qaeda members from war-torn Afghanistan is one of the most well known cases. The terrorist attacks in Paris in November 2015 by the self-declared Islamic State member is another typical case. The containment of Ebola virus epidemic in 2014 would have been much more difficult if Sierra Leone and Liberia had been in civil war as they actually were in 1990s. In addition to realistic benefits, the prevention and resolution of civil war to save life of thousands of innocent citizens are the responsibility of the whole international community from

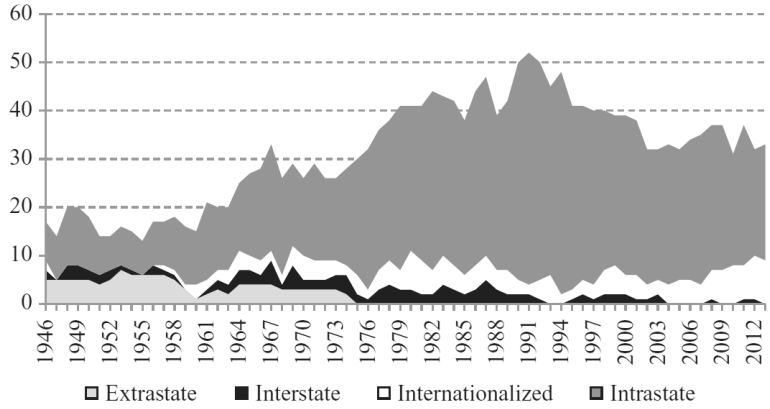

Figure 1.1: Number of ongoing armed conflicts by type, in 1946–2014, adopted from [2]. Civil war is divided into two categories, intrastate and internationalized. In the latter case, other states intervene in the conflict in the form of troops, while they do not in the former. Extrastate conflicts are imperial or colonial wars. Each armed conflict resulted in 25 battle-related death in a calender year. See Ref. [2] for more detailed definitions.

the humanitarian view point.

Actually, the international community have supported conflict resolution by various means, including peace talks mediation, peace keeping operations (PKOs), and military interventions. These efforts, however, often fail to prevent civil conflicts or to stop them, and many of them resumed soon even once peace was temporally achieved [5]. To design and implement more successful conflict resolution, we need more sound understating of civil conflict.

1.2 Organizational studies of armed groups

Until recently, the main focus of conflict studies was the onset and termination of civil war: what causes and ends civil war [6–8]. In contrast, current conflict studies pay more attention to the conflict process: what happens between the outset and the termination of conflict. For example, what type of violence is committed by whom against whom is an important question [9]. Variation of the types includes whether the violence is indiscriminate or discriminate [9], and whether sexual violence is committed or not [10]. Geographical diffusion of rebellion is another topic of research in this direction [11–13]. Civil war does not bring about violence uniformly in the country. Intensity of violence varies over time and space. Therefore understanding the patterns of the geographical diffusion is important for both counterinsurgency and the protection of civilians.

These studies of the conflict process showed that microscopic details of armed groups matter a lot for macroscopic patterns of the conflict process. For example, Kalyvas showed that types of violence is strategically determined by armed groups, based on the current situation of their territorial control [9]. Zhukov showed that the spreading of violence is affected by logistical constrains of armed groups, such that they need to move along road networks [11]. As a result, organizational studies of armed groups is now a burgeoning area of study: how they are formed, recruit combatants, raise funds, procure weapons, and commit violence [14, 15].

Though detailed description of armed groups itself is not new [16, 17], the current organizational studies pay more attention to the systematic comparison of armed groups and the causes and effects of their organizational characters. For example, Weinstein showed variety of organizational structure among four specific armed groups: National Resistance Army (NRA) in Uganda, Renamo in Mozambique, Sendero Luminoso Nacional and Sendero Luminoso-Huallaga in Peru [14]. NRA and Sendero Luminoso Nacional are much more disciplined than Renamo and Sendero Luminoso-Huallaga. As a result, the former built better governance, committed less violence, and were more resilient than the latter. Weinstein also argued that some groups are ill-disciplined because they are of rich economic endowment (e.g., natural resource or support from the foreign countries). The endowment makes it difficult for them to screen out members who are not passionate about their political goal but just interested in the economic benefit. Inclusion of such members inevitably undermines the discipline of the groups. Staniland also pointed out the organizational diversity of armed group [15]. His main case studies covers conflicts in Kashmir, Afghanistan, Sri Lanka, and Southeast Asia. He categorized insurgent groups into four types: integrated, vanguard, parochial, and fragmented. As shown in Table 1.1, the type depends on the strength of ties among leaders (horizontal ties) and those between leaders and local communities (vertical ties). He argued that the type of insurgent groups is determined by their prewar social base. For example, urban student groups tend to result in vanguard insurgent groups, while local village strong men tend to form parochial groups.

1.3 Changes of armed groups over time

Furthermore, the organizational characters of armed groups changes over time. Though the changes of armed groups are pointed out in several studies [14, 16, 18], the work of Staniland is unique in the strong emphasis on the phenomena [15]. He argued typical changes of insurgent types and their causes. For example, parochial groups, which are composed of loosely connected leaders who have strong ties with their own local communities, often turn into integrated groups by factional fusing under external support. Is

Table 1.1: Types of insurgent groups: the strength of ties and examples [15].

type	horizontal ties	vertical ties	example
integrated	strong	strong	Viet Cong
vanguard	strong	weak	Bolsheviks in Russia in 1917
parochial	weak	strong	Pakistani Taliban
fragmented	weak	weak	Red Brigades in Italy in the 1970s

is also common, however, that parochial groups get fragmented because of leadership feuds.

One of the most obvious changes of the organization of armed groups is their fission-fusion: armed groups split or merge into different groups. Not only is it common [19–22], it also largely affects the conflict process. The dynamics has significant implications for those who try to build peace because it complicates conflicts and makes their resolution much harder [23]. A typical example is its negative effects on peace negotiation: when a peace agreement is signed among armed groups, emergence of splinter groups, even minor ones, that oppose the agreement frequently prevent its implementation [24–27]. Furthermore, fission-fusion dynamics during the course of the conflict affects the stability of post-conflict society. For example, Rudloff and Findley showed that conflicts during which splintering of rebel groups occurred tend to have resumed sooner [28]. Their analysis controlled the number of rebel groups that fight the conflicts, therefore splintering itself matters.

The fission-fusion dynamics is also significant for those who seek a military victory. For leaders of armed groups, it is an important matter how to prevent fragmentation of their own groups and promote that of enemies [15, 29, 30]. External supporters of armed groups are also affected by the dynamics. Armed groups are often supported by the government of a neighboring state or diaspora communities, either covertly or overtly [31,32]. For the patrons, how to integrate their multiple clients into a cohesive armed group that can defeat the enemy, is a crucial question.

Fission-fusion of armed groups, however, has been investigated quantitatively only by several recent works. It is argued that the dynamics is affected by battle field outcomes, local rivalries, patronage networks, third party mediation, and repression against armed groups [20, 22, 33, 34]. As noted previously, the negative effects of fission-fusion on post-conflict societies is also studies [28].

1.4 Existing data on armed groups

A major obstacle in studies of fission-fusion of armed groups is the lack of data. On the one hand, there is an increase of conflict datasets regarding the armed groups [35]. For example, Armed Conflict Location and Event Dataset (ACLED) records violence committed by armed groups with higher time and space resolution than previous datasets [36, 37]. Pro-Government Militias Database (PGMD) includes details of pro-government militias, which has gained less attention than insurgent groups [38, 39]. The Sexual Violence in Armed Conflict (SVAC) dataset collects information about perpetration of sexual violence by armed groups, which has been studied almost only in qualitative methods [40, 41].

On the other hand, only a few existing data contain genealogical information, i.e., when, which armed group split/merged into which groups. One of them is the Uppsala Conflict Database Program (UCDP) Actor dataset [42]. The UCDP has collected various datasets on armed conflicts since 1946: years of onset and termination, incompatibility, battle-related deaths, and means of termination, among others. Among the datasets, the UCDP Actor dataset lists armed actors who fought the armed conflicts since 1946. It also identifies whether a group was created by splintering or merger of other group(s), and if so, its original group(s). Therefore the UCDP Actor dataset partially includes genealogical information of armed groups. However, the data does not tell us when the splintering or merger occurred. Similar deficits are fond in the data on splintering of armed groups collected by Christia [20]. It is another comprehensive data, which covers civil wars that erupted between 1816–2007. Her data enumerates which armed groups experienced splintering among those who fought the civil wars. However, the data also does not always identify when the splintering occurred and does not contain information on merger of armed groups.

In some cases, a temporally aggregated data is enough: for example you can investigate the relationship between the total number of fission-fusion events in a conflict and the stability of post-conflict society. However, temporally disaggregated (i.e., time series) data have a potential to improve our understanding. It may tell us more about the mechanism of the fission-fusion dynamics. The stability of post-conflict society may be different if the time series of the fission-fusion is different even with the same total numbers of events. Now that temporally disaggregated data on battles actually advanced the understanding of conflict dynamics [11, 12], it is reasonable to expect the potential of temporally disaggregated data on fission-fusion events.

In contrast to the two datasets introduced above, Kenny collected a data focusing on two insurgent groups: the Irish Republican Army (IRA) in Northern Ireland and the Karen National Union (KNU) in Myanmar [43]. Fig. 1.2 shows his data on the fragmentation processes: when, who splin-

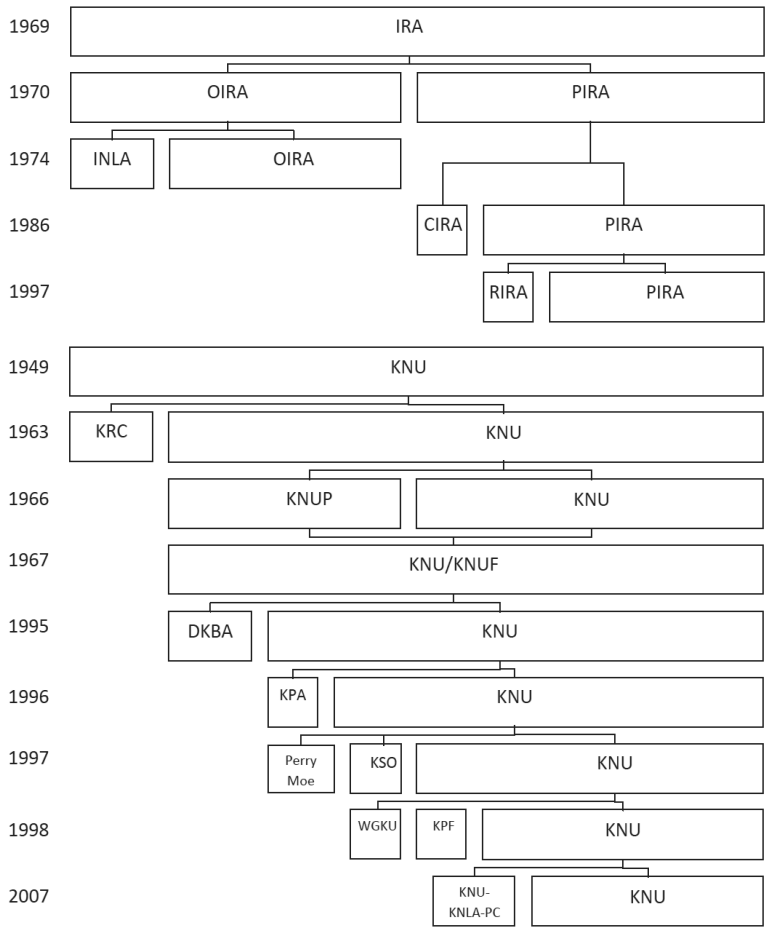

Figure 1.2: Fragmentation process of the IRA (top) and the KNU (bottom), adopted from [43].

tered from or reintegrated into IRA and KNU. Though the data is valuable in studying the development of the IRA and the KNU and other groups who originated from the two, it does not cover other armed groups who did not originated from them but fought the same conflicts. It is common that armed groups of completely different origins get integrated and the integration largely affects the course of conflict [44]. Recent studies also imply that interaction between armed groups of completely different origins has crucial effects on the conflict process, including peace negotiations [23]. Therefore, it is more desirable that data on fission-fusion covers all armed groups in a conflict regardless of what origin they have.

Another minor room for improvement of data is the inclusion of more various patterns of fission-fusion. Existing data only record splintering of a group and integration of multiple groups and do not include more complex

cases, in which part of armed groups splintered and immediately join other groups. The dynamics, which we call side-switching, is commonly observed in conflict [29]. A fission-fusion data that includes such events will tell us more realistic picture of the dynamics.

1.5 Aims of the present research

To overcome the weakness of the existing datasets, it is desired to collect new datasets on genealogy of armed groups that identify points of time of fission-fusion events, cover all the warring parties in the conflict, and contain various types of fission-fusion, i.e. splintering, integration, side-switching, etc. Such datasets have potential to tell us the mechanism of the fission-fusion dynamics and its impacts on conflict outcomes.

Collection of a data satisfying the conditions for all armed conflicts by the author is difficult because of time and budget constraints. Therefore, as a first step, this research focuses on a specific case: collection and analysis of a genealogical data of armed groups in the Democratic Republic of Congo (DRC) conflict since 1996. It is true that we need datasets covering a wider range of cases to study the impact of the fission-fusion dynamics on conflict outcomes and to investigate whether there is an universal mechanism of fission-fusion dynamics across different civil wars. The study of the DRC case, however, will tell us some information on the mechanism of fission-fusion dynamics in the specific conflict and provide us a starting point for broader investigation of the impact and universal characters of the dynamics.

Chapter 2

Case history

2.1 An overview of the DRC conflicts

Figure 2.1: A map of the DRC, adopted form [45].

The DRC is a country in Central Africa (see Fig. 2.1) that has the second largest territory in Africa and 81 million population today [45]. This section review the history of the DRC and the conflicts (See Table 2.1).

The DRC was a colony of Belgium until its independence in 1960. Im-

Table 2.1: A chronology of the DRC

year	event
1908	Establishment of Belgian Congo as an official Belgian colony
1960	Independence and the eruption of the Congo Crisis
1965	Mobutu coup
1990	Declaration of the introduction of multi-party democracy
1994	Massive inflow of Rwandan refugees after the genocide
1996	Eruption of the First Congo War
1997	Overthrow of the Mobutu regime
1998	Eruption of the Second Congo War
1999	Lusaka Peace Agreement
2001	Assassination of President Laurent-Désiré Kabila
2002	Pretoria Peace Agreement
2003	Formation of the transitional government
2006	Inauguration of President Joseph Kabila

mediately after its independence, the country fell into chaos of civil war, the Congo Crisis. A cause of this turmoil is the lack of preparation for independence: Belgium gave the Congolese leaders only five months and fundamental issues of the new nation had not been determined, especially whether to adopt federalism or not. Leaders from the areas with rich mineral resources, especially Katanga, who did not want to share the benefit from mining industry with other areas and therefore preferred federalism, declared secession from the Congo soon after the independence. Over the following years several rebellions were launched across the country and they were finally put down only with the help of Belgium, the US, and the UN. Even after the military crisis was over, a political deadlock ensued. Because of political rivalry, President Kasa-Vubu tried to replace Prime Minister Tshombe with Évariste Kimba, but the Parliament, which supported Tshombe, refused it. In the paralysis of the government, Mobutu Sese Seko, chief of staff of the army, seized power in a coup. He was supported by the US because of his anti-communist stance. His dictatorship lasted until the 1990s, during which the economy and governance of the DRC was destroyed.

When the DRC reintroduced a multi-party political system in 1990, ethic tension arose all over the country, especially in Eastern Congo. In the area, Banyarwanda and Banyamulenge, both of which had immigrated from Rwanda, and other autochthonous groups (e.g. Hunde in North Kivu and Bembe in South Kivu) had been in conflict over political rights and land tenure. Rwandan immigrants were prevented from running for elections. Autochthonous politicians started to explicitly agitate people to exclude

Rwandan immigrants because such agitation promoted their popularity and likelihood to win election. Violent clashes between Rwandan immigrants and autochthonous groups increased. Examples include the Masisi War, a series of clashes between Banyarwanda and Hunde-Nyanga militia in North Kivu since May 1993, which resulted in death of more than 6,000 people [61].

In 1994, the Rwandan civil war since 1990 resulted in the Rwandan Genocide, which generated a massive flow of Rwandan refugees to Eastern Congo. The abrupt increase of Rwandan people exacerbated anti-Rwandan sentiment and harassment against Rwandophone people escalated. In response, Rwandophone people started to organize armed resistance. The resistance received a strong military support from the new Rwandan government that was formed after the Rwandan Genocide and led by Paul Kagame. At the time, Rwanda was suffering from cross-border attacks of the former government forces of Rwanda who fled to the DRC after they were defeated in the Rwandan civil war. The continuation of the dysfunctional Mobutu regime effectively provided shelter to the Rwandan insurgent groups. The Kagame regime supported the armed resistance to oust Mobutu and eradicate the former government elements in the DRC. The armed resistance grew into a full-fledged rebellion of the Alliances des Forces Democratiques pour la Liberation du Congo-Zaïre (AFDL), which was formed in October 1996, when the First Congo War began. With the military support by the Rwandan government and the corruption of the Congolese national army, the rebellion swiftly succeeded. In May 1997, L. D. Kabila, the leader of the AFDL, ousted Mobutu and became the President.

At first, the Kabila regime was under strong influence of the Rwanda government and Rwandophone Congolese. However, Kabila tried to remove their influence, for example dismissing the chief of staff of the new national army, James Kabarebe, a Rwandan. As as result, the Rwandan government, which sought to retain the influence, became soured on Kabila. Then, another rebel group, Rassemblement Congolais pour la Démocratie (RCD), launched the Second Congo War, again with the help of Rwanda. This time, with intervention of other African countries, the battle reached a stalemate. With the mediation of the international community, belligerents signed the Lusaka peace agreement in 1999, which prescribed the ceasefire, the end of intervention of the neighboring countries, and the PKO of the UN, Mission de l'Organisation des Nations Unies en République démocratique du Congo (MONUC). However, actual peace was not achieved because most of signatories, especially L. D. Kabila himself, were not willing to implement it. It was after L. D. Kabila was assassinated in January 2001 that the peace process started to work. His son, Joseph Kabila, who succeeded the presidency, was more cooperative to the international community. With the mediation of the UN and the African Union (AU), warring parties finally signed the Pretoria peace agreement in December 2002. The agreement prescribed the end of the civil war and the power sharing in the new government, giving important

and lucrative positions in the cabinet and the army for leaders of both the government and the rebel groups. As a result, the provisional government was formed in 2003, and then the civil war was formally ended. Elections were held and Kabila was elected as president again in 2006. However, the new government was also weak and corrupt, failed to mediate ethnic tension in Eastern Congo, and fell out with Rwanda. In short, few of the fundamental problems of the DRC, which the following sections discuss in detail, were yet to be solved. As a natural consequence, violence has continued in Eastern Congo (North and South Kivu, and Ituri) even after the elections and the formation of the new government.

There are several reasons behind the selection of the DRC conflicts as the target case. The conflicts have been well investigated by scholars, so a large body of literature is available to understand the historical background, the detail of the conflict process, and purposes of conflict actors [46–54]. It also has gained a considerable attention from the international community because of its scale and atrocity. One of the largest UN peace keeping operations, MONUSCO, is working for the case. Therefore, there are numerous reports published by the United Nations and international NGOs, which includes detailed information about armed groups active in Congo [55–87]. The amount of these reports is a crucial advantage of this case for the database construction.

Additionally, the conflict shares some typical characters of civil wars in Africa in the 1990s. For example, its colonial period exacerbated ethnic problems that finally triggered the civil war. Then, the rapid adoption of multi-party democracy after the long period of dictatorship unleash the ethnic tension. The weak government failed to resolve the ethic and local disputes and the vicious cycle of violence, leading to the eruption of civil war. Therefore, the investigation of the DRC conflict is a good starting point for understanding civil wars in Africa. In the following sections, these features of the conflict are discussed further in regional, national, and local levels of analysis. The correspondence between several fission-fusion events mentioned in the following sections and the fission-fusion data shown in Table 4.1 is also indicated.

