



Intersecting realities: Exploring the nexus between armed conflicts in eastern Democratic Republic of the Congo and Global Health

Olivier Kambere Kavulikirwa ^{a, b, c, d, e, *}

^a Faculty of Veterinary medicine, Catholic University of Graben in Butembo, Democratic Republic of the Congo

^b Department of Social and Preventive Medicine, University of Montréal, School of Public Health, Canada

^c Department of Public Health Sciences, University of Liège, Belgium

^d Centre de Recherche en Santé Public(CReSP), Canada

^e Groupe de Recherche en Épidémiologie des Zoonoses et Santé Publique, Canada

ARTICLE INFO

Keywords:

Democratic Republic of the Congo
Armed conflict
Zoonotic disease
Healthcare disruption
Biodiversity loss
Population displacement
One Health
Global Health Security
Sustainable Development Goals
Universal Health Coverage

ABSTRACT

The eastern Democratic Republic of the Congo (DRC) grapples with entrenched armed conflicts, creating a complex humanitarian crisis with far-reaching implications for global health. This paper explores the intersection between armed conflict in the region and the risks of zoonotic disease transmission, shedding light on interconnected challenges and proposing integrated strategies for mitigation. Armed conflict disrupts healthcare systems, affecting healthcare facilities (HCF) and healthcare workers (HCW), destroying millions of lives, impoverishing communities, and weakening surveillance systems. This deleterious situation is a bottleneck to achieving the Sustainable Development Goals (SDGs), especially Universal Health Coverage (UHC), as it prevents millions of Congolese from accessing healthcare services. The direct impact of armed insecurity undermines Global Health Security (GHS) by fostering natural habitat degradation and biodiversity loss, exacerbating vulnerabilities to zoonotic disease outbreaks. Forced population displacement and encroachment on natural habitats amplify human-wildlife interaction, facilitating zoonotic disease spillover and increasing the risk of regional and global spread. Biodiversity loss and poaching further compound these challenges, underscoring the need for holistic approaches that address both conservation and public health concerns. Mitigating zoonotic disease risks requires strengthening surveillance systems, promoting community engagement, and integrating conservation efforts with conflict resolution initiatives. By adopting a comprehensive approach, including the incorporation of One Health considerations in all peace-seeking and humanitarian efforts, stakeholders can enhance Global Health Security, scale up UHC, and promote sustainable development in conflict-affected regions. Creativity and strategic foresight are essential to safeguarding the well-being of human, livestock, plant, and wildlife populations in the Eastern DRC.

1. Introduction

The eastern region of the Democratic Republic of the Congo (DRC) has been embroiled in a protracted and multifaceted series of armed conflicts, constituting one of the most enduring humanitarian crises of the modern era [1–3]. In the context of this paper, the use of “Eastern Democratic Republic of the Congo” refers to the region of the country that includes the provinces of North Kivu, South Kivu, Ituri, Maniema and parts of the former Katanga province like Lomami, Haut Katanga

and Haut Lomami, as shown in Fig. 1 [4]. The roots of these conflicts stretch deep into the annals of history, encompassing a complex interplay of colonial legacies, ethnic rivalries, resource competition, and geopolitical interests [2,5,6]. From the tumultuous aftermath of colonial rule to the tumultuous post-independence period marked by successive waves of rebellion and intervention, the trajectory of conflict in eastern DRC has been shaped by a myriad of historical forces.

Understanding the nature and dynamics of armed conflict in eastern DRC is essential for grasping its profound implications for global health.

Abbreviations: DRC, Democratic Republic of the Congo; GHS, Global Health Security; IDPs, Internally Displaced Persons; HCF, Healthcare facilities; HCW, Healthcare Workers; FDLR, Democratic Forces for the Liberation of Rwanda; ADF, The Allied Democratic Forces; CNDP, The National Congress for the Defense of the People; STIs, Sexually Transmitted Infections; OHHLEP, One Health High-Level Expert Panel.

* Corresponding author at: Faculty of Veterinary Medicine, Catholic University of Graben in Butembo, Democratic Republic of the Congo.

E-mail address: olivier.kambere.kavulikirwa@umontreal.ca.

<https://doi.org/10.1016/j.oneht.2024.100849>

Received 17 May 2024; Received in revised form 26 June 2024; Accepted 1 July 2024

Available online 3 July 2024

2352-7714/© 2024 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The region has been plagued by a kaleidoscope of armed groups, each with its own agenda, grievances, and spheres of influence [7]. From rebel militias vying for control over lucrative mineral resources to ethnic factions locked in cycles of reprisal and retaliation, the conflict landscape is characterized by fluidity, fragmentation, and perpetual flux [8,9]. The absence of a clear-cut conflict resolution framework has perpetuated a state of protracted violence, engendering a climate of fear, instability, and uncertainty for civilian populations caught in the crossfire.

The humanitarian fallout of armed conflicts in eastern DRC is staggering, with millions of civilians bearing the brunt of violence, displacement, and deprivation [6,10]. The conflict has unleashed a cascade of humanitarian crises, ranging from mass displacement and food insecurity to rampant human rights abuses such as sexual violence, with subsequent tremendous health and psychosocial consequences at both individual and societal levels. [6,11,12]. Civilians are caught in the crossfire, facing a daily struggle for survival amidst the chaos and carnage of conflict. The displacement of populations, both within the country and across international borders, has further exacerbated vulnerabilities, straining the capacity of host communities and humanitarian agencies to respond effectively to escalating needs.

The repercussions of armed conflict in eastern DRC reverberate far beyond its borders, extending into neighboring countries and resonating on the international stage [13]. The porous nature of borders, coupled with the proliferation of armed groups and illicit networks, has facilitated the spillover of violence and instability across regional boundaries. Moreover, the globalized nature of contemporary conflicts has rendered eastern DRC a focal point for international actors, ranging from peacekeeping missions and humanitarian agencies to diplomatic initiatives and multilateral interventions [14]. The region thus occupies a pivotal position within the broader geopolitical landscape, with its fate intertwined with the fortunes of global peace and security.