2.2 Regional levels

Regional politics in Central Africa played crucial roles in the conflicts. In pursuit of security and economic benefit, neighboring couturiers intervened. Among others, the involvement of Rwanda and Uganda was particular. They were the principal supporters of the largest rebel group, the AFDL in the First War and the RCD int the Second. Both governments benefited from rich mineral resources in Eastern Congo, including coltan, cassiterite, and gold.

Moreover, Rwanda had a strong incentive for the intervention because of a national security concern. After the 1994 genocide, the bulk of armed forces and paramilitary of the former Hutu-dominated Rwandan government fled the country and infiltrate into the DRC as refugees, without being disarmed. Then, they launched a fresh assault against the new Tutsi-dominated Rwandan government across the border. Kigali asked Kinshasa to disarm them but the latter did not live up to expectations, which led the former's direct involvement into the Wars. However, the Rwandan insurgent group, now called Forces démocratiques de libération du Rwanda (FDLR), sustained its presence in Eastern Congo, and the relation between Kinshasa and Kigali kept swinging between cooperation and confrontation over the disarmament of the group.

The rivalry between Rwanda and Uganda also exacerbated the conflict, playing a key role in the fission-fusion of rebels. Though the two couturiers collaborated in the support of the RCD at the outset of the Second War in 1999, they broke up soon. Then, Uganda created a new insurgent group in 1999, Mouvement de libération du Congo (MLC), and the RCD also split into the Uganda-supported faction, RCD-Kisangani/Mouvement de Libération (RCD-K/ML), and Rwanda-supported one, RCD-Goma, in 1999 (Data 22, 27, and 28). As as result, inter-rebel conflicts over territorial control rapidly increased, with the battle over Kisangani in August 1999 the most notable example. Similarly, the rivalry complicated and exacerbated the conflict in Ituri province, where armed groups with the different sponsors fought each other.

Therefore, the DRC conflicts have aspects of proxy wars between the Rwanda, Uganda, and the DRC. However, the armed groups supported by the government were not mere puppets, as they had their purpose and did not always obey their sponsors. For example, though the Ugandan government facilitated the integration of three Ugandan-supported armed groups, MLC, RCD-K/ML, and RCD-National (RCD-N), into Front de libération du Congo (FLC) in 2001 but the FLC soon fragmented because of their leadership dispute (Data 38 to 43). Armed groups sometime switches the sponsors. The Union des patriotes congolais (UPC) splintered from the Uganda-supported RCD-K/ML, continued to gain support from the government at first, but switched the sponsor from Kampala to its rival, Kigali (Data 37). Though the conflicts were surely internationalized, the agency of the domestic armed actors were no negligible at all.

2.3 National levels

Characters of the DRC national government promoted the conflicts. During the long period of dictatorship by Mobutu, the economy and administration collapsed and peripheral areas, including Eastern Congo, were out of the

reach of the governance. The lack of functional security and judicial sectors promoted the local conflicts and frustration of people against the government. Especially, in the 1990s, politicians facilitated local ethnic conflicts to gain popularity in their own ethnic community, which became more important in introduction of multi-party democracy. The dissolved local conflicts triggered the civil wars and have kept playing crucial roles in insecurity in Eastern Congo.

Moreover, under the Mobutu regime, the national army was intentionally kept weak by Mobutu to reduce the risk of a coup. Servicemen were not paid enough and engaged in illegal activities. People were exploited rather than protected by the national army. The traditional malfunction and ill discipline of the national army made it difficult for following presidents to defeat the insurgent groups and prevent people from supporting them.

Because of its inability to resolve the conflicts militarily, the government frequently signed peace agreements with insurgent groups and integrated them into the national army without complete destruction of their chain of command. However, it was common that former insurgents got dissatisfied by the treatment in the army and defected to organize a new rebellion. In other words, the disarmament, demobilization and reintegration (DDR) repeatedly failed in the DRC. For example, RCD, the group that launched the Second War, got integrated in the national army, Forces Armées de la République Démocratique du Congo (FARDC), as the 2002 Pretoria Agreement prescribed (Data 60). However, part of the former RCD members defected to organize Congrés national pour la défense du peuple (CNDP) in 2006 (Data 113). The CNDP was finally integrated into the FARDC in 2009 but part of its members defected again to launch a new rebellion, Mouvement du 23-Mars (M23), in 2012 (Data 138 and 181). Former rebel leaders in the army who rose up rebellion frequently signed a peace agreement with the government and got a higher position or a more lucrative position in the army. The impunity and promotion of the defectors made rebellion more attractive for other dissatisfied members in the army.

This vicious cycle has been exacerbated by the lack of strong incentives for the government to restore security in Eastern Congo. Since the end of the Second War, most of armed groups were not serious threats to the government considering their military capacity, even though the people suffered. The political support base of current leaders in Kinshasa is Katanga, the southern part the country, because of their ethnic ties. Moreover, the DRC economy has largely depended on the revenue that Katanga generates in machinery mining since the colonial period. It is also the important source of the patronage network of the president. While Eastern Congo is also rich in mineral resources, their production largely depends on artisanal mining and the economic importance is smaller for the government. Without incentives for fundamental conflict resolution, an easy and cheap way of response for insecurity has been the (repeated) superficial integration of insurgent

groups into the national army.

2.4 Local levels

Eastern Congo was rife with local conflicts between different ethnic communities over administrative/political power and land tenure. Exacerbated by regional and national dynamics, they formed the basis of the DRC conflict Above all, the key conflicts were between Banyarwanda and Hunde in North Kivu, Banyamulenge and Bembe in South Kivu, and Lendu and Hema in Ituri. Each community members supported and composed of the main part of armed groups, which attacked civilians of rival communities.

The history of these conflicts dates back to colonial period. The colonial and post-colonial governments gave favor to one side, and their preference sometimes changed to the other side of the rival communities. These ethnicity-based, unfair, incoherent policies increased the tensions. Finally, the regional and national instability in the 1990s allowed each conflict to turn into full-fledged wars.

Event after the end of the Second War, these local confrontations continued. Disarmament of these local armed groups did not progress partly because local people continued support them. The people trusted neither the rival ethnic community nor the national army, and they needed to keep the armed group who protected them from the assaults of the rival community and the national army. Local politicians also kept their support for the armed groups to gain popularity and win votes at elections.

On the one hand, armed groups that had strong ties to local communities often provided security that the national army did not. On the other hand, however, it was common that such groups started to use their military power for their own sake sooner or later. They intervened local politics, gained illegal profit, and harassed those who opposed the group. Therefore, the emergence and presence of local armed groups has exacerbated rather than solved the insecurity in Eastern Congo.

Chapter 3

Method

3.1 Data collection

3.1.1 Information sources

Information about fission-fusion of armed groups was collected from various secondary sources. They include academic literature and reports of the UN and international NGOs, including Human Rights Watch, International Crisis Group, Small Arms Survey, and Rift Valley Institute [55–87]. Reports of the UN Group of Experts of the DRC and those of the Rift Valley Institute (RVI) are particularly helpful to collect detailed information about the armed groups. The Usalama Project of the RVI has examined armed groups and their influence on Congolese society with extensive filed works, and has published a series of reports, each of which focused on an armed groups [60–73]. Therefore, the reports of the UN and the RVI compose the main information sources in the data construction, while they are complemented by various other sources mentioned above.

3.1.2 Data format

The unit of the data is a directed link from the group before a fission-fusion event (mother group) to the group after the event (daughter group). For example, the genealogy in Fig. 3.1 is composed of six directed links. Therefore, the corresponding data is composed of six units of data, which is shown in Table 3.1.

Each unit of data also records when the event occurred (year, month, day). How precisely the time of events is specified by the sources varies from event to event. Therefor, the uncertainty of the time of the event is also included in the data. If the date is fully specified (i.e. all of the year, month, and day are specified) by the sources, the uncertainty is 0 and the specified date (year, month, day) is recorded, as data 1 and 2 in Table 3.1. If the day is not specified but the month and year are specified, the uncertainty is 1.

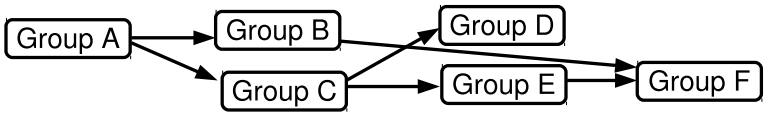

Figure 3.1: An example of genealogical networks, which represents that Group A split into B and C, then C split into D and E, finally B and E merged into F.

Table 3.1: A example of data. This corresponds to the genealogy in Fig. 3.1.

ID	year	month	day	uncertainty	mother	daughter
1	2000	10	10	0	Group A	Group B
2	2000	10	10	0	Group A	Group C
3	2005	8	1	1	Group C	Group D
4	2005	8	1	1	Group C	Group E
5	2010	1	1	2	Group B	Group F
6	2010	1	1	2	Group E	Group F

The day is assumed to be 1st if no information helps further identification, as data 3 and 4 in Table 3.1. If the month is not specified but the year is specified, the uncertainty is 2. The month is assumed to be January if no information helps further identification, as data 5 and 6 in Table 3.1. If the year is not specified by the sources, the uncertainty is 3. The year is conjectured from other indirect information.

Emergence and demise of armed groups are also included in the data. To represent them, two exceptional nodes are introduced: source and drain. Table 3.2 is a example. Emergence of an armed group is denoted as the directed link from the source to the groups as data 1, while demise as the link from the group that ceased to exist to drain as data 2.

Table 3.2: A example of data. Emergence of Group A and demise of Group B.

ID	year	month	day	uncertainty	mother	daughter
1	1999	1	11	0	source	Group A
2	2009	12	21	0	Group B	drain

3.1.3 Coding criteria

I read the reports thoroughly and coded fission-fusion events of armed groups into the data format explained above. Armed groups that experience the events must be independent organizations that have an independent chain of command. In other words, fission-fusion of organizations that are subordinated to others are excluded. For example, integration of two regiments of the national army is not included in the data. Focal armed groups also need to participate in either the Congo Wars (1996–2003) or Eastern Congo conflicts (2003–present). Armed groups that originated in foreign couturiers are also included as long as they fought the conflicts, with the FDLR the most notable example.

Fission-fusion of armed groups are recorded in the data when their leadership structure changed. This criterion is set because of importance and feasibility. The behavior of armed groups are largely determined by leaders and changes of leadership structure are frequently mentioned in the reports. In contrast, the enrollment or defection of individual rank and file soldiers, which are almost impossible to trace, are not included in the data. If an armed groups experiences a change of leadership structure, then it is regarded another group even it keeps to hold the same name. For example, when two groups, say A and B, merge into one group, the new group may be given a new name, C, or takes over one of the two names, A or B. In either case, both of the two original groups are regarded as changed because their leadership structure are different between before and after the integration.

The timing of fission-fusion is also based on the leadership changes, while changes of the whole organization of armed groups often take some time. For example, it is when leaders of the groups accepted the new integrated leadership that is coded as the time of integration of different armed groups. In many cases, such agreements are finally formalized in cease-fire or peace agreements, and therefore, the date in which they signed the agreement is recorded as the date of integration. By the same token, it is when (part of) the leaders get disobedient to the current leadership structure that is coded as the time of splintering of armed group. In some cases, the disobedience is announced through media, and in other cases it becomes public with the eruption of infighting. These determined the time of splintering in the data. Actually, integration of rank and file soldiers into the new troops may take several months because of necessary redeployment and training, and proceed gradually. Separation of troops into two or more groups also may takes long time. However, it is almost impossible to trace the process of such gradual changes with the available information sources. Therefore, the coding rule is set as such.

As previously noted, a part of an armed group, say A, may splinter from the group and immediately join another group, say B, without any activity as an independent group. It is distinguished from the case that A splits

into two groups in the first event, say A and C, then in the next event C joins B. Though the two cases are difficult to distinguish when the interval between the two event in the later case is extremely short, such confusing cases actually did not appear in the sources. This is probably because when the interval is extremely short, e.g. several days, the authors of the sources do not regard the armed groups' independent activity during the period.

Non-armed groups, such as political parties and self-help organizations, play important roles in conflicts. They sometimes financially support armed groups or help their recruitment of combatants by agitating young people. However, fission-fusion of armed groups and non-armed groups are out of scope of this study. Therefore, when an armed group A, splinter into an armed faction B and non-armed faction C, then only the change from A to B is recorded in the data as a directed link from A to B, and the directed link from A to C is excluded. The integration is also coded in the same way.

3.2 Network analysis

3.2.1 Genealogical networks

The information about which groups changed into which groups can be represented by a genealogical network, in which nodes represent groups and links represent genealogical relations. Genealogical networks are hardly studied in political science, let alone conflict studies. However, they have been intensively investigated in other fields. For example, genealogical networks of species, cells, pathogens, languages, individuals, and firms are studied in biology [88–91], epidemiology [92–95], linguistics [96, 97], and econo-/socio-physics [98,99], respectively. These works have shown that genealogical networks contain valuable information about the dynamics of the system.

A notable example is the study of phylogenetic trees, which represent genealogical relation of pathogens: which pathogens mutated into which pathogens. The relation between the transmission dynamics and the shape of phylogenetic trees of pathogens is a burgeoning area of research in epidemiology. Frost and Volz analyzed a mathematical model and showed that a quantity, imbalance, is large, if the pathogen has a period in which its infectiousness is high or if there are groups with high contact rate [93]. Similarly, Colijn and Gardy showed imbalance increases when the contact network is a chain or has a hub [94]. Levanthal *et al.* analyzed empirical phylogenetic trees of HIV virus sampled in Switzerland and found the high imbalance, consistently with the theoretical results [92].

Definitions

A genealogical network composed of a set of nodes $V = \{v_1, v_2, \ldots, v_N\}$ and that of directed links $E = \{e_1, e_2, \ldots, e_M\}$. A node represents a group and an directed link represents the genealogical relation between a mother group and a daughter group. When a group v_i originates from another group v_j, the network includes a directed link $(v_j, v_i) \in E$, and I call v_i a daughter node of v_j and v_j a mother node of v_i.

Directed acyclic graphs

An importance property of genealogical networks is the absence of cycles: If A originates from B, and B from C, then C does not originate from A. More precisely, genealogical networks are directed acyclic graphs (DAGs), which do not include any subset of nodes $\left\{v_{p(1)}, v_{p(2)}, \ldots, v_{p(l)}\right\}$ that satisfies $\left(v_{p(k)}, v_{p(k+1)}\right) \in E$ for $k = 1, \ldots, l-1$ and $v_{p(1)} = v_{p(l)}$, with p an arbitrary function.

A wide range of real networks are DAGs, in addition to genealogical networks. A well-known example is citation networks [100–102]. Nodes represent documents, such as academic papers, patents, and judicial precedents, and directed links represents which documents cite which documents. Citation networks are usually acyclic because documents can cite those published before. Food webs [103], dominance hierarchy networks [104], and transcriptional regulatory networks [106, 107] are also suitably described by DAGs.

3.2.2 Network characteristics

Various quantities have been proposed to characterize the structure of networks; diameter, clustering coefficients, degree distribution, centrality, hierarchy, among others [108–110]. However, most of them are not designed to characterize genealogical networks and their interpretations are not straightforward in application to genealogical networks. Two notable exceptions are imbalance [111] and reversibility [112]. Therefore, this study focuses on the two quantities, though more diverse characterization of genealogical networks remains to be proposed in future studies.

Imbalance

Imbalance is a quantity that was introduced to assess the level of asymmetry of genealogical trees [111]. It has been used to infer the process by which the trees have grown [113, 114]. Especially, previous studies in epidemiology and biology have shown that the quantity is one of the most suitable shape character for the detection of various types of heterogeneity in the growing process of genealogy [92–95, 115, 116].

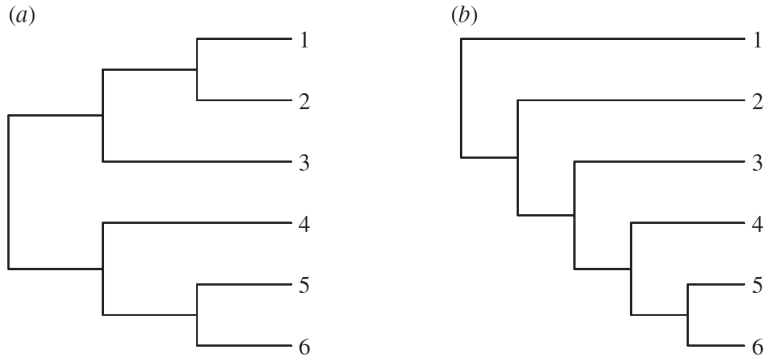

Figure 3.2: Graphs of (a) smaller imbalance and (b) larger imbalance, adopted form [93].

Imbalance was originally defined only for genealogical trees, and I call it tree imbalance for clarification. Tree imbalance is the average path length from the maximal node to a minimal node. Minimal (maximal) nodes are the nodes that do not have any daughter (mother) nodes, the set of which are denoted by m (M). Note that a genealogical tree has only one maximal node and the maximal node has an unique path to each minimal node. In other words, tree imbalance is denoted by

$$I_{\text{tree}} = \frac{1}{|m|} \sum_{i \in m} l\left(\pi(i)\right), \tag{3.1}$$

where $\pi(i)$ is the path from the maximal node to i and $l(\pi)$ is the length of π.

A genealogical network, however, may have multiple maximal nodes and a maximal node may have multiple paths to a minimal node. Therefore, I define imbalance of a network, which I call network imbalance, as

$$I_{\text{net}} = \frac{1}{|m|} \sum_{i \in m} l\left(\pi^*(i)\right), \tag{3.2}$$

$$\pi^*(i) = \underset{\pi(i) \in \phi(i)}{\arg\max}\, l\left(\pi(i)\right), \tag{3.3}$$

where $\phi(i)$ is the set of all paths from node i to any maximal nodes. This means that network imbalance is the average length of the longest path from any maximal node to a minimal node. In the language of fission-fusion of armed groups, network imbalance is the average number of fission-fusion events that armed groups experienced before they died or reached the end of the observation period. Different members of an armed group experienced different numbers of events and the quantity focuses on those who experienced the most frequent fission-fusion.

When the focal network is a tree, its network imbalance reduces to the tree imbalance. Though other analogous definitions may be possible, as a first step to search for characteristics of genealogical networks that imply the growing mechanism, current study adopts the definition. Note that isolated nodes, if included, are of neither incoming nor outgoing links, therefore they satisfy both of the definitions of maximal nodes and minimal nodes. However, they are defined as maximal nodes to prevents their effect on network imbalance.

A method to calculate network imbalance is to divide node into layers by leaf-removal algorithm [107]. The layer of node i is denoted by $L_i \in \{0, 1, \dots\}$. First, the maximal nodes are are assigned to layer 0 (i.e., if $i \in M$ then $L_i = 0$), and the maximal nodes and links attached to them are removed. Then, the maximal nodes in the reduced graph are assigned to layer 1, and the nodes and attached links are removed. This procedure is repeated until all the nodes are removed. Then, the layer of a node is equal to the longest path length to maximal nodes, as

$$L_i = l\left(\pi^*(i)\right). \tag{3.4}$$

The network imbalance is obtained by Eq. (3.2) and (3.4).

A proof of Eq. (3.4) is achieved by induction. When $l\left(\pi^*(i)\right) = 1$, it is trivial from the definition. Suppose the equation holds for $l\left(\pi^*(i)\right) \leq k$. Consider a node i such that $l\left(\pi^*(i)\right) = k + 1$. Suppose that $k - 1$ steps of node removal have been implemented and node j has any incoming links. A node that gives node i the incoming link, say node j, must be assigned to layer larger than k, i.e., $L_j \geq k + 1$. This means $l\left(\pi^*(j)\right) \geq k + 1$ because if $l\left(\pi^*(j)\right) \leq k$ then Eq. (3.2) hold by the current assumption. However, this contradict $l\left(\pi^*(i)\right) = k + 1$ because a longer path is obtained through node j. Therefore, node j in step k does not have any incoming link and $L_j = k + 1$.

Reversibility

Reversibility is a quantity that was recently proposed by Corominas-Murtra *et al.* to assess complexity of DAGs, especially with genealogical networks a typical target [112]. It is the average uncertainty of the process of going back from non-maximal nodes to maximal nodes. Large reversibility means that when one traces back from a non-maximal nodes to a maximal node (i.e., an origin), there are various paths. A genealogy of armed groups with larger reversibility implies that armed group on average have more diverse members who have different and more complicated histories of fission-fusion.

Let the set of paths from a non-maximal node i to any maximal nodes be denoted by $\phi(i)$. In the process of going back to maximal nodes, we suppose each mother node is chosen with the same probability. Then, the

probability that a path $\pi_k \in \phi(i)$ is chosen is,

$$P(\pi_k|i) = \prod_{j \in \nu(\pi_k)} \frac{1}{d_j^{\text{in}}}, \tag{3.5}$$

where $\nu(\pi_k)$ is the set of nodes participating in path π_k and d_j^{in} is the out-degree of node j . Then reversibility of a non-maximal node i is defined as

$$H_i = -\sum_{\pi_k \in \phi(i)} P(\pi_k|i) \ln P(\pi_k|i). \tag{3.6}$$

Reversibility of a network H is the average of the node reversibility,

$$H = \sum_{i \in V \setminus M} \frac{1}{N - |M|} H_i, \tag{3.7}$$

where N is the number of the nodes and M is the set of maximal nodes.

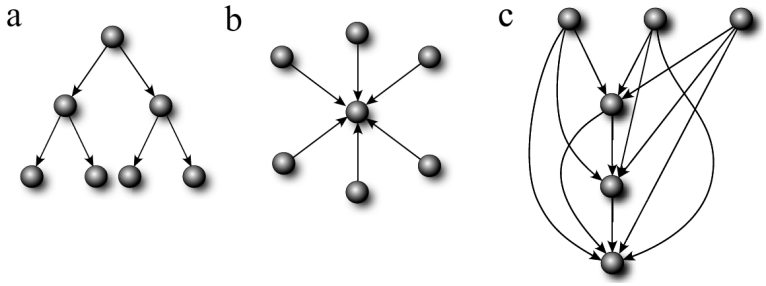

Figure 3.3: Graphs that are limits case in reversibility, adopted from [112].

Fig. 3.3 shows graphs that are limits case in reversibility [112]. Graph (a) is a tree and all non-maximal nodes have the unique path to the maximal node. Therefore, the reversibility is zero. Graph (b) has six maximal nodes and one non-maximal node. The non-maximal node has six paths to maximal nodes. Therefore, the reversibility is $\ln 6$. Graph (c) is the graph that has the largest reversibility in graphs that has three maximal nodes and three non-maximal nodes.

3.2.3 Network models

Comparison of network characteristics between empirical networks and randomized networks is a basic method to evaluate the structure of networks [108]. Randomized networks are most commonly generated by configuration models, which conserve the degrees of nodes (degree sequence) and randomizes the other information [117, 118]. Randomization methods that have been proposed for DAGs are also extension of configuration models

and conserve the directed degree sequence of DAGs [119–121]. However, the conservation of degree sequence of genealogical networks does not seem to have clear interpretations in the fission-fusion dynamics. Moreover, the configuration models may generate networks that does not make sense as a genealogy.

Therefore, this study proposes a new randomization method for genealogical networks. It is analogous to Yule model, which is commonly used in randomization of genealogical trees [122]. In the model, a tree grows as minimal nodes of the current tree branches with the same probability. Then, this model can randomize empirical genealogical trees with the number of splitting events conserved. The corresponding hypothesis for fission-fusion of armed groups is clear: each existing groups splits into two groups with the same probability. However, fission-fusion dynamics of armed groups contain more complex patterns of events. Armed groups not only split and but also merge. Moreover, splintering and merger may occur at the same time, as a part of a group defects from the group to join another. Therefore, this study propose a randomization method that conserves the number of each types of events, instead of the number of branching.

Decomposition

To implement the randomization, a genealogical network is decomposed into fission-fusion events. If two links share the same mother node or the same daughter node, then the two links belong to the same event. More precisely, a event is a set of links. Let the event that a link e belongs to be denoted by $\varepsilon(e)$, and the mother and daughter nodes of e by $v^s(e)$ and $v^t(e)$, respectively. Then, $\varepsilon(e) = \varepsilon(e')$ if $v^s(e) = v^s(e')$ or $v^t(e) = v^t(e')$. Fig. 3.4 illustrates the decomposition. The genealogy in Fig. 3.4 is the same with Fig.3.1 and Table 3.1. It is decomposed into three events (a), (b), and (c).

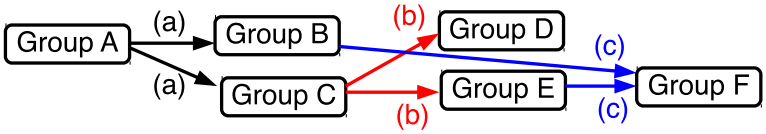

Figure 3.4: Illustration of decomposition of a genealogical network into events (a), (b), and (c).

As previously noted, birth and death of armed groups are represented by links between the groups and exceptional nodes, source and drain. These links are neglected in measurement of network characteristics because the source and drain are fictional. However, they are not neglected in the decomposition process to correctly count the birth and death events of armed groups. Nodes that existed before any events are called initial nodes. In

other words, initial nodes are maximal nodes in the networks that contain the exceptional links.

Composition

Events are randomly composed to generate a genealogical network. First, the order of event are randomly determined so that the number of existing groups do not become negative during the growing process of the genealogy. Suppose the number of events is T and a sequence of event $(\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_T)$ is drawn from the uniform distribution over all possible ordering. Let the number of different mother nodes in ε be denoted by $n^s(\varepsilon)$, that of daughter nodes by $n^t(\varepsilon)$, and the number of initial nodes by n_{init}. In event ε, $n^s(\varepsilon)$ existing groups evolve into $n^t(\varepsilon)$ new groups. Then if

$$n_{\text{init}} - \sum_{t=1}^{\tau} n^s(\varepsilon_t) + \sum_{t=1}^{\tau-1} n^t(\varepsilon_t) \geq 0 \tag{3.8}$$

holds for $\tau \leq T$, then the number of existing groups is always non-negative. If the condition is satisfied, the drawn sequence is adopted as the order of events, otherwise another sequence is drawn.

Second, the groups that participate in each event are determined. In each step $t = 1, 2, \ldots, T$, $n^s(\varepsilon_t)$ nodes are chosen as mother nodes, $n^t(\varepsilon_t)$ nodes are added as daughter nodes, and links contained in ε_t are wired between them. Only groups that exist (i.e., have not split, merged, or died) at the step can participate in the event of the step. Therefore, mother nodes are chosen from the minimal nodes in the current graph (that does not neglect links to drain). As analogous to Yule model, each existing node has the same probability to participate in the event. Fig. 3.5 illustrates this random composition, with events (a), (b), (c) and one initial node. The order of events of the randomized network is (b), (c), and (a).

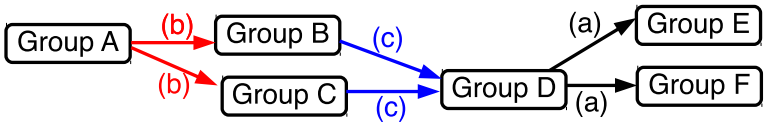

Figure 3.5: Illustration of random composition of events (a), (b), and (c) with one initial node.

Chapter 4

Result

4.1 Data and basic properties

Table 4.1 is the data of fission-fusion of armed groups in the DRC since 1996. It is composed of 204 data units. The details and references of each unit are in Appendix.

The genealogical network constructed based on the data includes 162 nodes and 186 links. Fig. 4.1 shows the largest connected component of the genealogical network, which contains 153 nodes and 184 links. It was visualized by Cytoscape 3.4.0 [123]. The label of a node shows the name of the group and the time of the event that generated the group. The vertical positions are arranged according to the order of the events by which the groups were created. If group A was created by a fission-fusion event earlier than group B, then A is in a higher position than B. The horizontal positions were arranged so that nodes representing the groups that have the same name have similar horizontal positions.

Fig. 4.2 shows the time development of the number of armed groups. The number steadily increased during the Wars (1996-2003), and did not decrease even after 2003, when the Second War ended. It rapidly increased since 2012. This indicates the insecurity in Eastern Congo since 2012, which was largely caused by the rebellion of the insurgent group M23 since 2012. Most of the groups that participated in the events since 2012 were pointed out to be related with the M23 or its supporter Rwanda (Appendix, Data 160–204).

Figure 4.3 shows the out- and in-degree distributions of the network. The distributions are both narrow and most of nodes have degree from zero to three. There is no node that has a huge number of incoming or outgoing links. In other words, fragmentation into a large number of groups or merger of such many groups were hardly observed.

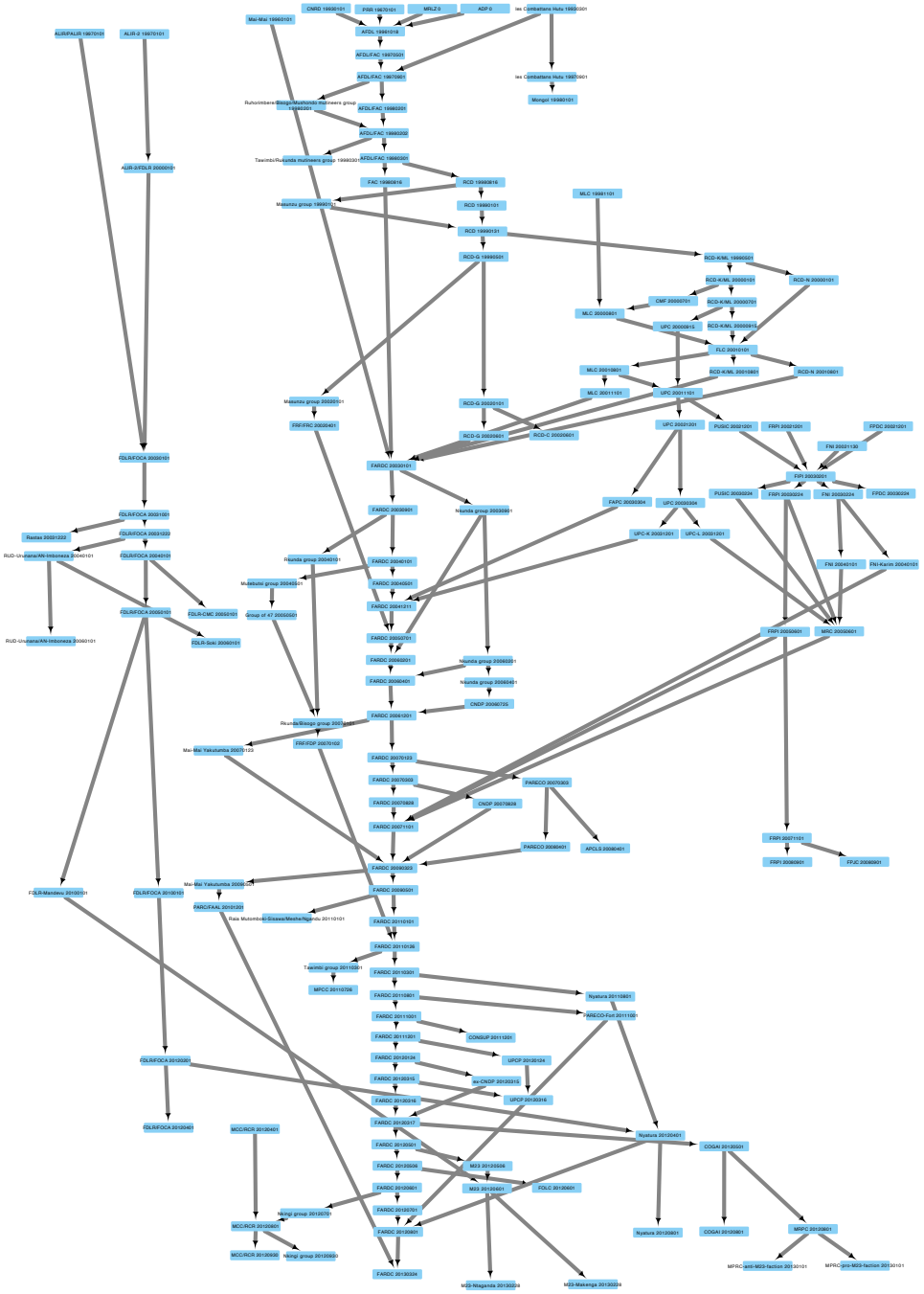

Figure 4.1: The largest connected component of the genealogical network of the armed groups.

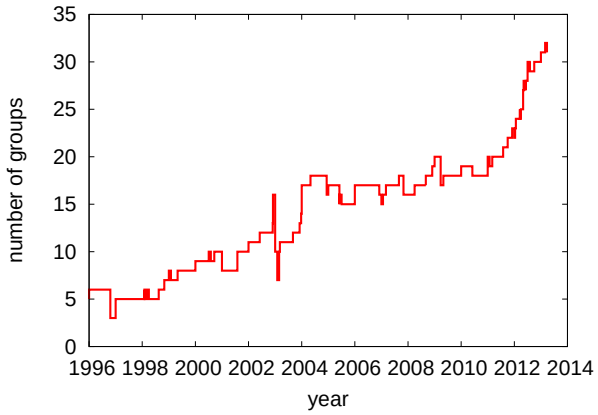

Figure 4.2: The time development of the number of armed groups.

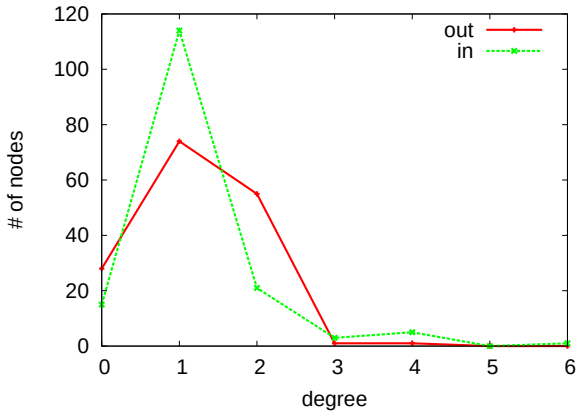

Figure 4.3: The out-degree distribution (red solid line) and in-degree distribution (green broken line) of the genealogical network.

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
1	1996	1	1	3	source	Mai-Mai
2	1996	10	18	0	PRR	AFDL
3	1996	10	18	0	CNRD	AFDL
4	1996	10	18	0	ADP	AFDL
5	1996	10	18	0	MRLZ	AFDL
6	1997	1	1	2	source	ALIR/PALIR
7	1997	1	1	2	source	ALIR-2
8	1997	5	1	3	AFDL	AFDL/FAC
9	1997	9	1	2	AFDL/FAC	AFDL/FAC
10	1997	9	1	2	les Combattans Hutu	les Combattans Hutu
11	1997	9	1	2	les Combattans Hutu	AFDL/FAC
12	1998	1	1	3	les Combattans Hutu	Mongol
13	1998	2	1	1	AFDL/FAC	AFDL/FAC
14	1998	2	1	1	AFDL/FAC	Ruhorimbere mutineers group
15	1998	2	2	3	AFDL/FAC	AFDL/FAC
16	1998	2	2	3	Ruhorimbere mutineers group	AFDL/FAC
17	1998	3	1	1	AFDL/FAC	AFDL/FAC
18	1998	3	1	1	AFDL/FAC	Tawimbi/Rukunda mutineers group
19	1998	3	31	3	Tawimbi/Rukunda mutineers group	drain
20	1998	8	16	0	AFDL/FAC	FAC

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
21	1998	8	16	0	AFDL/FAC	RCD
22	1998	11	1	1	source	MLC
23	1999	1	1	2	RCD	RCD
24	1999	1	1	2	RCD	Masunzu group
25	1999	1	31	3	RCD	RCD
26	1999	1	31	3	Masunzu group	RCD
27	1999	5	1	1	RCD	RCD-K/ML
28	1999	5	1	1	RCD	RCD-G
29	2000	1	1	2	ALIR-2	ALIR-2/FDLR
30	2000	1	1	1	RCD-K/ML	RCD-K/ML
31	2000	1	1	1	RCD-K/ML	RCD-N
32	2000	7	1	2	RCD-K/ML	RCD-K/ML
33	2000	7	1	2	RCD-K/ML	CMF
34	2000	8	1	3	MLC	MLC
35	2000	8	1	3	CMF	MLC
36	2000	9	15	0	RCD-K/ML	RCD-K/ML
37	2000	9	15	0	RCD-K/ML	UPC
38	2001	1	1	1	MLC	FLC
39	2001	1	1	1	RCD-K/ML	FLC
40	2001	1	1	1	RCD-N	FLC

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
41	2001	6	1	1	FLC	MLC
42	2001	6	1	1	FLC	RCD-K/ML
43	2001	6	1	1	FLC	RCD-N
44	2001	11	1	2	MLC	MLC
45	2001	11	1	2	UPC	UPC
46	2001	11	1	2	MLC	UPC
47	2002	1	1	1	RCD-G	RCD-G
48	2002	1	1	1	RCD-G	Masunzu group
49	2002	4	1	1	Masunzu group	FRF/FRC
50	2002	7	26	0	RCD-G	RCD-G
51	2002	7	26	0	RCD-G	RCD-C
52	2002	11	30	1	source	FNI
53	2002	12	1	1	UPC	UPC
54	2002	12	1	1	UPC	PUSIC
55	2002	12	1	2	source	FRPI
56	2002	12	1	2	source	FPDC
57	2003	1	1	2	ALIR-2/FDLR	FDLR/FOCA
58	2003	1	1	2	ALIR-2/FDLR	FDLR/FOCA
59	2003	1	1	2	FAC	FARDC
60	2003	1	1	2	RCD-G	FARDC

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
61	2003	1	1	2	RCD-K/ML	FARDC
62	2003	1	1	2	RCD-N	FARDC
63	2003	1	1	2	MLC	FARDC
64	2003	1	1	2	Mai-Mai	FARDC
65	2003	2	1	1	PUSIC	FIPI
66	2003	2	1	1	FNI	FIPI
67	2003	2	1	1	FRPI	FIPI
68	2003	2	1	1	FPDC	FIPI
69	2003	2	24	0	FIPI	PUSIC
70	2003	2	24	0	FIPI	FNI
71	2003	2	24	0	FIPI	FRPI
72	2003	2	24	0	FIPI	FPDC
73	2003	3	4	0	UPC	UPC
74	2003	3	4	0	UPC	FAPC
75	2003	9	1	1	FARDC	FARDC
76	2003	9	1	1	FARDC	Nkunda group
77	2003	10	1	1	FDLR/FOCA	FDLR/FOCA
78	2003	12	1	1	UPC	UPC-L
79	2003	12	1	1	UPC	UPC-K
80	2003	12	22	3	FDLR/FOCA	FDLR/FOCA

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
81	2003	12	22	3	FDLR/FOCA	Rastas
82	2004	1	1	2	FDLR/FOCA	FDLR/FOCA
83	2004	1	1	2	FDLR/FOCA	RUD-Urunana/AN-Imboneza
84	2004	1	1	2	FNI	FNI
85	2004	1	1	2	FNI	FNI-Karim
86	2004	1	1	3	FARDC	FARDC
87	2004	1	1	3	FARDC	Rkunda group
88	2004	5	1	1	FARDC	FARDC
89	2004	5	1	1	FARDC	Mutebutsi group
90	2004	12	11	0	FARDC	FARDC
91	2004	12	11	0	UPC-K	FARDC
92	2004	12	11	0	FAPC	FARDC
93	2005	1	1	2	FDLR/FOCA	FDLR/FOCA
94	2005	1	1	2	FDLR/FOCA	FDLR-CMC
95	2005	5	1	2	Mutebutsi group	Group of 47
96	2005	6	1	1	FRPI	FRPI
97	2005	6	1	1	FRPI	MRC
98	2005	6	1	1	UPC-L	MRC
99	2005	6	1	1	PUSIC	MRC
100	2005	6	1	1	FNI	MRC