While the armed conflicts in the eastern Democratic Republic of the

Congo (DRC) have primarily been viewed through a lens of political instability and humanitarian crisis, their ramifications extend deeply into the realm of global health security. The volatile conditions perpetuated by ongoing conflict serve as fertile ground for the proliferation of infectious diseases, posing significant challenges to regional and global health systems [15].

In the midst of violence and displacement, essential health services are disrupted, leaving populations vulnerable to disease outbreaks and exacerbating existing health disparities [16]. Moreover, the movement of armed groups and displaced populations across porous borders heightens the risk of cross-border transmission of infectious diseases, amplifying the threat to regional and international health security [17]. Therefore, understanding the nexus between armed conflict in eastern DRC and global health is imperative for devising effective strategies to mitigate the dual crises of violence and disease, and to safeguard the well-being of populations both within the region and beyond.

In illuminating the historical context, patterns of conflict dynamics, humanitarian fallout, and regional/international dimensions, this paper lays the foundation for a comprehensive exploration of the nexus between armed conflicts and Global Health in eastern DRC. Indeed, in this region, major conflict onsets appear to correlate with health events, as highlighted by the timeline in Fig. 2. Waves of escalating armed violence have coincided with outbreaks of diseases such as cholera, dysentery, malaria, STIs, measles, monkeypox, and four Ebola outbreaks [12,18–23].

Such an epidemiological may suggest a connection between insecurity, the functioning of the health system, and the frequency of disease outbreaks. So, by contextualizing the conflict within a broader socio-political and historical framework, this paper aims to elucidate the complex interplay of factors that underpin this enduring humanitarian crisis and its far-reaching ramifications for global health.

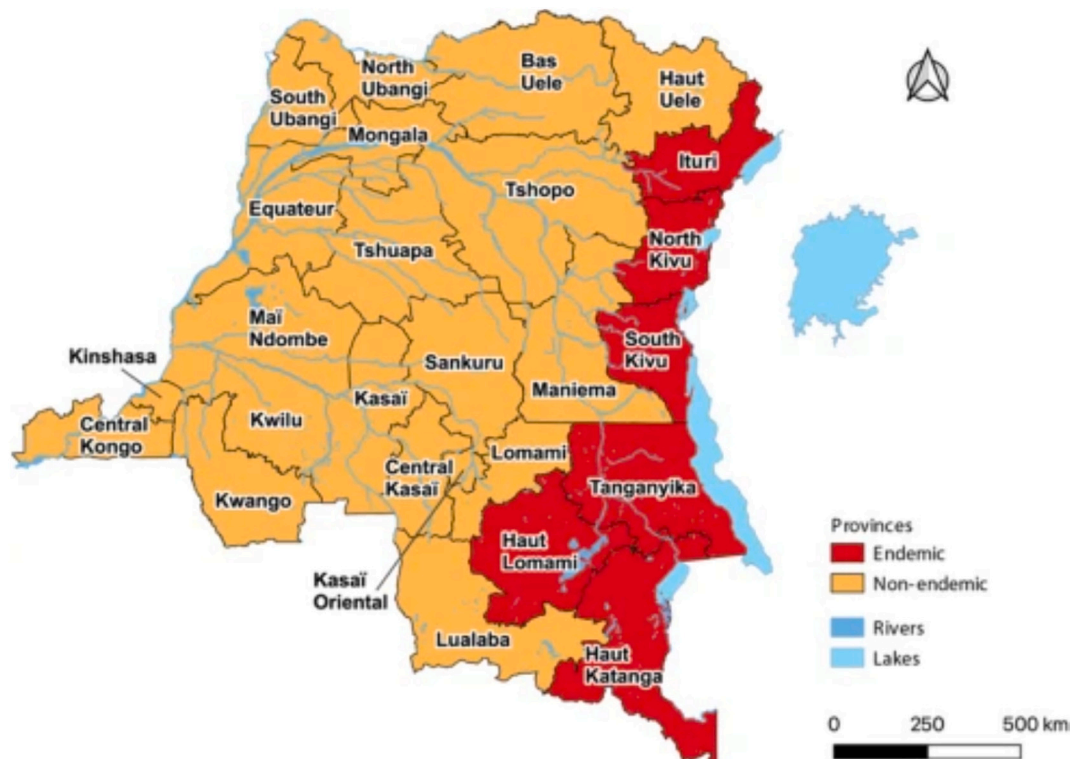


Fig. 1. Map of the DRC, highlighting in red the provinces referred to as “Eastern DRC” in the context of this paper. The map was retrieved from a study conducted by Taty et al. (2023), which investigated the spatiotemporal dynamics of cholera in DRC before and during the implementation of the Multisectoral Cholera Elimination Plan. One province (Maniema) was not highlighted in red, simply because the province was non endemic.