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
101	2005	6	1	2	source	Raia Mutomboki-Musumbu
102	2005	7	1	1	FARDC	FARDC
103	2005	7	1	1	FRF/FRC	FARDC
104	2006	1	1	2	source	Alexandre/Kyatend group
105	2006	1	1	2	RUD-Urunana/AN-Imboneza	RUD-Urunana/AN-Imboneza
106	2006	1	1	2	RUD-Urunana/AN-Imboneza	FDLR-Soki
107	2006	2	1	1	FARDC	FARDC
108	2006	2	1	1	Nkunda group	Nkunda group
109	2006	2	1	1	Nkunda group	FARDC
110	2006	4	1	2	FARDC	FARDC
111	2006	4	1	2	Nkunda group	Nkunda group
112	2006	4	1	2	Nkunda group	FARDC
113	2006	7	26	0	Nkunda group	CNDP
114	2006	12	1	1	FARDC	FARDC
115	2006	12	1	1	CNDP	FARDC
116	2007	1	1	3	Rkunda group	Rkunda/Bisogo group
117	2007	1	1	3	Group of 47	Rkunda/Bisogo group
118	2007	1	2	3	Rkunda/Bisogo group	FRF/FDP
119	2007	1	23	0	FARDC	FARDC
120	2007	1	23	0	FARDC	Mai-Mai Yakutumba

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
121	2007	3	3	0	FARDC	FARDC
122	2007	3	3	0	FARDC	PARECO
123	2007	8	1	1	FARDC	FARDC
124	2007	8	1	1	FARDC	CNDP
125	2007	11	1	1	FNI-Karim	FARDC
126	2007	11	1	1	FRPI	FARDC
127	2007	11	1	1	MRC	FARDC
128	2007	11	1	1	FARDC	FARDC
129	2007	11	1	1	FRPI	FRPI
130	2008	4	1	1	PARECO	PARECO
131	2008	4	1	1	PARECO	APCLS
132	2008	9	1	1	FRPI	FRPI
133	2008	9	1	1	FRPI	FPJC
134	2008	11	30	1	source	FPLC
135	2009	1	1	2	source	NDC/Mai-Mai-Sheka
136	2009	3	23	0	FARDC	FARDC
137	2009	3	23	0	PARECO	FARDC
138	2009	3	23	0	CNDP	FARDC
139	2009	3	23	0	Mai-Mai Yakutumba	FARDC
140	2009	5	1	2	FARDC	FARDC

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
141	2009	5	1	2	FARDC	Mai-Mai Yakutumba
142	2010	1	1	2	FDLR/FOCA	FDLR/FOCA
143	2010	1	1	2	FDLR/FOCA	FDLR-Mandevu
144	2010	6	1	2	Alexandre/Kyatend group	drain
145	2010	12	1	2	Mai-Mai Yakutumba	PARC/FAAL
146	2011	1	1	2	source	Raia Mutomboki-Eyadema/Kikuni
147	2011	1	1	2	FARDC	FARDC
148	2011	1	1	2	FARDC	Raia Mutomboki-Sisawa/Meshe/Ngandu
149	2011	1	26	0	FARDC	FARDC
150	2011	1	26	0	FRF/FDP	FARDC
151	2011	3	1	1	FARDC	FARDC
152	2011	3	1	1	FARDC	Tawimbi group
153	2011	7	26	0	Tawimbi group	MPCC
154	2011	8	1	3	FARDC	FARDC
155	2011	8	1	3	FARDC	Nyatura
156	2011	10	1	1	FARDC	FARDC
157	2011	10	1	1	FARDC	PARECO-Fort
158	2011	12	1	1	FARDC	FARDC
159	2011	12	1	1	FARDC	CONSUP
160	2012	1	1	1	CONSUP	drain

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
161	2012	1	11	1	source	FDC
162	2012	1	24	0	FARDC	FARDC
163	2012	1	24	0	FARDC	UPCP
164	2012	2	1	2	FDLR/FOCA	FDLR/FOCA
165	2012	3	15	1	FARDC	FARDC
166	2012	3	15	1	FARDC	ex-CNDP
167	2012	3	16	0	FARDC	FARDC
168	2012	3	16	0	UPCP	UPCP
169	2012	3	16	0	FARDC	UPCP
170	2012	3	17	1	FARDC	FARDC
171	2012	3	17	1	ex-CNDP	FARDC
172	2012	4	1	2	FDLR/FOCA	FDLR/FOCA
173	2012	4	1	2	Nyatura	Nyatura
174	2012	4	1	2	FDLR/FOCA	Nyatura
175	2012	4	1	3	source	MCC/RCR
176	2012	5	1	1	FARDC	FARDC
177	2012	5	1	1	FARDC	COGAI
178	2012	5	1	1	FDC	FDC
179	2012	5	1	1	FDC	FDC-Luanda
180	2012	5	6	0	FARDC	FARDC

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
181	2012	5	6	0	FARDC	M23
182	2012	6	1	3	M23	M23
183	2012	6	1	3	FDLR-Mandevu	M23
184	2012	6	1	3	FARDC	FARDC
185	2012	6	1	3	FARDC	FOLC
186	2012	7	1	1	source	ALEC
187	2012	7	1	2	FARDC	FARDC
188	2012	7	1	2	FARDC	Nkingi group
189	2012	8	1	2	MCC/RCR	MCC/RCR
190	2012	8	1	2	Nkingi group	MCC/RCR
191	2012	8	1	1	COGAI	COGAI
192	2012	8	1	1	COGAI	MRPC
193	2012	8	1	1	FARDC	FARDC
194	2012	8	1	1	Nyatura	Nyatura
195	2012	8	1	1	Nyatura	FARDC
196	2012	8	1	1	PARECO-Fort	FARDC
197	2012	9	30	3	MCC/RCR	MCC/RCR
198	2012	9	30	3	MCC/RCR	Nkingi group
199	2013	1	1	3	MRPC	MPRC-pro-M23-faction
200	2013	1	1	3	MRPC	MPRC-anti-M23-faction

Table 4.1: The fission-fusion data of armed groups in the DRC (1996–2013).

ID	year	month	day	uncertainty	mother	daughter
201	2013	2	28	1	M23	M23-Ntaganda
202	2013	2	28	1	M23	M23-Makenga
203	2013	3	24	0	FARDC	FARDC
204	2013	3	24	0	PARC/FAAL	FARDC

4.2 Comparison with randomized networks

Fig.4.4 shows the imbalance and the reversibility of the empirical network and randomized networks. The values for randomized networks are averaged over 1,000 samples. It shows that both of the imbalance and the reversibility of the empirical data are significantly larger than those of random networks. This result shows the existence of non-random structure in the fission-fusion network, answering the key question of this research. In the language of fission-fusion of armed groups, actual armed groups on average experienced more fission-fusion events until they died or reached the end of the observation period, and their members had more diverse and complex histories, than expected from the process in which every existing groups split and/or merge with the same probability.

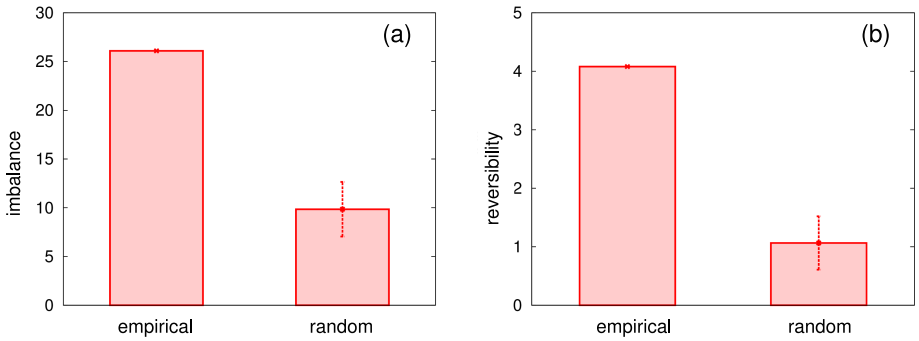

Figure 4.4: Comparison of (a) imbalance and (b) reversibility between the empirical network and randomized networks. The values for randomized networks are averaged over 1,000 samples. The error bars shows the standard deviation.

4.3 Pivotal group model

4.3.1 Definition

Motivation

The next question is how to explain the non-random structure of the network. A possibility is heterogeneity in probability to participate in fission-fusion event. This is because, first, the heterogeneity of branching probability in the growth of genealogical trees is known to increase tree imbalance [92–95], therefore similar heterogeneity is expected to increase network imbalance. Second, the heterogeneity also fits the reality of the Congolese conflicts. As explained Sec. 2.3, the DRC government repeated superficial integration of insurgent groups to pretend a responsible government under

the international pressure. The government was unwilling to tackle fundamental grievance in Eastern Congo, was not strong enough to defeat the insurgent groups, but needed to pretend doing something for the conflict resolution according to the norm of the international community [69]. Other armed groups usually do not have similar incentives to offer high positions of their groups and temporally integrate others. To reflect this reality, the random network model is extended to allow existing groups have different tendencies to participate in fission-fusion events and the tendencies are inherited to succeeding groups. We call this extended model the pivotal group model, which is explained in detail below. Though there can be other models to reflect the uniqueness of the national army, this model is one of the simplest models that the author conceives of.

Node selection

As the previous random model, the pivotal group model also decompose genealogical networks into fission-fusion events and uniformly randomize the order of events, . In the composition process of the random model, however, each existing groups have the same probability of participation. In other words, minimal nodes (i.e., existing groups) may have different probability to be mother nodes of a focal event. Specifically, each node is supposed to have its weight and is chosen to be a mother node according to its relative weight. Let the set of minimal nodes at step t of composition be denoted by $m(t) = \{v_1, v_2, \ldots, v_{n(t)}\}$. Suppose that each node v has the weight $w(v) > 0$. We choose $n^s(\varepsilon_t)$ nodes from $m(t)$ to be mother nodes of event ε_t. When we have finished choosing k nodes, the set of chosen node is denoted by $\tilde{m}(t, k)$. The nodes that have been already chosen to mother nodes are not chosen again. Then, in the choice of the k th node, the probability that node $v \in m(t) \backslash \tilde{m}(t, k)$ is chosen is,

$$\frac{w(v)}{\sum_{v' \in m(t) \backslash \tilde{m}(t,k)} w(v')}. \tag{4.1}$$

An exception is that when the event is the demise of an existing group (i.e. when the number of daughter nodes of an event is equal to zero) all existing nodes have the same probability to die (i.e., to be the mother node). This exceptional treatment is introduced to reflect the situation of the Congolese conflicts. Though armed groups frequently defected from and joined into the national army, the national army's demise was hardly observed. Another exceptional case is the birth of a group, in which we do not need to choose any mother node, and just adding another existing node is enough.

The pivot and its inheritance

This pivotal group model assumes that (1) there is a group that is more likely to participate in events, which we call the pivotal group, while the

other groups have the same probability of participation and (2) one of the daughter groups of the pivotal group is to be the next pivotal group, which has the same weight with the current pivotal group. Therefore, when v represents the current pivotal group, $w(v) = w^* \geq 1$, otherwise $w(v) = 1$. The weight w^* is called the pivot weight. The daughter node to become the next pivotal group is chosen from all the daughter nodes of the current pivotal node with the same probability. If the pivotal node dies, then no node is pivotal and every existing node has the weight $w(v) = 1$. Note if a group participates in a fission-fusion event, the group itself ceases to exist because it evolves into different groups. Therefore, even a pivotal group participates in only one fission-fusion event.

4.3.2 Two limit cases

To test the effects of the weight heterogeneity, we check the behavior of the model in limit cases: $w^* = 1$ (symmetric limit) and $w^* = \infty$ (asymmetric limit). In asymmetric limit, the pivotal group always participate in any fission fusion events except for the death of the group. For simplification, events are randomly chosen from split of one group into two group or merger of two groups into one group, the former with probability $p = 3/4$ and the later with $1 - p = 1/4$. Splintering is set to be more likely than merger because we are interested in the behavior of the model in which the number of existing groups increases, as the Congolese conflicts. No event of birth and death of armed groups is included. Sequences of events must satisfy Eq. (3.8), otherwise they are rejected and another sequence is randomly generated. Then, events are composed according to node weights as described above.

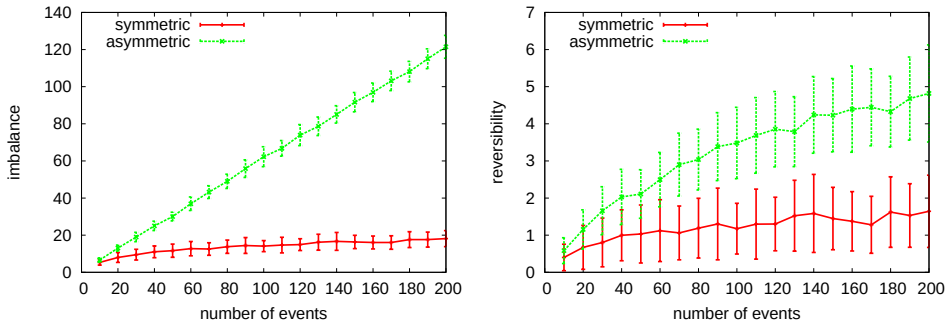

Figure 4.5: The dependence of the average imbalance (left) and reversibility (right) on the number of events of the symmetric limit (red solid lines) and the asymmetric limit (green broken lines). Averages are taken over 100 samples. Error bars represent the standard deviation.

Figure 4.5 shows the dependence of the average imbalance of reversibility on the number of events in the two limits. The imbalance in the asymmetry limit more rapidly increases than that of the symmetry model as the number of the event increases. The reversibility is also larger in the asymmetry limit than the symmetry limit. However, the difference of reversibility between the two limits does not increase as rapid as that of imbalance when the number of the event increases. This difference between the symmetric and asymmetric limits is consistent with the difference between the empirical network and randomized network, as the empirical network has larger imbalance and reversibility than randomized networks and the asymmetric limit does than the symmetric. This result of the preliminary tests implies that the pivotal group model is better to explain the structure of the genealogy of the Congolese armed groups than the randomization model.

4.3.3 Weight dependence

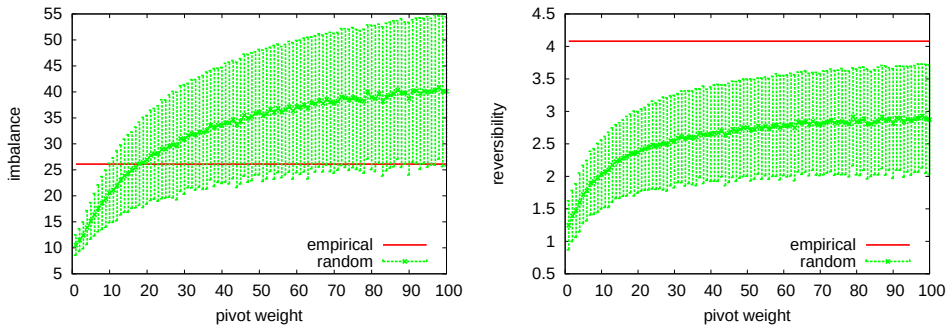

Figure 4.6: The dependence of imbalance (left) and reversibility (right) on pivot weight (green broken lines). The broken lines show the average of 1,000 randomly generated networks, and the error bars represent the standard deviation. The red solid lines show the values of the empirical network.

Next, we check the performance of the model with the empirical set of the events, which are obtained by decomposition of the genealogy of the Congolese armed group. Fig. 4.6 shows the dependence of imbalance and reversibility on the pivot weight. Both imbalance and reversibility increase as the pivot weight increases. In consistent with the two limit cases, the existence of the pivotal group of appropriate weight results in network characteristics that are closer to empirical values. The empirical imbalance is within one standard deviation from the average of values from the model in a wide range of pivot weight, about $10 \leq w^* \leq 100$. On the other hand, the empirical reversibility does not get within the one standard deviation even when the pivot weight is as large as $w^* = 100$, though the expectation

from the model gets much closer to the empirical value than the complete randomization.

4.3.4 Comparison with the national army

As previously noted, the candidate of the pivotal group in the contest of the Congolese conflicts is the national army. Therefore, we compare the number of events that the pivotal node participate in the model and the corresponding empirical value of the national army. It helps us to know how well the model can explain the network characteristics when we assume the national army play the role of the pivot.

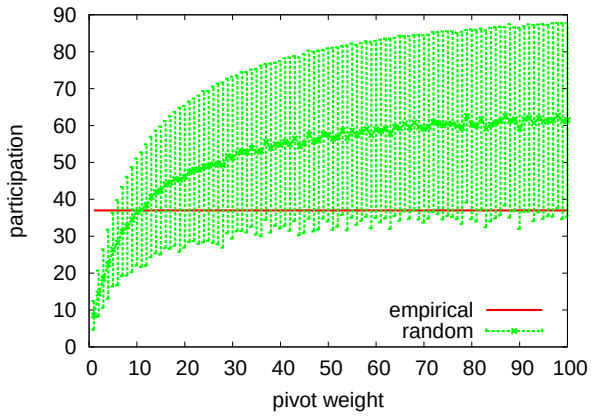

Figure 4.7: The dependence on the pivot weight of the number of events that pivotal nodes participate in the pivotal model (the green broken line) and the number of events that the national army participated in the empirical data (the red solid line). The broken lines show the average of 1,0000 randomly generated networks, and the error bars represent the standard deviation.

Fig. 4.7 compare theoretical expectation of the number of event that the pivot participates in and the empirical number of events that the national army participated in. The former is obtained from the simulation of the pivotal model. It shows that the empirical value for the national army is best expected when w^* is around 10. Therefore, when we suppose w^* is between 10 to 20 and the national army plays the role of the pivot, the expectation of the model is consistent with the empirical network in imbalance and the participation frequency of the pivot. Though the empirical value of reversibility is not correctly expected when w^* is about 10 to 20, the expected value is much closer to the empirical value than that of the original randomization model (i.e., when $w^* = 1$). These results are consistent with the claim that the national army is the main protagonist of fission-fusion dynamics, as previous studies of the Congolese conflicts points out [69].

At the same time, the result implies that additional modifications of the model are required to precisely explain the empirical reversibility. In other words, it is implied that there are additional factors in the fission-fusion dynamics other than the pivotal role of the national army. A possibility is that a group of a more complex origin is more likely to participate in fission-fusion events. A group of a complex origin may have complex internal structure, therefore it may tend to suffer internal struggles. Such a group may has diverse members, therefore it may be less reluctant to merge with other groups. A way to combine this factor into the model is making the node weight dependent on the node reversibility (Eq. (3.6)). Though it is conjectured that this mechanism makes networks locally more complex and enhances the reversibility, the investigation of the effects of this and other extensions remain to be done in future studies.

4.4 Summary of the results

This study collected the data of fission-fusion of the armed groups in the Congolese conflicts. The genealogical network of Congolese armed groups has larger imbalance and reversibility than those expected when every existing groups split and/or merge with the same probability. In other words, the Congolese armed groups on average experienced more fission-fusion events until they died or reached the end of the observation period, and their members had more diverse and complex histories than expected from the random process with the homogeneous fission-fusion probability.

The characters of the genealogical network are better explained when we assume that the national army is 10–20 times more likely to split and/or merge than a non-state armed group. A possible reason of this heterogeneity is that the government army, to deflect the international pressure, uniquely has an incentive to superficially integrate other armed groups even when the integration would finally collapse. This implies that that conflict resolution in the DRC should be modified; The government should address the political grievance of people in Eastern Congo instead of relying on cheap methods of army integration. It also provides a lesson that the international community should more closely monitor the implementation process of peace agreements or army integration, instead of being satisfied with superficial conflict-resolution.

Chapter 5

Discussion

5.1 Contributions of the present study

There are two key contributions of my research. The first contribution is that I found that a genealogical data of armed groups actually tells us possible fission-fusion mechanisms. The genealogy of the Congolese armed groups obtained in this research suggests that the national army is more likely to split and/or merge than a non-state armed group, rejecting the assumption that every group has the same tendency of fission-fusion. The data also implies that there are some mechanisms of fission-fusion that made the genealogy so complex that it cannot be explained by the uniqueness of the national army alone. It was not trivial that a genealogical network of armed groups can be this informative. Therefore, this study not only corroborates the understanding of the DRC conflicts but also provides a starting point for the collection and analysis of genealogical data of armed groups in a wider range of civil wars, which was the principal aims of the current research as discussed in Sec. 1.5.

Concerning the first contribution, however, there are two notable points that are beyond the reach of this study. The first limitation is, as noted in Sec. 1.5, that this study alone cannot tell us whether the fission-fusion in other conflicts shares similar characters with that in the DRC conflicts. Though civil wars are different to each other in various dimensions, conflict studies have pointed out that they have part of the structure in common [6–8, 53]. Therefore, it is not so unreasonable to expect some common characters of fission-fusion dynamics of armed groups across different conflicts. To answer the question precisely, however, we need to expand the date to cover a enough number of conflicts.

The second limitation is that fission-fusion of armed groups is not everything of civil war. Important phenomena related civil war include battles between armed groups, atrocities committed against civilians, cease-fire negotiations, and the implementation of peace agreements, among others.

Data and analysis of fission-fusion of armed groups alone do not directly tell us these aspects and how the fission-fusion dynamics interacts with these dimensions, as this study cannot. However, existing studies imply that fission-fusion of armed groups is strongly related with them. The fission-fusion may prolong civil war because they balance the power of warring parties [20], change the likelihood of sexual violence by producing indisciplined splintering factions [10], hinder peace agreements and their implementation because incessant changes of armed groups make their confidence-building more difficult [23, 28]. Though these connections have not been understood clearly, detailed data of fission-fusion of armed groups, including that of this study, will help us to investigate them more soundly when future studies combined them with data on other dimensions.

The second contribution is that I developed a new quantitative approach to social dynamics: the genealogical network analysis. While many social phenomena are recently studied with quantitative and computational methods, genealogical networks of social groups have hardly been analyzed. Therefore, this study opened a new field that various computational methods, especially those of network science, can be applied. However, as discussed in this study, most of network analysis methods are originally not designed to study genealogical networks and therefore need to be modified or extended. To find appropriate methods for genealogical networks, it may be useful to extend the methods of genealogical tree analysis to those of the corresponding networks analysis, as this study did tree imbalance to network imbalance. Another way is using the methods of DAG analysis that are designed to study genealogical networks. Reversibility in the case. Nevertheless, such methods are still very limited, and the expansion is a task of future studies.

Genealogical network analysis of social groups can be applied to various social phenomena. Fission-fusion is observed in a wide range of social groups: social movements, firms, NGOs, sovereign states, administrative organizations of a government, peer groups in schools, musicians, hunter-gatherers, to name a few. Each of them is an important subject in each field of study: sociology, economics, political science, educational research, anthropology, etc. While this study focused on a specific armed conflict in Africa, African studies also have other topics of studies that analysis of genealogy can be applied to meaningfully. For example, many African states experiences rapid introduction of multi-party democracy and the collapse of government since 1990s. The evolution of political and military organizations, ranging form ruling political parties to anti-government civil movements, in the process of these rapid and chaotic changes was extremely complicated. Collection of the fission-fusion data and analysis of the genealogy may help description and understanding of the shifts between autocracy, democracy, and collapse during the period.

5.2 Future problems

It is strongly desired that future studies construct a more comprehensive database that covers a wider range of cases, for deeper understanding of fission-fusion dynamics, especially the causes and effects of genealogical network characteristics. Therefore, it is valuable to discuss room for improvement in data collection procedure for the expansion of data.

Above all, efficient data collection is necessary to construct the comprehensive dataset, because it is extremely time-consuming and it takes several years without any improvement of the procedure. For the purpose, details of coding process should be recorded in a data (coding process data), separately from the data that is finally published or analyzed (output data). For example, the coding process data should records (1) parts of documents that have been already checked, (2) parts that are irrelevant for the purpose of the dataset, (3) parts that are included in the output data and the reason of the judgment of inclusion, and (4) parts that are excluded from the output data and the reason of the judgment of exclusion. The first element is useful for the management of the coding. The second to fourth elements are important for efficient verification, correction, and review of the data.

The information about what is excluded from the output data is especially important. The current procedure does not record excluded events, which do not satisfy the criteria and therefore are not regarded as a fission-fusion event. This is problematic when the criteria are modified during the coding process, because the coder must read again all the documents to include the events that satisfy the new criteria. It is obvious that the modification of the criteria during the coding itself should be avoided. However, the behaviour of armed groups has a tremendously wide variety. Therefore, it is almost inevitable that unexpected cases require some modification of criterion.

Another candidate of modification is the introduction of event categories. The categories of fission-fusion events may include, for example, splintering, independence, mutiny, coup, peace agreement, subordination, and side-switching. Though there are many cases that are difficult to categorize, this rough categorization would allow coders to remember and users to understand more easily why the events are included in the data. In other words, the categorization may not help the data analysis but it will allow for more efficient verification or correction of the data, as the coding process data will.

Though the necessary coverage of datasets to lead a significant result is difficult to estimate, a reasonable goal is to contain the armed conflicts that common datasets (e.g. the UCDP [42]) include, which is usually more than 100 cases. At the same time, however, the addition of only several cases may allow for a valuable comparison. For example, the Liberian civil wars (1989–1996 and 1999–2003) are an interesting case for the comparison with

the DRC's because they are known as to have seen complicated changes of warring parties but the country established a functioning and stable democracy after the conflicts in contrast with the DRC where the authoritarian regime has kept effectively dominating the national politics. It is not clear how much time and how large a budget are required when a project expands the data because I have not recorded the time taken for the coding of the current data though I should have. Moreover, the time required for the coding would be largely different from coder to coder. Therefore pilot experiments are necessary regardless of whether the project employs research assistants or the principal investigators code the data by themselves.

Chapter 6

Conclusion

Civil war is one of the most serious risks for human security today. To understand the dynamics of civil war precisely, it is necessary to understand the armed groups who fight the conflict. A characteristic phenomena concerning armed groups in civil conflict is that they repeatedly split and merge during the course of the war. Despite the importance of the fission-fusion dynamics on the conflict resolution and prevention, pertinent data with enough resolution for the analysis of genealogical network structure were not available.

Therefore, I constructed a data on when, which armed groups split/merge into which group during the course of conflicts the Democratic Republic of Congo (DRC) since 1996. Necessary information was collected form various secondary sources. The obtained genealogical network was found to have larger imbalance and reversibility than randomized networks. This means that the Congolese armed groups on average experienced more fission-fusion events until they died or reached the end of the observation period, and their members had more diverse and complex histories, than expected from the process in which every existing groups split and/or merge with the same probability.

A possible explanation is that the national army plays the pivotal role in the fission-fusion of armed groups in the DRC because it temporally integrates other armed groups to deflect the international pressure. This interpretation is consistent with the observation that the superficial conflict resolution by the government resulted in the repeated failure of army integration and continued insecurity in Eastern Congo and support the claim that the DRC government should address the political grievance of people in Eastern Congo and disarm the insurgent groups, instead of relying on cheap methods of army integration.

This study elucidates the feasibility and value of genealogical data of armed groups, which has significant implications for various fields including conflict studies, African studies, and network science. Possible improve-

ments of the data collection methods were also discussed with the extension of the data to cover a wide range of cases in mind.

Appendix A

Details of the fission-fusion data

In this appendix, the details of the fission-fusion data are explained. The data units that compose the same fission-fusion event are explained together. Several events are also explained together when they are related and it is better to explain them together.

Data 1

An armed group, Mai-Mai, emerged in response to the AFDL offensive. According to Ref. [72],

> In reaction to the AFDL offensive, youths mobilized in the Ruzizi Plain to stop the advance of what was perceived to be a foreign occupation force. They were supported by customary chiefs and former Mulelist combatants, who arranged for healers or seers to immunize them against bullets, using potions and rituals with water (mai) similar to those the Simba rebels had used. Thereafter these groups came to be known as Mai-Mai.

Though the year of establishment is not clearly mentioned, the AFDL offensive started in 1996, therefore the year of the event is coded as 1996 and the uncertainty is coded as 3.

Data 2, 3, 4, 5

Four insurgent groups (PRP, CNRD, ADP, and MRLZ) merged into a new insurgent group AFDL on 18 October 1996, aiming to topple the Mobutu regime was formed with the support of Rwanda. According to Ref. [47]:

> The AFDL was created on 18 October 1996 at Lemera in South Kivu at Lemera in South Kivu, nearly two months after the beginning of the offensive from Rwanda. It was a coalition of four

> groups: Kabila's own PRP, which was now reduced to a few exiles in Europe and America; the Conseil national de résistance pour la deémocratie (CNRD), a small Lumumbist guerrilla group established in 1993 in eastern Congo by Andre Kisasé Ngandu; the Alliance démocratique des peuples (ADP), a grouping of Congolese Tutsi led by Déogratis Bugera; and the Mouvement révolutionnaire pour la libération du Zaïre (MRLZ), and opposition group centred around the Bashi of South Kivu led by Anseleme Masasu Nindaga.

Data 6, 7

Two armed groups, ALIR/PALIR and ALIR-2, were formed by Rwandan refugees in 1997. The ALIR/PALIR was created by ex-FAR commanders in 1997. According to Ref. [56]:

> In 1997, an estimated 5,000 ex-FAR and Interahamwe rebels who had dispersed in North Kivu regrouped to create the Armée de Libération du Rwanda (Rwanda Liberation Army, ALIR) and its political branch, the Peuple en Action pour la Libération du Rwanda (People in Action for the Liberation of Rwanda, PALIR) (Omaar, 2008, pp. 40–41). Meanwhile, Rwandan Hutus who had fled to the western DRC, but also to Angola, the Central African Republic, the Republic of the Congo, and Sudan, formed ALIR-2.

Data 8

The AFDL defeated the army of the Mobutu regime and become the national army of the DRC, which we call AFDL/FAC. It was May 1997 when the AFDL ousted Mobutu, but when the AFDL became the national army is not clearly written in sources. Therefore, the uncertainty is coded as 3. It is natural to suppose the AFDL absorbed some other elements and there were some leadership changes. However, which elements it absorbed are also not clearly written in sources, therefore the event is coded as a change form AFDL to AFDL/FAC.

Data 9, 10, 11

A part of an armed group les Combattans Hutu defected to join the AFDL/FAC in 1997. According to Ref. [62],

> In May 1997, the First Congo War ended with the AFDL's arrival in Kinshasa. Laurent Kabila was declared the new president and Zaire became the Democratic Republic of the Congo. By September the same year, those involved in the continuing

> conflict in North Kivu were seeking a strategic shift. The Rwandan government began reaching out to co-opt Hutu leaders, some of whom responded positively, persuading thousands of combattants to join the AFDL. Among them was Robert Seninga, vice-president of the combattants.

The month of side-switching is not found in the text, therefore the uncertainty is coded as 2. The month is coded as September, the latest possible month that is consistent with the text.

Data 12

The armed group les Combattans Hutu changed into Mongol. According to Ref. [62],

> By early 1998, those who resisted the call to join the AFDL radicalized their resistance, basing themselves in southern Masisi under the command of Bigembe Turinkinko and Hassan Mugabo. This group called itself 'Mongol'–according to some, a derivation of the Kinyarwanda expression kumongore ('to choose a piece') and a reference to the militia's practice of taxing and looting in relative moderation.

Though in the radicalization of the group les Combattans Hutu to Mongol, some elements are expected to have joined or defected, they are not written in sources. Therefore, the event is coded as the change from les Combattans Hutu to Mongol. The year of change is not found in the text, therefore the uncertainty is coded as 3. The year is coded as 1998 because it should later than the side-switching of part of les Combattans Hutu to AFDL/FAC.

Data 13, 14, 15, 16

A group led by Eric Ruhorimbere, Venant Bisogo and Mukalay Mushondo defected from the national army but was forced to rejoin to the army soon after the mutiny. According to Ref. [66],

> Another persistent source of friction was the marginal status of the Banyamulenge within the newly formed Congolese armed forces. Confined to the lower ranks within the Rwandan army and serving under Rwandan superiors during the AFDL insurgency, they now aspired to more influential positions. Tensions came to a head in February 1998: following reports that the Chief of Staff of the Congolese armed forces, Rwandan Colonel James Kabarebe, had given orders to deploy Banyamulenge officers outside the Kivus, a number of troops mutinied in Bukavu. Led by Eric Ruhorimbere, Venant Bisogo and Mukalay Mushondo, the

> mutineers could only be persuaded to reintegrate through the personal intervention of Colonel Kabarebe.

The day of mutiny and the year of reintegration are not found in the text, therefore the uncertainty is coded as 1 and 3, respectively. The later is coded to be immediately after the former.

Data 17, 18, 19

A group led by Richard Tawimbi and Michel 'Makanika' Rukunda, defected from the national army but was captured soon after the mutiny. According to Ref. [66],

> The February 1998 mutiny was the first in a series of incidents. The following month, a group of around 30 Banyamulenge deserters attacked the Rwandan army in Bukavu, an incident allegedly motivated by the mistreatment of Banyamulenge soldiers. Many of these dissidents, who were led by Richard Tawimbi and Michel 'Makanika' Rukunda, were captured; some were sentenced to death.

The reintegration of the mutineers is not implied by the text and other sources, therefore the group was coded to be eliminated rather that forced to be integrated the army. The day of mutiny and the year of demise are not found in the text, therefore the uncertainty is coded as 1 and 3, respectively. Demise of the group is conjectured to be in the same month.

Data 20, 21

The RCD was formed on 16 August 1998 to launch a new rebellion to the Kabila regime. The RCD was formed by former members of the national army, which were deployed in Eastern Congo. Therefore, it is coded as the splintering of the AFDL/FAC. After the event, the national army is simply called the FAC. This event is mentioned in various sources: for example, "RCD-Goma announced its leadership on 16 August 1998" in Ref. [55]. Note that RCD-Goma is the name with which the current RCD was mentioned with later.

Data 22

An insurgent group MLC was formed in mid-November 1998. Ref. [51] says: "In mid-November, a new rebellion started in the northern Equateur province, which it largely occupied after defeating the FAC and their Chadian allies who suffered heavy losses."

Data 23, 24, 25, 26

A group led by Pacifique Masunzu defected the army and rejoined later. Ref. [66] says:

> In early 1999, the RPA commander of Uvira, Colonel Dan Gapfizi, ordered his arrest, but Masunzu was able to escape with the help of fellow Banyamulenge soldiers, fleeing to Bijombo in the Hauts Plateaux. In an effort to subdue this mutiny, the RCD reintegrated Masunzu back into its ranks, leaving him in the highlands as a deputy battalion commander.

The month of mutiny and the year of reintegration are not found in the text, therefore the uncertainty is coded as 2 and 3, respectively. The later is conjectured to be in the same month with the former.

Data 27, 28

A group led by Wamba dia Wamba, a leader of the RCD at the time, defected from the group to form a splinter group RCD-K/ML in May 1999. The mainstream faction of the RCD was called RCD-Goma (RCD-G) after the splintering. This event is explained by many sources: for example, Ref. [51] explains the behavior of Wamba dia Wamba as, "in March 1999, he set up headquarters in Kisangani."

Data 29

ALIR-2 changed to ALIR-2/FDLR in 2000. Ref. [56] says "Its political branch–the FDLR–was created in 2000 out of the Kinshasa-based Comité de Coordination de la Résistance (Coordination Committee for Resistance)." Though the group integrated another organization and the leadership changed, the Coordination Committee for Resistance is not pointed out to be an armed groups in sources, the event is coded as the change of ALIR-2 to ALIR-2/FDLR.

Data 30, 31

A group led by Roger Lumbala defected from the RCD-K/ML to form RCD-National (RCD-N) in January 2000. Lumbala was sent by Wamba, the leader of RCD-K/ML to regain control of Bafwasende in January 2000, where he created his own movement [50].

Data 32, 33, 34, 35

A group of Hema commanders defected form the RCD-K/ML to form the CMF in 2000. The group finally surrendered to be absorbed into the MLC's armed wing. Ref [63] says,

> In July, Hema APC commanders launched a mutiny in protest against what they perceived as a pro-Lendu stance by Wamba, calling themselves the Chui ('Leopard') Mobile Force (CMF). [...]. Accompanied by a group of high-ranking Ugandan officials, the delegation travelled back to Bunia to negotiate the CMF's peaceful surrender; in return, the Ugandans agreed to provide military training to the mutineers. [...]. Following their training in Kyankwanzi (for new recruits) and Jinja (for officers), most of them had been sent to Equateur Province to join the MLC's armed wing. After some months of fighting for Bemba, the soldiers had grown increasingly frustrated. They knew that fellow Hema were still dying in Ituri's inter-ethnic clashes, and they felt that the MLC used them 'like dogs'.

The day of splintering and the year of integration are not found in the text, therefore the uncertainty is coded as 1 and 3 respectively. The later event is conjectured to be before the UPC's creation (Data 36, 37) because otherwise it seems natural for them to join the UPC rather than the MLC, therefore it is coded to be in August in 2000.

Data 36, 37

A group led by Thomas Lubanga defected form the RCD-K/ML on 15 September 2000 to form the UPC. Ref. [63] describe the role of Lubanga is the creation of the UPC as, "he assembled a group of educated Iturians, many but not all of whom were Hema. On 15 September 2000, they created the UPC and named Lubanga as president."

Data 38 to 43

The MLC, RCD-K/ML, and RCD-N formed the FLC in January 2001 but splintered into the original groups in the same year. Ref. [63] says about it formation,

> Exasperated by the constant infighting in Ituri—for which its own army was largely responsible—the Ugandan government invited all three of the Congolese rebel groups that it supported to talks in Kampala at the end of 2000: Jean-Pierre Bemba's MLC, the RCD-K/ML, and Roger Lumbala's RCD-National (RCD-N). The result of these deliberations was the merger of all three groups under the banner of the short-lived Front de libération du Congo (FLC, Front for the Liberation of Congo) in January 2001.

and about its splintering,

> The FLC was only a brief interlude in what was becoming an increasingly factionalized conflict. In June 2001, troops loyal to Mbusa, who was scheming from afar, launched an attack against Bemba in Beni, forcing him to flee.

Data 44, 45, 46

A group of former CMF members defected form the MLC in 2001 to join Lubanga's UPC. In Ref. [63]:

> The mutiny marked the return to prominence of the commanders who had been behind the earlier CMF mutiny. Following their training in Kyankwanzi (for new recruits) and Jinja (for officers), most of them had been sent to Equateur Province to join the MLC's armed wing. After some months of fighting for Bemba, the soldiers had grown increasingly frustrated. They knew that fellow Hema were still dying in Ituri's inter-ethnic clashes, and they felt that the MLC used them 'like dogs'. When the FLC fell apart in north-eastern Congo, these soldiers—led by Floribert Kisembo—rebelled in Equateur, demanding to be sent back to Ituri. Bemba gave in and let them return to Bunia, where they rallied to Lubanga's side.

Data 47, 48

Masunzu defected from the RCD-Goma in January 2001. Ref. [66] explains his defection as,

> In January 2002, a clash between him and his superior ensued. Various reasons have been given for this standoff: a conflict related to the management of tax revenues; a power struggle between Masunzu and his superior, Safari; the RCD using Safari to get rid of Masunzu; and even a drunken dispute over a girl. Whatever the cause, the result was that Masunzu took to the hills again, with around 20 followers.