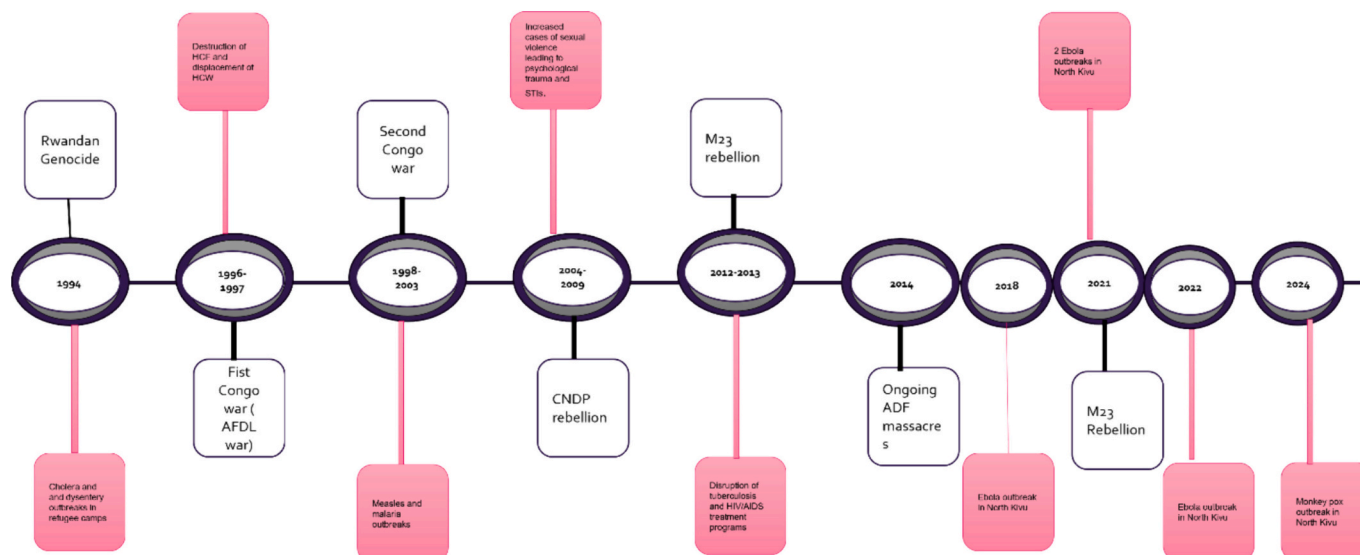


Fig. 2. Timeline of Conflict and Health Events in Eastern DRC since the Rwandan Genocide in 1994. In addition to major outbreaks of armed violence, the region endures persistent insecurity due to the presence of local and foreign armed groups such as the FDLR and various Mai-Mai factions.

2. The intersection of armed conflict, zoonotic disease spillover, and Global Health security

2.1. Impact of conflict on healthcare infrastructure and disease surveillance

Armed conflict in the eastern Democratic Republic of the Congo (DRC) has inflicted severe damage on healthcare infrastructure, disrupting essential services and undermining disease surveillance capabilities [1]. The destruction of hospitals, clinics, and medical supply chains has left communities without access to vital healthcare resources, exacerbating vulnerabilities to zoonotic disease outbreaks [15]. With healthcare facilities in disarray, the ability to detect, diagnose, and respond to emerging infectious diseases, including zoonoses, has been significantly compromised.

The conflict has not only physically damaged healthcare infrastructure but has also disrupted the functionality of healthcare systems. Health workers have been displaced or killed, leading to a shortage of trained personnel capable of managing outbreaks and providing essential medical care. Furthermore, ongoing violence and insecurity have hindered the delivery of medical supplies and the transportation of HCW to affected areas, impeding the delivery of critical healthcare services [16].

In 2009, the Democratic Republic of Congo (DRC) embarked on the ambitious journey towards achieving Universal Health Coverage (UHC) [24]. However, the chronic insecurity in Eastern DRC presents significant challenges to this goal. Armed conflicts directly damage healthcare facilities, worsen working conditions, and threaten the lives of healthcare workers. These conflicts displace communities, further weakening the overall health system. As a result, the persistent insecurity severely hampers the achievement of UHC by hindering both the physical and financial accessibility of healthcare services, as well as their availability [25].

Furthermore, in the war-torn eastern DRC, insecurity-driven psychosocial pressure may significantly alter healthcare-seeking behavior among the affected populations. Fear of violence, lack of trust in healthcare providers, and cultural barriers can play critical roles in these changes [26,27]. The persistent insecurity and associated psychological stress discourage people from accessing necessary health services, as they might avoid HCF due to fear of attacks or mistrust in the safety and reliability of these services. Cultural barriers, including traditional beliefs and practices, can further impede the utilization of health services,

exacerbating the challenge of achieving UHC in this region [25,27,28]. Addressing these issues requires a multifaceted approach that enhances security, builds trust in healthcare systems, and respects cultural contexts to improve health service utilization and overall health outcomes.

In addition to the direct impact on healthcare infrastructure, armed conflict has severely weakened disease surveillance mechanisms. Disease surveillance relies on functioning healthcare systems, effective communication networks, and trained personnel to detect and report outbreaks promptly. However, in conflict-affected areas, these systems have been fractured, resulting in underreporting of cases and delayed responses to disease threats [15].

The breakdown of disease surveillance exacerbates the risk of zoonotic disease spillover, as outbreaks may go undetected until they reach a critical stage. Zoonotic diseases thrive in environments where humans, animals, and pathogens intersect, and the disruption of surveillance systems increases the likelihood of these interactions leading to transmission to humans. Without robust surveillance measures in place, the early warning signs of zoonotic disease outbreaks may be missed, allowing diseases to spread unchecked and escalate into larger-scale public health emergencies [15].

Therefore, addressing the impact of conflict on healthcare infrastructure and disease surveillance is essential for mitigating the risk of zoonotic disease spillover and promoting global health security in the eastern DRC. Efforts to rebuild and strengthen healthcare systems, restore damaged infrastructure, train healthcare workers, and revitalize disease surveillance networks are critical components of a comprehensive approach to addressing the intersection of armed conflict and zoonotic disease transmission [16]. By investing in healthcare resilience and surveillance capacity, the international community can help prevent and mitigate the devastating health consequences of conflict-related disruptions in the eastern DRC and beyond. To this end, one of the ways out would be to scaling up the Integrated Diseases Surveillance and Response strategy (IDSR), to foster early detection and timely response [18].

2.2. Vulnerabilities to zoonotic disease outbreaks and regional spread

Armed conflict in the eastern Democratic Republic of the Congo (DRC) has created a conducive environment for the emergence and spread of zoonotic diseases, with significant implications for regional and global health security. The disruption of traditional livelihoods, forced displacement of populations, and encroachment on natural

habitats have increased human-livestock-wildlife interaction, facilitating the transmission of pathogens between animals and humans [17,29,30]. These conditions elevate the risk of zoonotic disease spillover, where pathogens jump from animal reservoirs to human populations, leading to outbreaks with potentially catastrophic consequences.