Data 49

Masunzu integrated his group with a political group FRF to for FRF/FRC, with the FRC the military wing of the FRF in April 2002. Since the FRF was not an armed group, this event is coded as a change of Masunzu group into FRF/FRC. In Ref. [66], the event is described as,

> In April 2002, along with FRF leaders, he transformed the FRF into a politico-military movement, with a military branch called Forces congolaises de résistance (FRC, Congolese Resistance Forces), which gained popularity among the population of the Plateaux.

Data 50, 51

A group led by Kin-Kiey Mulumba defected from the RCD-G to form RCD-Congo (RCD-C) in 26 July 2002 . Ref. [84] says,

> Mulumba and Babadi split away from RCD-Goma after its failure to join the Kinshasa government, the Ugandan-backed Mouvement de liberation du Congo armed opposition group, and a majority of political opposition parties and civil society organisations, which signed the Sun City accord in South Africa at the conclusion of the inter-Congolese dialogue in April.

Data 52

The FNI was created in November 2002. It was a Lendu militia group in Ituri. Ref. [66] says,

> Despite disagreements with Lendu elders, who were opposed to foreign influence, the Ndjabu group decided to move forward, informally creating the FNI in late November.

Data 53, 54

A group led by Yves Kahwa defected form the UPC to form the PUSIC in December 2002. The PUSIC is a Heme militia group in Ituri. Ref. [66]:

> Divisions within the UPC emerged in late 2002. In early December, deputy Minister of Defence Chief Kahwa fled to Kampala. He had become disillusioned by the fact that the Rwandans, while supporting the UPC, were indirectly cooperating with Lendu groups by supporting the PRA in Kpandroma. Former UPC members also suggest that Kahwa thought he deserved a more important position within the movement, given that he had secured Rwandan backing and that the UPC's main power base, Mandro, was in his chieftaincy.

Data 55, 56

Two Iturian ethnic militia groups, FRPI and FPDC, were formed in late 2002. According to Ref [65], the former "emerged out of several smaller Lendu militias and were formally established in late 2002." The later was "launched by Alur and Lugbara from Aru and Mahagi in late 2002" according to Ref. [63].

Data 57, 58

Two Rwandan armed groups, ALIR-2/FDLR and ALIR-2/FDLR, merged into FDLR/FOCA in 2003. Ref. [56] says, "ALIR and ALIR-2 combatants only joined their military forces in 2003 in South Kivu, thereby creating the FDLR's armed wing, the FOCA, a force comprising more than 10,000 men at that time."

Data 59 to 64

In 2013, the Second War formally ended. Then, the former warring parties, RCD-Goma, RCD-K/ML, RCD-N, MLC, Mai-Mai, and FAC merged to form the new national army. In Ref [65]: "The FARDC was created in 2003 by a merger of the belligerents of the Second Congo War."

Data 65 to 72

Four armed groups in Ituri, PUSIC, FNI, FRPI, and FPDC, formed the FIPI in February 2003, but it soon broke into the original groups. Ref. [63] describes its formation as

> In late 2002 and early 2003, the Ugandans organized negotiations among all of Ituri's armed groups. When the UPC refused to sign any agreement with Lendu groups, Uganda helped create the Front pour l'integration et la paix en Ituri (FIPI, Front for Integration and Peace in Ituri), an alliance that brought together Kahwa's PUSIC, the Lendu-dominated Front des nationalistes intégrationnistes (FNI, Front of Integrationist Nationalists) and Force de résistance patriotique en Ituri (FRPI, Ituri Patriotic Resistance Force) as well as the Force populaire pour la démocratie du Congo (FPDC, Popular Force for Democracy in the Congo), which was launched by Alur and Lugbara from Aru and Mahagi in late 2002.

and its splintering as

> The FIPI had effectively ceased to exist shortly after its creation, not least due to the Lendu attack on Bogoro on 24 February 2003, for which FRPI leader Germain Katanga is currently still on trial at the ICC.

Data 73, 74

A group led by Jérome Kakwavu defected form the UPC to form the FAPC on 4 March 2003. In Ref. [63]: "On 4 March, Uganda convinced—or perhaps forced—Kakwavu to break away from the UPC and create his own armed group, the FAPC, in Aru and Mahagi."

Data 75, 76

A group led by Laurent Nkunda defected from the national army in September 2003. He was a former member of the RCD-Goma. In Ref. [60]: "In September 2003, General Laurent Nkunda and two fellow senior officers refused to join the newly integrated national army, citing both personal and community-wide security concerns and a general mistrust of Kinshasa."

Data 77

A group led by Paul Rwarakabije, the former leader of the group, defected from the FDLR/FOCA to return to Rwanda. While this is a clear change of the leadership structure, no source suggests that Paul Rwarakabije led an armed group after he return to Rwanda. Therefore, the event is coded as a change of a FDLR/FOCA to another FDLR/FOCA, which have the same name but different leaders. In Ref. [86]: "The previous leader, Paul Rwarakabije, fell out with the head of the western faction, Sylvestre Mudacumura, and accepted an offer from the Rwandan government to return."

Data 78, 79

Because of a leadership dispute, the UPC split into two factions, UPC-Lubanga (UPC-L) and UPC-Kisembo (UPC-K) in December 2003. In Ref. [63]: "Lubanga' own army chief of staff, Floribert Kisembo, staged a coup in December 2003, splitting the group into two factions: UPC-Lubanga (UPC-L) and UPC-Kisembo (UPC-K)."

Data 80, 81

A savage criminalized element of the FDLR, called Rastas, splintered [56]. When it occurred is not clearly mentioned in sources, therefore the uncertainty is coded as 3. The group members committed in abduction on 22 December 2003 [82], therefore the day is coded as the day of splintering as a rough guide, though the exact time of the splintering must be earlier.

Data 82, 83

The RUD-Urunana/AN-Imboneza splintered form the FDLR/FOCA in 2004. In Ref. [86]:

> The political wing—which at the time was largely based in Europe—split as the Vice President Jean-Marie Vianney Higiro and Treasurer Félicien Kanyamibwa defected to found the Ralliement pour l'Unité et la Démocratie–Urunana (RUD-Urunana).21 The organisation's military wing followed suit as officers split off from

> FOCA to create the Armée Nationale-Imboneza (AN-Imboneza), the RUD's armed wing.

and in Ref. [74]:

> The group, which officially split from FDLR-FOCA in 2004 and which comprises a few hundred elements, is politically headed by Jean-Marie Vianney Higiro and Felicien Kanyamibwa, and the military commander Jean Damascene Ndibabaje (nicknamed Musare).

Data 84, 85

A group led by Peter 'Karim' Udaga defected form the FNI to form his own group, which was called the FNI-Karim, in 2004 [63, 65]. Ref. [65] describe Karim's setting up of the group as:

> After the first phase of the DCR programme was launched in September 2004, the dynamics of violence further shifted from an inter-ethnic conflict to one pitting MONUC and the renamed Forces armées de la République démocratique du Congo (FARDC, Armed Forces of the Democratic Republic of the Congo) against groups resisting disarmament. [...]. When the DCR programme began, he retreated to the Dhera forest near Kpandroma, setting up a new militia and soon gaining notoriety for banditry and harassment of civilians.

Data 86, 87

A Banyamulenge group led by Michel Rukunda defected form the national army in South Kivu [66]. The reason of defection is equivocal, as in Ref. [66], "Rukunda's defection is also the subject of speculation: some attribute it to his clan affiliation with Mutebutsi, while others say it was because he was chafing under the command of Colonel Mutupeke. However, it seems clear that Rukunda's poor relations with Masunzu were a factor, as well." When he defected is not specified by sources, therefore the uncertainty is coded as 3. The year of defection is conjectured to be 2004 because Masunzu demote Rukunda in 2004 and this betrayal of Masunzu is, as explained the above quotation, one of the reasons of the defection.

Data 88, 89

A group led by senior Munyamulenge commander Jules Mutebutsi defected from the national army to form his own group in May 2004. In Ref. [66]: "Fearing the erosion of the RCD's power in the transitional government, Mutebutsi rebelled against his commanding officer in May 2004."

Data 90, 91, 92

The UPC-K was integrated into the national army when its leader Floribert Kisembo was appointed a general in the FARDC in 11 December 2004 [49] Though another source [63] says that his appointment was in early 2005, with a slight difference from the indication of Ref. [49], I adopted the information in Ref. [49] because the reliability of the two sources seems similar and Ref. [49] indicates more precise time of the event.

Data 93, 94

A splinter faction, Commandement Militaire pour le Changement (FDLR-CMC), was formed in 2005 by dissident officers of the FDLR/FOCA [56].

Data 95

The group led by Mutebutsi changed to a group called, Group of 47. Mutebutsi group went to Rwanda after it mutinied in May 2004 (Data 88, 89) and spent a year in Rwanda before coming back to the DRC in 2005. Some change of leadership structure is implied by the fact that Mutebutsi did not participated in the Group of 47. In Ref. [63]:

> Mutebutsi's group, meanwhile, was planning its next move. After the Bukavu mutiny, it had been confined to a military camp in Rwanda in dreary conditions. Finally, after spending over a year there, a group of 46 of these officers and one civilian—the RCD politician Dada Abbas—infiltrated themselves into the DRC across the Rusizi river and climbed into the Moyens Plateaux. They were led by Colonel Venant Bisogo, not Mutebutsi: the latter was reported to have clashed with his Rwandan hosts and to have been detained in Rwanda, where he remains. [...]. As an indication of the complexity of internal Banyamulenge politics, the return of the Group of 47, who established themselves as an insurgent group on the Plateaux under Colonel Bisogo, would ultimately spark the worst internal fighting the community had ever seen.

Data 96 to 100

A new group MRC was formed in Ituri in June 2005 by UPC-L, PUSIC, and FNI, and a part of FRPI. In Ref. [65]:

> In March 2005, Ngudjolo was released from prison in Kinshasa and went back to north-eastern Congo. Together with former RCD-K/ML commander Frank Kakolele Bwambale (a Nande) and UPC president Lubanga's former chief of staff Dieudonnré

> Mbuna (a Hema), Ngudjolo then began to rally those FNI, FRPI, PUSIC, and UPC elements that continued their struggle against a common enemy, the FARDC and MONUC. The Mouvement révolutionnaire congolais (MRC, Congolese Revolutionary Movement) was officially created in Jinja (Uganda) in June 2005. Ngudjolo became the MRC president and military commander, whereas Mbuna was named secretary-general, in charge of representing the movement on the political stage.

Though a former leader of RCD-K/ML, Frank Kakolele Bwambale, join the movement, the RCD-K/ML had already ceased to exist after its integration into the FARDC, and no sources suggested that Kakolele lead any armed group when the MRC was founded, the MRC was coded as a coalition of UPC-L, PUSIC, FNI, and a part of FRPI. It was not the entire FRPI that joined the MRC, and the main faction of the FRPI kept its independence under the leadership of Cobra Matata. In Ref. [65]: "After Katanga ' s departure in January, Cobra had become the main leader of the Ngiti militias in Irumu; it was he rather than Sambidhu who effectively controlled the FRPI from 2005 to 2007."

Data 101

A local armed group, Raia Mutomboki, emerged in Shabunda in 2005. It was created and led by Jean Musumbu, a local witchdoctor. We call it Raia Mutomboki-Musumbu, to distinguish other groups that emerged later and call themselves Raia-Mutomboki. The month of emergence is not found in sources but coded as June (with the uncertainty 2), because the event that is said to have triggered its emergence occurred in June, which is described in Ref. [64]:

> The events that led to the first small group using the name Raia Mutomboki now form part of the militia's folklore. On 29 March 2005, a group of local traders was on its way to sell food to gold miners in Kyoka, a jungle village in the far south of Shabunda territory. The group was ambushed by FDLR soldiers; four traders escaped and alerted a nearby Congolese army patrol. When together they finally tracked down the kidnapped party, they discovered that all their 12 colleagues, including two women and four children, had been killed with machetes.

Data 102, 103

The military wing of FRF/FRC, the FRC, was integrated into the FARDC, when its leader Masunzu was "sworn in as a general in July 2005" [64]. While the political wing, FRF, remained to be independent from the government,

based in Bujumbra, no source indicates that the FRF had the military wing before its integration with the FDP (Data 118). Therefore, the event is coded as the integration of the FRF/FRC into the FARDC, rather than side-switching of the FRF from the FRF/FRC into the FARDC.

Data 104

An armed group, which we call Alexandre/Kyatend group, emerged in southern Shabunda in 2006. The group was led by Mwami Alexandre and Kyatend Dittman. According to Ref. [64], the former "had been a Mai-Mai commander under General Padiri during the war against the RCD" and the later was "a Rega musician who had been in Germany since the 1980s, returning to the Congo in 2003 to try his hand at local politics." Though, Alexandre was a former Mai-Mai commander, Mai-Mai was integrated into the FARDC when the Second War ended and it is reasonable to conjecture that he was demobilized after the integration and returned to civilian or political life, because no sources indicates that he led an armed groups before he created the Alexandre/Kyatend group. Therefore, the event is coded as emergence of a new group, rather than a change of a Mai-Mai splinter faction into the Alexandre/Kyatend group.

Data 105, 106

A group led by Sangano Musohoke (alias Soki) defected from the RUD-Urunana/AN-Imboneza in 2006. We call this group FDLR-Soki. In Ref. [86]:

> Two years after RUD's split from the FDLR [in 2004], commander Sangano Musohoke (alias Soki) defected with a small number of troops, founding the FDLR-Soki based in northern Rutshuru territory of North Kivu. While this group no longer collaborates with the FDLR, the two have a non-aggression pact.

Data 107 to 112

Two groups led by David Rugayi and Smith Gihanga side-switched from the Nknuda group to the FARDC, respectively. In Ref. [62]:

> In February 2006, the 83rd brigade commander, Major David Rugayi, led over 1,400 soldiers out of the CNDP and into army integration. Several months later, the 81st brigade commander, Colonel Smith Gihanga, also a Hutu, followed suit.

The month in which the group led by Smith Gihanga side-switched is not specified by the text. Therefore, the uncertainty is coded as 2 and the month is conjectured to be April because it is several months later than February.

Data 113

On 26 July 2006, the Nkunda group, another name of which was CMDP, changed to the CNDP, when Nkunda integrated his armed group with an political organization Synergie. In Ref. [60]:

> During this crucial phase, Nkunda merged his political operation, Synergie, with his military identity, the CMDP The result was the CNDP—formally born on 26 July 2006, with Nkunda as both Chairman and Supreme Commander.

Data 114, 115

The intensive fighting that erupted on 24 November 2006 between the CNDP and the FARDC led to the temporal integration of the CNDP into the FARDC in December 2006, which gave the CNDP money and weapons. In Ref. [62]:

> These early, tentative steps to counterbalance Nkunda were accelerated in December 2006, when the first major fighting between the CNDP and the national army took place. In order to defuse the crisis, the Congolese government struck the first of several peace deals with the CNDP, resulting in mixage, the on-site integration of the CNDP into the national army. This agreement gave CNDP commanders prominent positions in the Congolese army, raising Nkunda's stature and influence.

Data 116, 117, 118

The Rkunda group and Bisogo's Group of 47 merged into an armed group, which we call Rkunda/Bisogo group. Then the armed group merged with the FRF to form the FRF/FDP, with the FDP its armed wing. The FRF was a political organization, therefore the event was coded as the change of the Rkunda/Bisogo group into the FRF/FDP, rather than integration of two armed groups. In Ref [66]:

> In January 2007, Masunzu's troops clashed with Rukunda's Muramvya faction, killing nine senior officers. This attack brought about the merger of Rukunda's faction and Bisogo's Group of 47, who realized they were too weak to survive separately. This unification appears initially to have been more driven by strategic considerations rather than by a shared political vision: Rukunda, for example, is fiercely opposed to Rwanda, while Bisogo maintained contacts with top commanders in Kigali throughout this period. The FRF leadership, then based in Bujumbura with Gasore Zébédée at its helm, used this opportunity to approach

> the dissidents in view of gaining military leverage for their political goals. Eventually they came to a preliminary agreement to reconstitute the FRF as a politico-military movement; its armed wing was now called the Force pour la défense du peuple (FDP, Force for the Defense of the People). Rukunda became its chief of staff, while Bisogo was made president of the FRF.

When the two events occurred is not specified by the text, therefore the uncertainty of both events was coded as 3. Both are conjectured to have occurred in January 2007 because they were after the clash between Masunzu's and Rukunda's factions in the month.

Data 119, 120

A group led by William Amuri Yakutumba defected from the FARDC to form Mai-Mai Yakutumba on 23 January in South Kivu. The group was also called Mai-Mai Réformé. It was composed of the former members of Mai-Mai who had been integrated into the FARDC after the end of the Second War. In Ref. [67]:

> A key figure in this resistance was Captain William Amuri Yakutumba, a battalion commander in the 118th Brigade, one of Dunia's ex-Mai-Mai units, deployed in Baraka. [...]. On 23 January, Yakutumba and 34 other founding members created the Mai-Mai Réformé (Reformed Mai-Mai), a name that was chosen to distinguish themselves from previous Mai-Mai groups.

Data 121, 122

A group of former Mai-Mai militias who had been integrated into the FARDC defected from the national army to form the PARECO in North Kivu. It was "a coalition of [former] Mai-Mai militias established on 3 March 2007" [55].

Data 123, 124

The CNDP, which was once integrated into the FARDC in the process of "mixage", finally defected from the national army again in August 2007. "In August 2007, the mixage process collapsed, owing to mistrust between CNDP and FARDC, and PARECO engaged for the first time in large-scale military operations. [62]" "As mixage collapsed, fighting broke out as Nkunda's units separated from the army to defend strategic positions. [60]"

Data 125 to 129

Three armed groups in Ituri (FNI-Karim, FRPI, MRC) were integrated into the FARDC in November 2007, though part of the FRPI continued its rebellion. In Ref. [63]:

> Negotiations about the specifics of their integration into the FARDC continued for another year, but in November 2007 their three main leaders—Peter 'Karim' Udaga, Cobra Matata, and Mathieu Ngudjolo (all Lendu)—finally boarded a plane at Bunia airport that took them to Kinshasa.

Data 130, 131

A group led by Janvier Karairi Bwingo defected from the PARECO to form another armed group in April 2008. The group was later called APCLS. In Ref. [62]:

> Around the same time, the Hunde wing of PARECO split off under the leadership of Colonel Janvier Karairi Bwingo. A former Mai-Mai, Bwingo did not feel bound by the Actes d'engagements, which had been signed only by Hutu and Nande representatives. By May 2008, his splinter group had become known as the Alliance patriotique pour un Congo libre et souverain (APCLS, Patriotic Alliance for a Free and Sovereign Congo), although he continued to profess his support for PARECO.

Data 132, 133

A part led by Jean-Claude Baraka defected form the FRPI to form the FPJC in September 2008 [75]. Though remnants of other groups are also implied to have joined the group, their inclusion in the leadership of the FPDJ is not pointed out in the sources. Therefore other groups other than the FRPI were excluded from the participants of the events. In Ref. [63]:

> The main Hema commander who chose not to integrate into the FARDC was Jean-Claude Baraka. In 2008, he reappeared as one of the leaders of the Front Populaire pour la Justice au Congo (FPJC, Popular Front for Justice in the Congo), a group that included FNI, FRPI, PUSIC, and UPC remnants.

Data 134

A new armed group FPLC emerged in North Kivu. It was a small multi-ethnic group based in Rutshuru and hostile to the Rwandan government. In Ref. [77]:

> According to a former FPLC source, this armed group was first established in November 2008 in response to CNDP attacks at Kiwanja.

Data 135

A new armed group NDC/Mai-Mai Sheka emerged in North Kivu. In Ref. [85]:

> Formed in 2009 by long-time minerals businessman Ntabo Ntaberi Sheka in North Kivu's Walikale Territory, Maï Maï Sheka has 150-180 men, mainly army deserters and youths, according to the Enough Project.

Data 136 to 139

Three armed groups (PARECO, CNDP, Mai-Mai Yakutumba) were integrated into the FARDC. In Ref. [60]:

> The agreement was formalized on 23 March 2009 with the formal signatures by the Kinshasa government of two separate agreements: one with the CNDP, the other with separate armed groups.

Data 140, 141

The Mai-Mai Yakutumba, which was once integrated into the FARDC, defected form the national army again. The month of defection is not found in the text, therefore the uncertainty was coded as 2 and the month was conjectured to be May because the event was in mid-2009. In Ref. [67]:

> Integration eventually failed, as the logic of the CNDP integration further eroded whatever little trust Yakutumba had in the central government. In mid-2009, the government embarked on a new offensive against the FDLR, Kimia II. [...]. The Yakutumba group declared the arrival of these troops to be a provocation and threatened to restart hostilities, withdrawing all its troops to the gold-mining area of Misisi, close to Lubondja, Yakutumba's village of birth.

Data 142, 143

A group led by Gaston Mugasa (alias Mandevu) defected from the FDLR/FOCA in 2010. We call the group FDLR-Mandevu. In Ref. [86]: "The last faction to split from the FDLR was that of Lieutenant-Colonel Gaston Mugasa (alias Mandevu), in 2010."

Data 144

The Alexandre/Kyatend group came to an end in 2010. The month of demise is not specified by the text, therefore the uncertainty was coded as

2 and the month was conjectured to be June because the leaders were in prison since June. In Ref. [64]:

> Kyatend's militia came to an end when the Congolese army arrested Muligi V in 2010. When he called on young people in his chefferie to turn in their weapons, just 12 were handed over to the FARDC, an indication of how small the group was. The local population then captured Kyatend and handed him over to the government. Both Kyatend and Alexandre have been in prison since June 2010.

Data 145

The Mai-Mai Yakutumba changed to the PARC/FAAL in 2010. Yakutumba created a political organization, PARC, with Looba Undji. They integrated the PARC and Mai-Mai Yakutumba into the PARC/FAAL, with the FAAL its military wing. In Ref. [67]:

> This training was not only military: Yakutumba and Looba Undji also insisted that ideology, including religion and national history, be taught. This new emphasis on religion was reflected in the addition of the word 'Allelujah' to the name of the group at the end of 2010, eventually leading to a formal re-baptizing of the armed wing as Forces armées alléluia (FAAL, Allelujah Armed Forces). At the start of 2011, the movement became known as PARC-FAAL, reflecting the increasing importance of the political wing.

Data 146

An armed group led by Eyadema Mugugu emerged in South Kivu in response to the FDLR attacks to the civilians in the region. We call the group Raia Mutomboki-Eyadema/Kikuni to distinguish other Raia Mutomboki groups. In Ref. [64]:

> In early 2011, the local population responded. According to one version of events, Eyadema Mugugu, a young mineral trader from Nduma who had been one of Musumbu's leading followers, travelled to southern Shabunda to get advice and the magical dawa from his former leader. Alternative accounts suggest that Eyadema obtained his first batch of dawa from the Mai-Mai of Amuli Yakutumba in Fizi territory. Networks of demobilized combatants and artisanal miners seem to have been particularly important in Eyadema's mobilization but, initially at least, the main motivation was self-defence.

Data 147, 148

A group led by several Rega officers defected form the FARDC in 2011 to form a new Raia Mutomboki group, which we call Raia Mutomboki-Sisawa/Meshe/Ngandu. In Ref. [64]:

> The third group that appeared in Shabunda was the most opportunistic and internally fragmented. It was launched initially by Rega Congolese army officers who were upset by their treatment. The defectors mostly came from the 11th integrated brigade, which had an entire battalion made up of officers without jobs, the so-called battalion cadre, created by the Congolese army to regroup officers who did not have the connections, education, or physical fitness needed to obtain more lucrative deployments.

Data 149, 150

The FRF/FRC, which was sometime called simply FRF, was integrated into the FARDC on 26 January 2011, when the integration ceremony was held in Minembwe, South Kivu. In Ref. [66]:

> Negotiations started on 18 January 2011 in Kamombo, on the Plateaux. The FRF succeeded in obtaining a deal that allowed for the in situ integration of FRF into the Congolese army, along with the creation of a new operational sector on the Hauts Plateaux under FRF command. In addition, the government promised to recognize FRF ranks and their political party, the appointment of FRF officers in high-ranking positions, and to give them $20,000 in cash. [...]. When the FRF arrived in Minembwe on 26 January for an integration ceremony, they could muster just 348 fighters, claiming that others had been left behind.

Data 151, 152, 153

A group led by Richard Tawimbi defected from the FARDC in March 2011 to form his own group, which we call Tawimbi group. The group changed to the MPCC on 26 July in 2011.

In Ref. [66]:

> With the FRF integrated, and with several Banyamulenge officers in influential and lucrative positions, the insurgent networks in the community have been largely dismantled. However, two small new groups have emerged since 2011, one led by Richard Tawimbi, the other, allied to the M23 rebellion, by Muhima Nkingi. [...]. The now ex-FRF managed to bribe him out of

> jail, but once back in the Kivus in March 2011, he was reluctant to join a Congolese army dominated by the ex-CNDP, for fear of being arrested or killed due to his anti-Rwandan track record. [...]. While the bulk of the FRF integrated in 2011, Tawimbi split off and founded his own group, the Mouvement populaire pour le changement du Congo (MPCC, Popular Movement for Changing the Congo), on 26 July 2011.

Data 154 to 157

Two groups, called Nyatura and PARECO-Fort, defected from the FARDC in 2011. They were composed of former members of the PARECO, which had been integrated in the national army. In Ref. [62]:

> In August 2011, reports emerged of a group of several hundred armed youths mobilizing in the Kalehe high plateau, around the town of Lumbishi. Like many other, unrelated Hutu groups, they called themselves Nyatura. [...]. The second major splinter faction, PARECO-Fort, is based around Lukopfu in the central Masisi highlands. [...]. Its leader is Lieutenant Colonel Marcel Habarugira Rangira, a former PARECO commander who was deployed to Walikale after integrating into the army. In October 2011, he deserted from his FARDC unit during the regimentation process: a deputy brigade commander, he was expecting to be promoted to battalion commander.

Data 158, 159, 160

A group, called CONSUP, defected form the FARDC in December 2011 but was dismantled by the Congolese intelligence services in January 2012. In Ref. [80]:

> The Conseil supérieur de la paix (CONSUP) was created in December 2011 following the elections in order to foment unrest among disgruntled populations who questioned the credibility of the November vote (see S/2012/348, para. 128).

In Ref. [66]:

> The Gasore camp was supported by Colonel Bisogo. This faction—said to be close to Rwanda and Colonel Sultani Makenga, deputy commander of the Amani Leo operations in South Kivu before his desertion in March 2012—is suspected to have participated in a nebulous movement called Conseil supérieur de la paix (CONSUP, Superior Council for Peace) in late 2011, which was plotting an insurrection before being dismantled by Congolese intelligence services in January 2012.

Data 161

A new group led by Butu Luanda emerged in North Kivu, which was called FDC. In Ref. [79]:

> FDC is a Congolese armed group which emerged in early 2012 as an important force along the border of western Masisi and eastern Walikale. Originally created as a local defence organization against FDLR and supporters of FARDC operations, FDC was officially established under the overall command of "Gen." Butu Luanda, a self-declared ex-CNDP officer. FDC took part in several critical operations against the senior FDLR leadership in the areas surrounding Ntoto and Kimua in January and February 2012.

Data 162, 163

A group led by Albert Kahasha and Sikuli Lafontaine defected from the FARDC to form the UPCP on 24 January 2012. In Ref. [60]:

> Union des patriotes Congolais pour la paix (UPCP, Union of Congolese Patriots for Peace): This new group is led by Colonel Albert Kahasha (aka 'Foka Mike') and self-styled General Sikuli Lafontaine. [...]. UPCP has positions in southern Lubero and in Rutshuru territory.

In Ref. [79]:

> On 24 January 2012, Col. Albert Kahasha, Commander of the 808th regiment deployed in Oicha, north-east of Beni, deserted from FARDC with an estimated 30 men.[...]. According to Congolese intelligence sources, in reality Col. Kahasha had aligned with PARECO Gen. Kakule Sikuli Lafontaine in Lubero territory in North Kivu, forming the Union des patriotes congolais pour la paix (UPCP).

Data 164

A group of the FDLR defected the group to turn themselves over at a MONUSCO base in North Kivu in 2012. This event is not coded as splintering but as a change of the FDLR/FOCA because the defected group did not continue to be an armed group but surrendered. In Ref. [86]:

> At the same time, Rwandan authorities organized assassinations of senior FDLR leaders, using two companies of Special Forces that Kinshasa had allowed to be based clandestinely in Rutshuru

> territory. This surge in assassinations and attacks led to a haemorrhaging of top officers. Following FDLR Chief of Staff General Mugaragu's assassination in January 2012, for example, approximately 200 combatants defected, along with their dependents and other refugees.

Data 165, 166

A group of former CNDP officers who had been integrated into the FARDC defected the national army in March 2012, to launch a new rebellion in North and South Kivu. We call this group ex-CNDP. In Ref. [60]:

> Lubanga's conviction triggered mobilization in earnest. After a succession of statements demanding the full implementation of the 23 March 2009 peace deal and denouncing anti-Tutsi discrimination within the army, ex-CNDP officers held secret meetings in Goma and Gisenyi in mid-March. Then the defections started, simultaneously in North and South Kivu.

Data 167, 168, 169

A group led by Déo Chirimwami defected from the FARDC on 16 March 2012 to join the UPCP, which was led by Albert Kahasha. In Ref. [79]: "On 16 March, Lt Col. Déo Chirimwami defected from the 809th regiment based near Kanyabayonga and joined Col. Kahasha."

Data 170, 171

The Ex-CNDP was integrated into the FARDC in March 2012. The mutiny the group had launched failed and the group was forced to be reintegrated. In Ref. [60]:

> Within several days, most ex-CNDP troops had re-defected back to the army. 'The soldiers were tired of seeing their commanders get rich and not give them anything,' said one ex-CNDP officer. 'Why risk your lives for commanders you don't believe in?' Another commented, 'officers told Ntaganda: "We can do this, we are prepared." But they weren't.'

Data 172, 173, 174

A faction of the FDLR/FOCA defected from the group to join the Nyatura in April or May 2012. The month of the side-switching was conjectured to be April and the uncertainty was coded as 2. In Ref. [64]: "When the FDLR high command took the decision in April and May 2012 to vacate its strongholds in southern Masisi due to the Raia Mutomboki attacks, some FDLR troops integrated into Nyatura groups."

Data 175

A new group led by Bede Rusagara, which we call MCC/RCR, emerged in Rusizi Plain in South Kivu. When it emerged was not specified by the sources, therefore the uncertainty was coded as 3. It is conjectured to be April 2012, when the leader Bede Rusagara was released from prison. In Ref. [60], the group is called RCR:

> Rassemblement Congolais pour le renouveau (RCR, Congolese Rally for Renewal): This group of several dozen fighters is led by self-styled Colonel Bede Rusagara, a member of the Fuliro community based in the hills above the Ruzizi plain in South Kivu. A former member of the CNDP, Rusagara was arrested by FARDC in early 2012 and, with the help of Makenga, released in April at the beginning of the mutiny. Rusagara has since put together a ramshackle coalition of soldiers from the Banyamulenge, Fuliro and even Burundian communities.

In Ref. [66], the group is called MCC: "the Mouvement congolais pour le changement (MCC, Congolese Movement for Change), a multi-ethnic group based in the hills overlooking the Rusizi Plain, led by self-proclaimed Colonel Bede Rusagara, an ex-CNDP officer from the Fuliro community."

Data 176, 177

A group of former member of Heme militias who had been integrated into the FARDC defected to form a new armed group COGAI in Ituri in May 2012. In Ref. [63]:

> In May 2012, other former UPC combatants re-emerged as members of the Coalition des groupes armés de l'Ituri (COGAI, Coalition of Ituri's Armed Groups), an attempt to unite several smaller militias with the mostly Ngiti FRPI of Cobra Matata, who had defected from the army and returned to Ituri in mid-2010.

In Ref. [65]:

> In the meantime, in May 2012, a group of former PUSIC and UPC combatants, mostly Hema, asked Cobra to become the head of a new rebel alliance, the Coalition des groupes armés de l'Ituri (COGAI, Coalition of Ituri's Armed Groups), which united several smaller militias that had sprung up in Djugu and Irumu territories in the wake of the M23 rebellion in North Kivu. According to a COGAI representative, the idea of the coalition was born when the combatants heard that Cobra had been asked to form an alliance with the M23, fearing that he might then grow powerful enough to attack their villages.

Data 178, 179

The FDC split in May 2012 into two factions, which we call the FDC and the FDC-Luanda, with the latter under Luanda Butu. In Ref. [79]:

> According to ex-combatants, Gen. Ntaganda's insistence on attacking FARDC, following the start of the ex-CNDP mutiny, and the theft of FDC salaries by "Gen." Luanda led to divisions within the group in early May 2012.

In Ref. [60]:

> It [the FDC] has since split, due to internal disagreements over an alliance with Rwanda, but one wing under self-styled General Luanda Butu still collaborates with the M23.

Data 180, 181

A group of former CNDP members who had been integrated into the FARDC defected to form a new group M23 on 6 May 2012 and launch a new rebellion. In Ref. [55]:

> The M23 movement was formed by veterans of recent armed conflicts in the DRC and neighbouring Rwanda, and in particular by members of the DRC's close-knit Tutsi community in North Kivu Province. M23 refers to the peace agreement signed on 23 March 2009 between the Kinshasa government and the CNDP rebel group. [...]. On 6 May 2012 the army mutineers issued a statement announcing the creation of the M23 movement and denouncing the failed implementation of the March 2009 agreement. Former CNDP loyalist Jean-Marie Runiga Lugerero acted as the group's political coordinator, while former CNDP colonel Sultani Makenga led the group's armed wing.

Data 182, 183

The FDLR-Mandevu was integrated into the M23 in 2012. The month of integration is not specified by the sources, therefore the uncertainty was coded as 2 and the month was conjectured to be June, which is immediately after the month of the M23 creation. In Ref. [86]: "Mandevu integrated his 185 combatants into the M23 in 2012 and came to control a small area north of Goma between Nyiragongo and Nyamuligira volcanoes."

Data 184, 185

A group of former members of the RCD-K/ML who had been integrated into the FARDC defected to form a new armed group FOLC in Beni, North

Kivu. When it defected is not specified by sources, therefore the uncertainty was coded as 3. It was conjectured to be June 2012 because the FOLC forged an alliance with M23 in June 2012 [79]. The M23 was created in May, and therefore the FOLC was created in May or June, the later of which was conjectured to be the case here. In Ref. [60], more details are described:

> Force Œcuménique pour la libéniqration du Congo (FOLC, Ecumenical Force for the Liberation of the Congo): This strangely-named group has been built around members of the former RCD-ML rebellion in northern Beni territory. It is led by Colonel Jacques Nyoro and is linked to former Congolese minister of foreign affairs, Mbusa Nyamwisi. It has loose ties with the M23, as well as alleged ties to both Uganda and Rwanda.

Data 186

A group of Banyamulenge created a new armed group, ALEC, led by Akim Hakizimana Muhoza, in July 2012. In Ref. [79]:

> In July 2012, a group of Banyamulenge from the diaspora established the Alliance de libération de l'est du Congo (ALEC), an armed movement allied with MCC and M23. Its statute proclaims that the movement's objective is to "create an independent republic of the Kivu" (see annex 35 to the present report).

Data 187 to 190

A group led by Nkingi defected from the FARDC in July 2012 to form a new armed group, which we call Nkingi group. The group was integrate into the MCC/RCR in August 2012. In Ref. [66]:

> [...] Muhima Nkingi, a young Munyamulenge officer who defected from the Congolese army in August 2012. [...]. At first, Nkingi headed his own group, but then he joined forces with the Mouvement congolais pour le changement (MCC, Congolese Movement for Change), a multi-ethnic group based in the hills overlooking the Rusizi Plain, led by self-proclaimed Colonel Bede Rusagara, an ex-CNDP officer from the Fuliro community.

In Ref. [81]:

> MCC has sought to recruit Banyamulenge since the beginning of the M23 rebellion. In July 2012, a Congolese armed forces deserter, Nkingi Muhima, himself a member of the Banyamulenge community, joined MCC and became its spokesperson. "Col." Rusagara told the Group that currently half of his commanders were Banyamulenge.

The two sources contradict each other because the group defected from the FARDC in August in the former source but it got integrated into the MCC is July in the later source. Moreover, the former source also notes that the defection came first and Nkingi once formed his own independent group before the integration. It is natural to think the two events occurred in the two months, though the exact time is not clear. Therefore, as a way to compromise the two explanations, the defection was conjectured to be in July 2012 and the integration in August 2012. The uncertainty was coded as 2 for both events.

Data 191, 192

A group of COGAI members who regarded the group as a failure defected to form another armed group, MPRC in Ituri in August 2012. In Ref. [63]:

> However, COGAI never gained any real momentum. It began to recruit former UPC combatants in Djugu but failed to obtain broader support from the Hema community there. As a result of this failure, several COGAI members launched another group in August: the Mouvement de Résistance Populaire au Congo (MRPC, Popular Resistance Movement in the Congo).

Data 193 to 196

Nyatura and PARECO-Fort were partly forced to be integrated into the FARDC in August 2012. In Ref. [62]:

> In August 2012, the national army was forced to take action against these militias. Officials in Kinshasa were also worried that, left to their own devices, the Nyatura could be co-opted by the M23 and the earlier Hutu-Tutsi alliance could be rekindled. General Gabriel Amisi, commander of land forces, with the help of Seninga and Turinkinko, constituted a regiment under the command of Habarugira, thereby integrating the bulk of Nyatura soldiers in the Kibabi and Katoyi areas of southern Masisi, including some FDLR, into the Congolese army. Other Nyatura groups, however, in the northern part of Masisi, including those under the command of Munyamariba in Mianja and Bavakure in Mokoto, remain outside army control.

Data 197, 198

The Nkingi group, that had been integrated into the MCC/RCR of Bede Rusagara, defected from the group, partly because of the tension between the Fuliro and Banyamulenge communities, which supported Bede and Nkingi, respectively. In Ref. [66]:

> The alliance between the two groups [Nkingi's and Bede's group] never solidified, although they collaborated in an attack on the Luberizi military camp on 16 September 2012. Soon after, growing tensions made Nkingi part ways with Bede and continue independently with his own movement.

When it defected is not specified by the text, therefore the uncertainty was coded as 3. The time of defection was conjectured to be in September 30, when the last collaboration between them was observed.

Data 199, 200

The MPRC splintered into two factions over the attitude toward the M23 (i.e., pro- or anti-M23). In Ref. [63]:

> When the Congolese army dislodged the MRPC from Djugu and arrested two of its leaders one month later, the movement split into at least two factions—one opposed, the other very close to the M23. The pro-M23 faction is led by army defectors Papy Maki and John Bebwa, both former officers in the UPC's armed wing.

When they splintered is not specified by the sources, therefore the uncertainty was coded as 3. The time of splintering was conjectured to be in October 2012 because it is implied to be soon after the arrest of the two leader, which was made in September 2012 [87].

Data 201, 202

The M23 split into two factions in late February 2013, which we call M23–Ntaganda and M23–Makenga. It was a result of the leadership struggle between Bosco Ntaganda and Sultani Emmanuel Makenga. In Ref. [71] the details are described:

> With Ntaganda relegated to the background, Makenga became the M23 ' s military commander and public face. But the M23 still revolved around two poles, one loyal to Ntaganda, the other to Makenga. Its political head, Jean–Marie Runiga, as well as Baudouin Ngaruye, the deputy military commander, were both Ntaganda loyalists. Tensions escalated over the fall of Goma in November 2012, eventually erupting in full–blown violence in late February 2013, causing further civilian displacement and suffering.