Furthermore, the porous borders of the DRC, with its nine international boundaries, pose challenges for disease containment and control. Movement of armed groups, displaced populations, and illicit trade exacerbates the risk of zoonotic disease spread across regional borders, amplifying the threat to neighboring countries and beyond [14,18,31]. The interconnectedness of the region necessitates coordinated efforts among countries to monitor and respond to zoonotic disease outbreaks, underscoring the importance of cross-border collaboration in safeguarding public health [32,33].

Moreover, the unique biodiversity of the eastern DRC, home to diverse ecosystems and wildlife species, presents additional complexities for zoonotic disease management. Armed groups engaged in poaching activities disrupt fragile ecosystems, leading to biodiversity loss and altering wildlife populations [13,34–36]. The depletion of natural habitats and the loss of biodiversity create ecological disruptions that can drive zoonotic disease emergence and transmission [37,38].

In this context, addressing vulnerabilities to zoonotic disease outbreaks and regional spread requires a multifaceted approach that integrates public health, environmental conservation, and security measures. Strengthening disease surveillance systems, enhancing cross-border collaboration, promoting sustainable conservation practices, and addressing the root causes of biodiversity loss are essential strategies for

mitigating the risks posed by zoonotic diseases in the eastern DRC and mitigating their potential impact on regional and global health security.

3. The unique challenges of zoonotic disease management in eastern DRC

3.1. Permanent forced population displacement and human-livestock-wildlife interaction

Armed conflict in the eastern Democratic Republic of the Congo (DRC) has resulted in permanent forced population displacement, exacerbating human-livestock-wildlife interaction and creating unique challenges for zoonotic disease management. Displacement disrupts traditional livelihoods, forcing displaced populations to rely on wildlife resources for sustenance, income generation, and medicinal purposes [39,40]. This increased interaction between humans, livestock and wildlife in displacement camps and host communities, as shown in Fig. 3, elevates the risk of zoonotic disease transmission, as displaced populations often live in overcrowded conditions with limited access to clean water, sanitation, and healthcare services [41–44].

The precarious living conditions in displacement camps and host communities further amplify the risk of zoonotic disease spillover, as inadequate sanitation facilities and poor hygiene practices create environments conducive to disease transmission [15,45,46]. Moreover, the displacement of populations into previously uninhabited areas or natural habitats increases the likelihood of encounters with wildlife, potentially leading to zoonotic disease transmission events [42].

Managing human-wildlife interaction and preventing zoonotic



Fig. 3. Image depicting forced displacement driven by ongoing armed conflicts in eastern Congo. Captured by AP News during a clash between M23 rebels and the Congolese armed forces, the photograph shows internally displaced people fleeing with animals and wood near Virunga National Park. This context of persistent instability can alter human-livestock-wildlife interaction dynamics and exacerbate the human impact on the park's ecosystems, thereby endangering health security. During a fight between the M23 rebels and the Congolese armed forces, shows Internally Displaced People fleeing with animals and wood around the Virunga National Park. This context of permanent instability has the potential to influence the human-livestock-wildlife interaction dynamics and to worsen the human impact on the protected area's ecosystems, putting Health Security.

disease spillover in displacement settings pose significant challenges for humanitarian organizations and health authorities. Efforts to improve sanitation and hygiene practices, provide access to clean water and healthcare services, and promote community awareness of zoonotic disease risks are essential for reducing the transmission of infectious diseases in displacement camps and host communities [16]. Additionally, implementing measures to minimize human-wildlife conflict, such as wildlife deterrents, habitat restoration, and community-based conservation initiatives, can help mitigate the risk of zoonotic disease transmission and promote health security in conflict-affected regions.

3.2. Biodiversity loss and poaching amidst armed conflicts

Armed conflict in the eastern DRC has led to significant biodiversity loss and increased poaching activities, further exacerbating the challenges of zoonotic disease management. The activities of armed groups, including illegal logging, mining, and wildlife trafficking, have resulted in habitat destruction, fragmentation, and degradation, threatening biodiversity and disrupting ecosystems [13,47]. This loss of biodiversity creates ecological disruptions that can facilitate the emergence and spread of zoonotic diseases, as changes in wildlife populations and ecosystems alter the dynamics of pathogen transmission.

Moreover, increased poaching and illegal wildlife trade in conflict-affected areas contribute to biodiversity loss and further disrupt ecosystems [13]. Poaching activities target wildlife species for their meat, skins, and body parts, driving population declines and disrupting ecological balance. The depletion of wildlife populations not only poses conservation concerns but also increases the risk of zoonotic disease transmission, as interactions between humans and wildlife become more frequent and intense. Fig. 4 visualizes the way the complex intertwined interplays between armed conflicts and subsequent forced population and health systems disruption as well as biodiversity loss can be

conceptualized through the lens of Health Security. Using a systems approach, the chart helps gain a broader understanding of the interactions between the different drivers.

The implications of biodiversity loss and poaching amidst conflict for zoonotic disease management underscore the need for integrated approaches that address both conservation and public health concerns. Conservation efforts should be coupled with measures to prevent and control zoonotic disease transmission, including surveillance of wildlife populations, monitoring of zoonotic disease hotspots, and implementation of measures to reduce human-wildlife contact [15]). Additionally, addressing the underlying drivers of biodiversity loss, such as poverty, insecurity, and governance failures, is essential for promoting sustainable conservation practices and enhancing health security in conflict-affected regions.

4. Strategies for mitigating zoonotic disease risks and promoting Global Health security

4.1. Strengthening surveillance systems and wildlife health monitoring

Effective surveillance systems and wildlife health monitoring are essential components of efforts to mitigate zoonotic disease risks and promote global health security in conflict-affected regions like the eastern Democratic Republic of the Congo (DRC).

Enhancing disease surveillance capacity in conflict-affected areas is crucial for early detection, rapid response, and containment of zoonotic disease outbreaks [15]. This requires strengthening existing healthcare infrastructure, improving access to healthcare services, and enhancing laboratory capacity for diagnosing and monitoring infectious diseases. Training healthcare workers and equipping them with the necessary skills and resources to identify and report suspected cases of zoonotic diseases are also critical for effective surveillance efforts.