Data 203, 204

The PARC/FAAL, which had been led by Yakutumba, was integrated into the FARDC on 23 March 2012, when Yakutumba "arrived in a Congolese army camp with his 60-member bodyguard, declaring that he was ready to join the army and serve the nation," after several rounds of negotiations between the PARC/FAAL and the FARDC [68].

Bibliography

[1] Joseph S. Nye Jr. and David A. Welch. *Understanding Global Conflict and Cooperation: An Introduction to Theory and History.* Pearson, London (2012).

[2] Therése Pettersson and Peter Wallensteen. "Armed conflicts, 1946–2014." *Journal of Peace Research* **52**, 536–550 (2015).

[3] William Zartman. *Collapsed States: The Disintegration and Restoration of Legitimate Authority.* Lynne Rienner Publishers, Boulder (1995).

[4] Paul Collier. *The Bottom Billion: Why the Poorest Countries Are Failing and What Can Be Done about It.* Oxford Univ. Press, Oxford (2008).

[5] Michael W. Doyle and Nicholas Sambanis. *Making War and Building Peace: United Nations Peace Operations.* Princeton Univ. Press, Princeton (2006).

[6] J. D. Fearon and D. D. Latin. "Ethnicity, insurgency, and civil war." *Am. Polit. Sci. Rev.* **97**, 75–90 (2003).

[7] J. D. Fearon. "Why Do Some Civil Wars Last So Much Longer than Others?" *J. Peace Res.* **41**, 275–301 (2004).

[8] Paul Collier and Anke Hoeffler. "Greed and grievance in civil war." *Oxford Economic Papers* **54**, 563–95 (2004).

[9] Kalyvas, S. N. *The Logic of Violence in Civil War.* Cambridge Univ. Press, New York (2006).

[10] Elisabeth Jean Wood. "Armed Groups and Sexual Violence: When Is Wartime Rape Rare?" *Politics and Society* **37**, 131-61 (2009).

[11] Yuri M. Zhukov. "Roads and the Diffusion of Insurgent Violence: The Logistics of Conflict in Russia's North Caucasus." *Political Geography* **31**, 144–156 (2012).

[12] Andrew Zammit-Mangion *et al.* "Point process modelling of the Afghan War Diary." *Proc. Natl. Acad. Sci. USA* **109**, 12414–19 (2012).

[13] Keisuke Nakao. "Expansion of rebellion: From periphery to heartland." *J. Peace Res.* **52**, 591–606 (2015).

[14] Jeremy M. Weinstein. *Inside of Rebellion: The Politics of Insurgent Violence.* Cambridge Univ. Press, New York (2006).

[15] Paul Staniland. *Networks of Rebellion: Explaining Insurgent Cohesion and Collapse.* Cornell Univ. Press, Ithaca (2014).

[16] Christopher Clapham. *African Guerrillas.* Indiana Univ. Press, Bloomington (1998).

[17] Morten Boas and Kevin C. Dunn. *African Guerrillas: Raging Against the Machine.* Lynne Rienner Publishers, Boulder (2007).

[18] Theodore McLauchlin and Wendy Pearlman, "In-Group Unity, Out-Group Conflict? Exploring the Effect of Repression on Intramovement Cooperation." *Journal of Conflict Resolution* **56**, 41–66 (2012).

[19] Katherine Glassmyer and Nicholas Sambanis. "Rebel–Military Integration and Civil War Termination." *Journal of Peace Research* **45**, 365–384 (2008).

[20] Fotini Chritia. *Alliance Formation in Civil Wars.* Cambridge Univ. Press, New York, (2012).

[21] Michael Findley and Peter Rudloff. "Combatant Fragmentation and the Dynamics of Civil Wars." *British Journal of Political Science* **42**, 879–901 (2012).

[22] Lee J. M. Seymour, "Why factions switch sides in civil wars: rivalry, patronage, and realignment in Sudan." *Int. Security* **39**, 92–131 (2014).

[23] D. E. Cunningham, "Veto players and civil war duration." *Am. J. Polit. Sci.* **50**, 875–892 (2006).

[24] Stephen John Stedman. "Spoiler Problems in Peace Processes." *International Security* **22**, 5-53 (1997).

[25] Andrew Kydd and Barbara F. Walter. "Sabotaging the Peace: The Politics of Extremist Violence." *International Organization* **56**, 263-296 (2002).

[26] Desireé Nilsson "Partial Peace: Rebel Groups Inside and Outside of Civil War Settlements." *Journal of Peace Research* **45**, 479–495 (2008).

[27] Wendy Pearlman. "Spoiling Inside and Out: Internal Political Contestation and the Middle East Peace Process." *International Security* **33**, 79–109 (2009).

[28] Peter Rudloff and Michael G. Findley, "The downstream effect of combatant fragmentation on civil war outcome." *Journal of Peace Research* **53**, 19–32 (2016).

[29] Patrick Johnston, "Negotiated Settlements and Government Strategy in Civil War: Evidence from Darfur." *Civil Wars* **9**, 359–377 (2007).

[30] Fotini Chritia and Michael Semple. "Flipping the Taliban How to Win in Afghanistan." *Foreign Affairs* **88**, 34–45 (2009).

[31] Navin A. Bapat and Kanisha D. Bond. "Alliances between Militant Groups." *British Journal of Political Science* **42**, 793–824 (2012).

[32] Jérôme Tubiana. *The Chad-Sudan Proxy War and the 'Darfurization' of Chad: Myths and Reality.* (Small Arms Survey, Geneva, 2008).

[33] M. Olson-Lounsbery and A. H. Cook, "Rebellion, mediation, and group change: An empirical investigation of competing hypotheses." *J. Peace Res.* **48**, 73–84 (2011).

[34] Lee J. M. Seymour, Kristin M Bakke, and Kathleen Gallagher Cunningham. "E pluribus unum, ex uno plures: Competition, violence, and fragmentation in ethnopolitical movements." *J. Peace Res.* **53**, 3–18 (2016).

[35] Kristian Skrede Gleditsch, Nils W Metternich, and Andrea Ruggeri. "Data and progress in peace and conflict research." *Journal of Peace Research* **51**, 301–314 (2014).

[36] Clionadh Raleigh, *et al.* "Introducing ACLED: An Armed Conflict Location and Event Dataset." *Journal of Peace Research* **47**, 651–660 (2010).

[37] Armed Conflict Location and Event Dataset (ACLED). http://www.acleddata.com/

[38] Sabine C. Carey, Neil J. Mitchell and Will Lowe."States, the Security Sector, and the Monopoly of Violence: A New Database on Pro-Government Militias." *Journal of Peace Research* **50**, 249–258 (2013).

[39] The Pro-Government Militias Database (PGMD), 1.1-2013, http://www.sabinecarey.com/militias-data/

[40] Dara Kay Cohen and Ragnhild Nordås. "Sexual violence in armed conflict: Introducing the SVAC dataset, 1989–2009." *Journal of Peace Research* **51**, 418–428 (2014).

[41] Sexual Violence in Armed Conflict (SVAC) dataset. http://www.sexualviolencedata.org/

[42] Uppsala Conflict Database Program. http://ucdp.uu.se/

[43] Paul D. Kenny. "Structural Integrity and Cohesion in Insurgent Organizations: Evidence from Protracted Conflicts in Ireland and Burma." *Int. Stud. Rev.* **12**, 533–555 (2010).

[44] Andrew McCutchen. *The Sudan Revolutionary Front: Its Formation and Development* (Small Arms Survey, Geneva, 2014).

[45] Central Intelligence Agency. The World Factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/cg.html

[46] John F. Clark. *The African Stakes of the Congo War.* (Palgrave Macmillan, New York, 2002).

[47] Georges Nzongola-Ntalaja. *The Congo: From Leopold to Kabila: A People's History.* (Zed Books, London, 2002).

[48] Thomas Turner. *The Congo Wars: Conflict, Myth and Reality.* (Zed Books, London, 2007).

[49] Shinichi Takeuchi. "Peace process in the Democratic Republic of Congo: Leadership of the international community and its problems." in Takeuchi, S., eds., *Between war and peace: African conflicts and the international community.* (IDE-JETRO, Chiba, 2008) (in Japanese).

[50] Prunier, G. *From Genocide to Continental War; The 'Congolese' Conflict and the Crisis of Contemporary Africa.* (Hurst and Company, London, 2009).

[51] Reyntjens, F. *The Great African War: Congo and Regional Geopolitics, 1996–2006.* (Cambridge Univ. Press, New York, 2009).

[52] Séverine Autesserre. *The trouble with the Congo: local violence and the failure of international peacebuilding.* (Cambridge University Press, Cambridge, 2010).

[53] Emizet Francois Kisangani. *Civil Wars in the Democratic Republic of Congo, 1960-2010.* (Lynne Rienner Publisher, Boulder, 2012).

[54] Jason K. Stearns. *Dancing in the glory of monsters: the collapse of the Congo and the great war of Africa.* (PublicAffairs, New York, 2012).

[55] Small Arms Survey. *Demobilization in the DRC: Armed groups and the role of organizational control.* (Small Arms Survey, Geneva, 2013).

[56] Debelle, Raymond and Nicolas Florquin. "Waning Cohesion: The Rise and Fall of the FDLR." In Small Arms Survey. *Small Arms Survey 2015: Weapons and the World.* (Cambridge University Press, Cambridge, 2015).

[57] Kibasomba, Roger. "Post War Defence Integration in the Democratic Republic of the Congo". Institute for Security Studies, 1 December 2005. https://www.issafrica.org/uploads/119.pdf

[58] Schlindwein, Simone and Dominic Johnson. "Endgame or Bluff? The UN's Dilemma with the FDLR Militia in DRC." (2014).

[59] Timo Mueller and Fidel Bafilemba. "Taking Back Eastern Congo: Comprehensively Addressing the FDLR and M23 Rebel Groups." (Enough Project, October 2013).

[60] Stearns, J. *From CNDP to M23: The evolution of an armed movement in eastern Congo.* (Rift Valley Institute, London, 2012).

[61] Stearns, J. *North Kivu: The background to conflict in North Kivu province of eastern Congo.* (Rift Valley Institute, London, 2012).

[62] Stearns, J. *PARECO: Land, local strongmen and the root of the militia politics in North Kivu.* (Rift Valley Institute, London, 2013).

[63] Tamm, H. *UPC in Ituri: The external militarization of local politics in north-eastern Congo.* (Rift Valley Institute, London, 2013).

[64] Stearns, J., *et al. Raia Mutomboki: The flawed peace process in the DRC and the birth of an armed franchise.* (Rift Valley Institute, London, 2013).

[65] Tamm, H. *FNI and FRPI: Local resistance and regional alliances in north-eastern Congo.* (Rift Valley Institute, London, 2013).

[66] Stearns, J., *et al. Banyamulenge: Insurgency and exclusion in the mountains of South Kivu.* (Rift Valley Institute, London, 2013).

[67] Stearns, J., *et al. Mai-Mai Yakutumba: Resistance and racketeering in Fizi, South Kivu.* (Rift Valley Institute, London, 2013).

[68] Vlassenroot, Koen. *South Kivu: Identity, territory, and power in the eastern Congo.* (Rift Valley Institute, London, 2013).

[69] Stearns, J., Verweijen, J., and Baaz, M. E. *The national army and armed groups in the eastern Congo; Untangling the Gordian knot of insecurity.* (Rift Valley Institute, London, 2013).

[70] Stearns, J. *M23' s operational commander: A profile of Sultani Emmanuel Makenga.* (Rift Valley Institute, London, 2012).

[71] Stearns, J. *Strongman of the eastern DRC: A profile of General Bosco Ntaganda.* (Rift Valley Institute, London, 2013).

[72] Judith Verwijen *A Microcosm of Militarization: Conflict, governance and armed mobilization in Uvira, South Kivu.* (Rift Valley Institute, London, 2016).

[73] Hugo de Vries. *The Ebb and Flow of Stabilization in the Congo.* (Rift Valley Institute, London, 2016).

[74] UN Security Council. (S/2008/43), "Final report of the Group of Experts on the DRC", 13 February 2008.

[75] UN Security Council. (S/2008/773), "Final report of the Group of Experts on the DRC", 12 December 2008.

[76] UN Security Council. (S/2009/603), "Final report of the Group of Experts on the DRC", 23 November 2009.

[77] UN Security Council. (S/2010/596), "Interim report of the Group of Experts on the DRC", 29 November 2010.

[78] UN Security Council. (S/2011/345), "Interim report of the Group of Experts on the DRC", 7 June 2011."

[79] UN Security Council. (S/2012/348), "Interim report of the UN Group of Experts on the DRC", 27 June 2012.

[80] UN Security Council. (S/2012/348/Add.1), "Addendum to the Interim report of the UN Group of Experts on the DRC", 27 June 2012.

[81] UN Security Council. (S/2012/843), "Final report of the UN Group of Experts on the DRC", 15 November 2012.

[82] Human Rights Watch. *Democratic Republic of Congo: Civilians at Risk During Disarmament Operations.* (Human Rights Watch, New York, 29 December 2004).

[83] Human Rights Watch. *Killings in Kiwanja: The UN' s Inability to Protect Civilians.* (Human Rights Watch, New York, 2008).

[84] IRIN. "Continuing reaction to UN panel report." http://www.irinnews.org/fr/node/203950

[85] IRIN. "Armed groups in eastern Congo."

[86] SSRC (Social Science Research Council). *FDLR: Past, Present, and Policies*. Report prepared on behalf of the DRC Affinity Group. (March 2014).

[87] Radio Okapi. "RDC : les FARDC arrêtent Eric Dedhonga, un chef milicien de l'Ituri" (17 September 2012).

[88] Noah A. Rosenberg and Magnus Nordborg. "Genealogical trees, coalescent theory and the analysis of genetic polymorphisms." *Nature Reviews Genetics* **3**, 380–390 (2002)

[89] Bernard M.E. Moret, *et al.* "Phylogenetic Networks: Modeling, Reconstructibility, and Accuracy." *IEEE Transactions on Computational Biology and Bioinformatics* **1**, 13–23 (2004).

[90] Yuichi Wakamoto, Alexander Y. Grosberg, and Edo Kussell. "Optimal lineage principle for age-structured populations." *Evolution* **66**, 115–134 (2012)

[91] Guillaume Lambert and Edo Kussell. "Quantifying Selective Pressures Driving Bacterial Evolution Using Lineage Analysis." *Phys. Rev. X* **5**, 011016 (2015).

[92] G. E. Leventhal et al. "Inferring epidemic contact structure from phylogenetic trees." *PLoS Comput. Biol.* **8**, e1002413 (2012).

[93] S. D. Frost and E. M. Volz, "Modelling tree shape and structure in viral phylodynamics." *Phil. Trans. R. Soc. B* **368**, 20120208 (2013).

[94] C. Colijn and J. Gardy, "Phylogenetic tree shapes resolve disease transmission patterns." *Evolution, Medicine, and Public Health*, 96–108 (2014).

[95] Plazzotta, *et al.*, "Effects of memory on the shapes of simple outbreak trees." *Sci. Rep.* **6**, 21159 (2016).

[96] Paul Heggarty, Warren Maguire, and April McMahon. "Splits or waves? Trees or webs? How divergence measures and network analysis can unravel language histories." *Phil. Trans. R. Soc. B* **365**, 3829–3843 (2010).

[97] Simone Pompei, Vittorio Loreto, and Francesca Tria. "On the Accuracy of Language Trees." *PLoS One* **6**, e20109 (2011).

[98] Bernard Derrida, Susanna C. Manrubia, and Damián H. Zanette. "Statistical Properties of Genealogical Trees." *Phys. Rev. Lett.* **82**, 1987 (1999).

[99] Eduardo Viegas, *et al.* "The dynamics of mergers and acquisitions: ancestry as the seminal determinant." *Proc. R. Soc. A* **470**, 20140370 (2014).

[100] E. A. Leicht, *et al.* "Large-scale structure of time evolving citation networks." *Eur. Phys. J. B* **59**, 75–83 (2007).

[101] Sergi Valverde, *et al.* "Topology and evolution of technology innovation networks." *Phys. Rev. E* **76**, 056118 (2007).

[102] P. Chen and S. Redner. "Community structure of the physical review citation network." *Journal of Informetrics* **4**, 278–290 (2010).

[103] Stefano Allesina and Mercedes Pascual. "Food web models: a plea for groups." *Ecology Letters* **12**, 652–662 (2009).

[104] Shimoji, *et al.* "Global network structure of dominance hierarchy of ant workers." *J. R. Soc. Interface* **11**, 20140599 (2014).

[105] Daizaburo Shizuka and David B. McDonald. "The network motif architecture of dominance hierarchies." *J. R. Soc. Interface* **12**, 20150080 (2015).

[106] S. Mangan and U. Alon. "Structure and function of the feed-forward loop network motif." *Proc. Natl. Acad. Sci. USA* **100**, 11980–11985 (2003).

[107] Hong-Wu Ma, Jan Buer, and An-Ping Zeng. "Hierarchical structure and modules in the *Escherichia coli* transcriptional regulatory network revealed by a new top-down approach." *BMC Bioinformatics* **5**, 199 (2004).

[108] M. E. J. Newman. "The Structure and Function of Complex Networks." *SIAM Review* **45**, 167–256 (2003).

[109] Bernat Corominas-Murtra, *et al.* "Measuring the Hierarchy of Feedforward Networks." *Chaos* **21**, 016108 (2011).

[110] Enys Mones, Lilla Vicsek, Tamás Vicsek. "Measuring the Hierarchy of Feedforward Networks." *PLoS ONE* **7**, e33799 (2012).

[111] M. J. Sackin. "'Good' and 'bad' phenograms." *Syst. Zool.* **21**, 225 (1972).

[112] Bernat Corominas-Murtra, *et al.* "Topological reversibility and causality in feed-forward networks." *New J. Phys.* **12**, 113051 (2010).

[113] Michael G.B. Blum and Olivier Francǫis. "On statistical tests of phylogenetic tree imbalance: the Sackin and other indices revisited." *Mathematical Biosciences* **195**, 141–153 (2005).

[114] Michael G.B. Blum and Olivier Francoıs. "Which Random Processes Describe the Tree of Life? A Large-Scale Study of Phylogenetic Tree Imbalance." *Syst. Bio.* **55**, 685–691 (2006).

[115] Haipeng Li and Thomas Wiehe. "Coalescent Tree Imbalance and a Simple Test for Selective Sweeps Based on Microsatellite Variation." *PLoS Comput. Biol.* **9**, e1003060 (2013).

[116] Oskar Hagen, *et al.* "Age-Dependent Speciation Can Explain the Shape of Empirical Phylogenies." *Syst. Bio.* **64**, 432–440 (2015).

[117] M. Molloy and B. Reed. "A Critical Point for Random Graphs with a Given Degree Sequence." *Random Struct. Algorithms* **6**, 161 (1995).

[118] M. Molloy and B. Reed. "The Size of the Giant Component of a Random Graph with a Given Degree Sequence." *Combin. Probab. Comput.* **7**, 295 (1998).

[119] B. Karrer and M. E. J. Newman. "Random Acyclic Networks." *Phys. Rev. Lett.* **102**, 128701 (2009).

[120] B. Karrer and M. E. J. Newman. "Random graph models for directed acyclic networks." *Phys. Rev. E* **80**, 046110 (2009).

[121] Joaquín Goñi. "Exploring the randomness of directed acyclic networks." *Phys. Rev. E* **82**, 066115 (2010).

[122] G. U. Yule. "A mathematical theory of evolution, based on the conclusions of Dr J.C. Willis." *Philos. Trans. Roy. Soc. Lond. B* **213**, 21 (1924).

[123] Cytoscape. http://www.cytoscape.org/