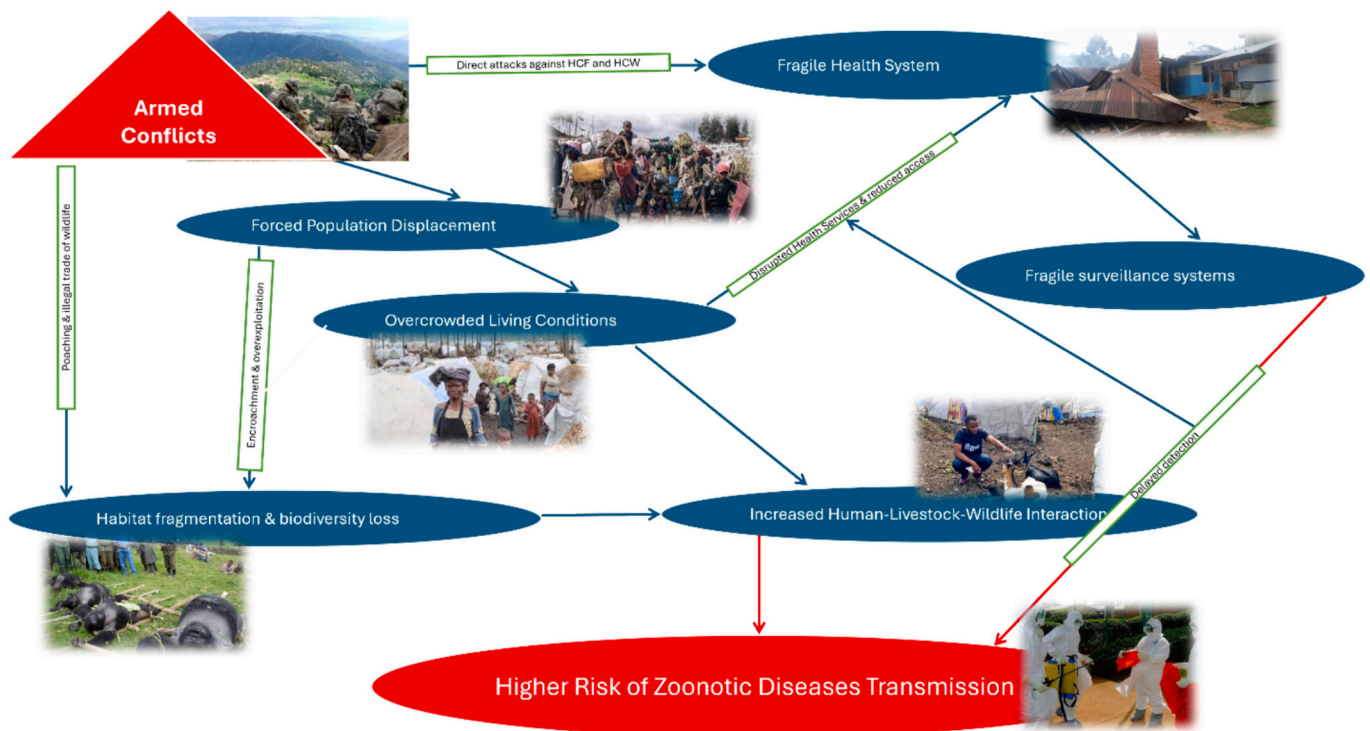


Fig. 4. Flowchart illustrating the pathway from insecurity in the war-torn Eastern DRC to the risk of zoonotic spillover and spread. The diagram visualizes how armed conflict leads to population displacement, branching into increased human-livestock-wildlife interaction through overcrowded living conditions and biodiversity loss, which heightens the risk of zoonotic spillover and spread. Additionally, the flowchart highlights how armed conflicts in eastern DRC weakened the health system, resulting in disrupted healthcare services. Fragile health systems have inefficient surveillance mechanisms, increasing the risk of disease transmission due to a lack of early detection and response. The images incorporated in the design were retrieved from open sources including media and humanitarian agencies websites.

Implementing One Health approaches, which recognize the interconnectedness of human, animal, and environmental health, is essential for monitoring zoonotic disease threats and addressing emerging risks [15]. One Health initiatives involve collaboration among various sectors, including healthcare, veterinary medicine, environmental conservation, and wildlife management, to identify and mitigate zoonotic disease risks at the human-animal-environment interface. By integrating surveillance data from humans, animals, and ecosystems, One Health approaches can provide early warning of potential disease outbreaks and inform targeted intervention strategies.

Investing in wildlife health monitoring and research is another key strategy for mitigating zoonotic disease risks and promoting global health security [16]. Monitoring wildlife populations for signs of disease, conducting epidemiological studies to identify reservoir hosts and transmission pathways, and studying the ecology of zoonotic pathogens are essential for understanding the dynamics of zoonotic disease transmission and developing effective prevention and control measures. Collaborative research efforts involving scientists, veterinarians, and conservationists can help build knowledge and capacity for zoonotic disease management and contribute to the development of evidence-based policies and interventions.

By strengthening surveillance systems, implementing One Health approaches, and investing in wildlife health monitoring and research, stakeholders can mitigate zoonotic disease risks, enhance global health security, and promote the well-being of populations in conflict-affected regions like the eastern DRC. These strategies require sustained commitment and collaboration among governments, international organizations, NGOs, and local communities to effectively address the complex challenges of zoonotic disease management in conflict-affected areas.

Addressing the root causes of a weakened health system and promoting good governance at all levels is crucial. While enhancing the implementation of resilient and robust surveillance systems is essential for improved health security, these efforts can be undermined by governance issues, corruption, and lack of community trust [48]. Overcoming these challenges is imperative to ensure the effectiveness and sustainability of health surveillance initiatives.

4.2. Promoting sustainable conservation and community engagement

Integrating conservation efforts with conflict resolution and peace-building initiatives is essential for promoting sustainable conservation practices and addressing zoonotic disease risks in conflict-affected regions like the eastern Democratic Republic of the Congo (DRC). By engaging local communities in biodiversity conservation and disease prevention, stakeholders can build trust, foster cooperation, and empower communities to become stewards of their natural resources [13,49,50].

Addressing underlying drivers of biodiversity loss and wildlife exploitation, such as poverty, insecurity, and governance failures, is essential for promoting sustainable conservation practices and enhancing health security [15]. By addressing these root causes, stakeholders can create enabling environments for conservation efforts to thrive, reduce human-wildlife conflict, and mitigate the risk of zoonotic disease transmission.

Moreover, promoting community engagement in biodiversity conservation and disease prevention can yield multiple benefits, including improved livelihoods, enhanced resilience to environmental and health risks, and strengthened social cohesion [11,51]. By involving local communities in decision-making processes, promoting equitable access to natural resources, and providing opportunities for capacity building and income generation, stakeholders can empower communities to actively participate in conservation initiatives and contribute to global health security. To tackle such a complex Global Health security threat, there is a dire need for creativity to adapt the One Health approach to the local context. Therefore, peace agreements and humanitarian

strategies should incorporate One Health considerations. Fig. 5 visualizes how incorporating the One Health approach in the peace-seeking and humanitarian initiatives in eastern DRC can more effectively address the multifaceted health challenges posed by ongoing conflicts. Designed from the OHHLEP's conceptualisation of the One Health concept, the visual shows how this integrated strategy can help build more resilient communities by mobilizing a whole-of-stakeholders approach and reinvigorating the roles of traditional One Health stakeholders at all levels.

5. Limitations to the study

One of the primary research challenges in conflict-affected regions is the limited availability and poor quality of data. This study could have been more robust with access to comprehensive data. For instance, visualizing the extent of damage to HCF and the impact on HCW in conflict zones over time would have been valuable. An evidence-based bar graph showing the number of damaged or destroyed healthcare facilities over specified time intervals would have significantly strengthened the section on the impact of conflict on healthcare infrastructure and disease surveillance. Unfortunately, due to the lack of reliable sources, this paper relied solely on published literature. So, future studies could capture such hard-to-reach data by exploring grey literature, including reports from humanitarian agencies and unpublished archives from official institutions in the DRC.

Additionally, while the insights presented in this paper may apply to other regions experiencing armed conflicts, the socio-political and environmental contexts may vary significantly. This variability means that findings from the Eastern DRC might not be universally applicable.

Finally, it is essential to acknowledge that integrating conservation, public health, and conflict resolution efforts can be challenging due to differing priorities and methodologies across disciplines. Addressing these interdisciplinary challenges requires a concerted effort to align goals and strategies, which can be a complex and demanding process.

6. Conclusion

In summary, the nexus between armed conflict in regions like the eastern DRC and the risks of zoonotic disease transmission poses significant threats to human, livestock and wildlife health, thereby challenging global health security. The disruption of ecosystems, forced population displacement, and biodiversity loss exacerbate vulnerabilities to infectious disease outbreaks, necessitating a comprehensive, interdisciplinary, and collaborative approach.

To effectively address these dual crises, stakeholders across sectors must work together to develop integrated strategies that recognize the interconnectedness of human, animal, and environmental health. This requires prioritizing investments in healthcare infrastructure, disease surveillance, wildlife health monitoring, and community engagement.

By addressing underlying drivers of conflict and promoting sustainable conservation practices, stakeholders can mitigate zoonotic disease risks, enhance global health security, and safeguard the well-being of populations in conflict-affected regions like the eastern DRC and beyond. It is vital to incorporate this holistic approach in peace seeking and humanitarian endeavours. An innovative One Health approach is pivotal for building resilience, fostering cooperation, and promoting sustainable development in conflict-affected regions, thereby contributing to broader efforts to safeguard public health and biodiversity conservation worldwide.

CRediT authorship contribution statement

Olivier Kambere Kavulikirwa: Writing – review & editing, Writing – original draft, Conceptualization.

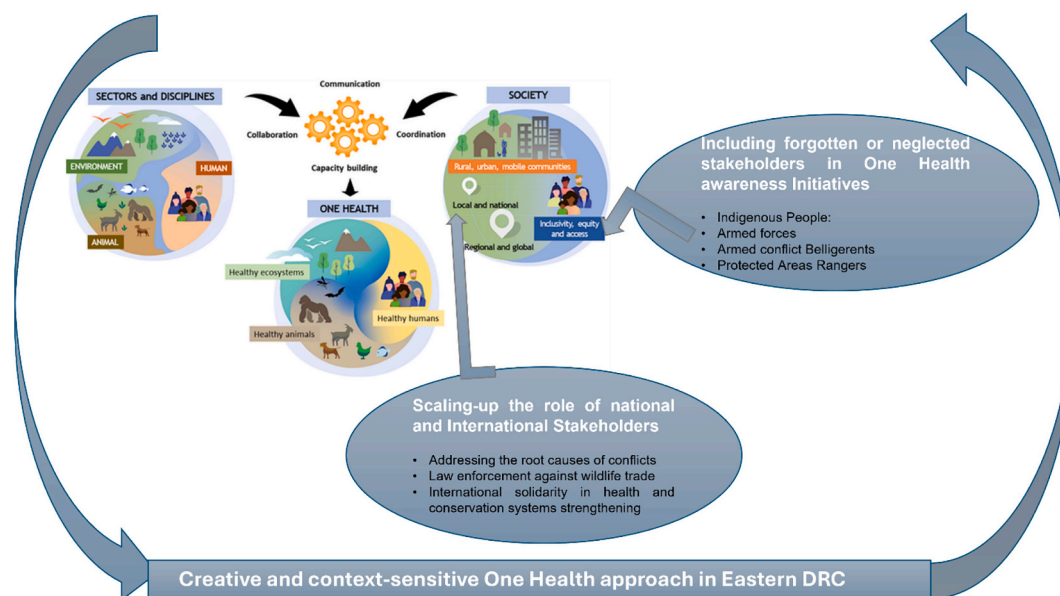


Fig. 5. Visual representation of how the One Health approach can be adapted to the context of eastern DRC for enhanced effectiveness. Drawing from the One Health High-Level Expert Panel's definition (OHHLEP, 2021), it outlines actions to improve inclusion and equity at the community level by involving typically forgotten or neglected stakeholders. The visual also highlights actions at national, regional, and international levels to strengthen GHS.

Declaration of competing interest

The author declares that there is no conflict of interest in this work.

Data availability

No data was used for the research described in the article.

Acknowledgments

O.K.K expresses gratitude to the University of Montréal School of Public Health for generously providing scholarships that support his doctoral studies in Global Health. Special thanks are extended to the DESIGN project for funding his research related to his PhD.

References

- [1] S. Autesserre, *The Trouble with the Congo: Local Violence and the Failure of International Peacebuilding*, Cambridge University Press, Cambridge New York Melbourne Madrid Cape Town Singapore Sao Paulo Delhi Mexico City, 2010.
- [2] A. Cojocar, Ongoing humanitarian crisis and peace process in the Democratic Republic of the Congo, *Euro-Atl Stud.* (2022) 57–89.
- [3] W.C. Soderlund, E.D. Briggs, T.P. Najem, B.C. Roberts, *Africa's Deadliest Conflict: Media Coverage of the Humanitarian Disaster in the Congo and the United Nations Response, 1997–2008*, Wilfrid Laurier Univ. Press, 2012.
- [4] N. Taty, D. Bompangue, N.M. de Richemond, J. Muyembe, Spatiotemporal dynamics of cholera in the Democratic Republic of the Congo before and during the implementation of the multisectoral cholera elimination plan: a cross-sectional study from 2000 to 2021, *BMC Public Health* 23 (2023) 1592, <https://doi.org/10.1186/s12889-023-16449-2>.
- [5] G. Prunier, *Africa's World War: Congo, the Rwandan Genocide, and the Making of a Continental Catastrophe*, Reprint edition, Oxford University Press, Oxford, 2011.
- [6] C. Kabemba, The Democratic Republic of Congo: the land of humanitarian interventions, in: B. Everill, J. Kaplan (Eds.), *Hist. Pract. Humanit. Interv. Aid Afr.*, London, Palgrave Macmillan UK, 2013, pp. 140–157, https://doi.org/10.1057/9781137270023_7.
- [7] S. Autesserre, *Peaceland: Conflict Resolution and the Everyday Politics of International Intervention*, New York, Cambridge University Press, 2014.
- [8] J. Stearns, *Dancing in the Glory of Monsters: The Collapse of the Congo and the Great War of Africa*, Illustrated edition, PublicAffairs, New York, NY, 2012.
- [9] O.A. Olumide, *Armed Conflict in Resource-Endowed African States: A Case Study of the Democratic Republic of Congo (DRC)*, 2019, p. 5.
- [10] E. Kabengele Mpinga, M. Koya, J. Hasselgard-Rowe, E. Jeannot, S.B. Rehani, P. Chastonay, Rape in armed conflicts in the Democratic Republic of Congo: a systematic review of the scientific literature, *Trauma Violence Abuse* 18 (2017) 581–592, <https://doi.org/10.1177/1524838016650184>.
- [11] B. Coghlan, R.J. Brennan, P. Ngoy, D. Dofara, B. Otto, M. Clements, et al., Mortality in the Democratic Republic of Congo: a nationwide survey, *Lancet* 367 (2006) 44–51, [https://doi.org/10.1016/S0140-6736\(06\)67923-3](https://doi.org/10.1016/S0140-6736(06)67923-3).
- [12] M. VanRooyen, S. Bartels, J. Leaning, J. Kelly, J. Scott, Now, *The World Is Without Me: An Investigation of Sexual Violence in Eastern Democratic Republic of Congo*, 2010.
- [13] K. Vlassenroot, T. Raeymaekers, *Conflict and Social Transformation in Eastern DR Congo*, Academia Press, 2004.
- [14] J. O'Loughlin, F.D.W. Witmer, A.M. Linke, A. Laing, A. Gettelman, J. Dudhia, Climate variability and conflict risk in East Africa, 1990–2009, *Proc. Natl. Acad. Sci.* 109 (2012) 18344–18349, <https://doi.org/10.1073/pnas.1205130109>.
- [15] D.L. Heymann, L. Chen, K. Takemi, D.P. Fidler, J.W. Tappero, M.J. Thomas, et al., Global health security: the wider lessons from the west African Ebola virus disease epidemic, *Lancet* 385 (2015) 1884–1901, [https://doi.org/10.1016/S0140-6736\(15\)60858-3](https://doi.org/10.1016/S0140-6736(15)60858-3).
- [16] P.B. Spiegel, F. Checchi, S. Colombo, E. Paik, Health-care needs of people affected by conflict: future trends and changing frameworks, *Lancet Lond. Engl.* 375 (2010) 341–345, [https://doi.org/10.1016/S0140-6736\(09\)61873-0](https://doi.org/10.1016/S0140-6736(09)61873-0).
- [17] C.N.L. Macpherson, Human behaviour and the epidemiology of parasitic zoonoses, *Int. J. Parasitol.* 35 (2005) 1319–1331, <https://doi.org/10.1016/j.ijpara.2005.06.004>.
- [18] O.K. Kavulikirwa, F.K. Sikakulya, Recurrent Ebola outbreaks in the eastern Democratic Republic of the Congo: a wake-up call to scale up the integrated disease surveillance and response strategy, *One Health* (2022) 100379, <https://doi.org/10.1016/j.onehlt.2022.100379>.
- [19] CDC, History of Ebola Disease Outbreaks | History | Ebola (Ebola Virus Disease), CDC, 2023. <https://www.cdc.gov/vhf/ebola/history/chronology.html>. accessed February 28, 2024.
- [20] MSF, DRC Ebola Outbreak Crisis Update | MSF, Médecins Front MSF Int, 2021. <https://www.msf.org/drc-ebola-outbreak-crisis-update>. accessed February 27, 2024.
- [21] J. Sun, O. Uwishema, H. Kassem, M. Abbass, L. Uweis, A. Rai, et al., Ebola virus outbreak returns to the Democratic Republic of Congo: an urgent rising concern, *Ann. Med. Surg.* 2022 (79) (2012) 103958, <https://doi.org/10.1016/j.amsu.2022.103958>.
- [22] A.K. Siddique, *Cholera Epidemic Among Rwandan Refugees: Experience of ICDDR, B in Goma, Zaire 16*, Glimpse, Dhaka Bangladesh, 1994, pp. 3–4.
- [23] IRC, Mortality in the DR Congo: Results From a Nationwide Survey. <https://reliefweb.int/report/democratic-republic-congo/mortality-dr-congo-results-nationwide-survey>, 2003 accessed June 25, 2024.
- [24] A.B. Nyamugira, A. Richter, G. Furaha, S. Flessa, Towards the achievement of universal health coverage in the Democratic Republic of Congo: does the country walk its talk? *BMC Health Serv. Res.* 22 (2022) 860, <https://doi.org/10.1186/s12913-022-08228-3>.
- [25] O.O. Olu, A. Petu, A. Usman, Leaving no one behind in armed conflict-affected settings of Africa: is universal health coverage a possibility or mirage? *Glob. Health Res. Policy* 9 (2024) 17, <https://doi.org/10.1186/s41256-024-00360-3>.
- [26] O. Ojeleke, W. Groot, I. Bonuedi, M. Pavlova, The impact of armed conflicts on the nutritional status of children: evidence from northern Nigeria, *Int. J. Health Plann. Manag.* 39 (2024) 502–529, <https://doi.org/10.1002/hpm.3742>.
- [27] A. Ekzayez, Y. Alhaj Ahmad, H. Alhaleb, F. Checchi, The impact of armed conflict on utilisation of health services in north-West Syria: an observational study, *Confl. Heal.* 15 (2021) 91, <https://doi.org/10.1186/s13031-021-00429-7>.

- [28] E. Munezero, S. Manoukian, The social determinants of health and health seeking behaviour in populations affected by armed conflict: a qualitative systematic review, *Med. Confl. Surviv.* 37 (2021) 293–318, <https://doi.org/10.1080/13623699.2021.1971824>.
- [29] S.B. Cáceres, Global Health security in an era of Global Health threats, *Emerg. Infect. Dis.* 17 (2011) 1962–1963, <https://doi.org/10.3201/eid1710.101656>.
- [30] S.J. Ravi, D. Meyer, E. Cameron, M. Nalabandian, B. Pervaiz, J.B. Nuzzo, Establishing a theoretical foundation for measuring global health security: a scoping review, *BMC Public Health* 19 (2019) 954, <https://doi.org/10.1186/s12889-019-7216-0>.
- [31] A.M. Medley, J. Gasanani, C.A. Nyolimati, E. McIntyre, S. Ward, B. Okuyo, et al., Preventing the cross-border spread of zoonotic diseases: multisectoral community engagement to characterize animal mobility—Uganda, 2020, *Zoonoses Public Health* 68 (2021) 747–759, <https://doi.org/10.1111/zph.12823>.
- [32] Authority (EFSA) EFS, J. Berezowski, K. de Balogh, F.C. Dórea, S. Rüegg, A. Broglia, et al., Prioritisation of zoonotic diseases for coordinated surveillance systems under the One Health approach for cross-border pathogens that threaten the Union, *EFSA J.* 21 (2023) e07853, <https://doi.org/10.2903/j.efsa.2023.7853>.
- [33] L.N. Miller, W.K. Saadawi, W.B. Hamouda, A.S. Elgari, E.A. Abdulkarim, A.M. M. Lmrabet, et al., Assessing one health capacities for transboundary zoonotic diseases at the Libya-Tunisia border, *One Health Outlook* 6 (2024) 3, <https://doi.org/10.1186/s42522-024-00101-z>.
- [34] R.L. Beyers, J.A. Hart, A.R.E. Sinclair, F. Grossmann, B. Klinkenberg, S. Dino, Resource wars and conflict ivory: the impact of civil conflict on elephants in the Democratic Republic of Congo - the case of the okapi reserve, *PLoS ONE* (2011) 6, <https://doi.org/10.1371/journal.pone.0027129>.
- [35] V. Butsic, M. Baumann, A. Shortland, S. Walker, T. Kuemmerle, Conservation and conflict in the Democratic Republic of Congo: the impacts of warfare, mining, and protected areas on deforestation, *Biol. Conserv.* 191 (2015) 266–273, <https://doi.org/10.1016/j.biocon.2015.06.037>.
- [36] J. Lepointe, Working-Group B, *Biodiversity Conservation Related Violence in the Democratic Republic of Congo*, 2021.
- [37] A.W. Bartlow, C. Machalaba, W.B. Karesh, J.M. Fair, Biodiversity and Global Health: intersection of health, security, and the environment, *Health Secur.* 19 (2021) 214–222, <https://doi.org/10.1089/hs.2020.0112>.
- [38] J. Brema, S. Gautam, D. Singh, Global implications of biodiversity loss on pandemic disease: COVID-19, COVID-19 *Sustain. Dev. Goals* (2022) 305–322, <https://doi.org/10.1016/B978-0-323-91307-2.00006-7>.
- [39] Protected zones in context: exploring the complexity of armed conflicts and their impacts on the protection of biodiversity, *Int. Rev. Red Cross* (2023). <http://international-review.icrc.org/articles/protected-zones-in-context-exploring-the-complexity-of-armed-conflicts-924> (accessed May 7, 2024).
- [40] Wilson Center, Book Discussion: People on the Move: Reducing the Impact of Human Migration on Biodiversity |, Wilson Center, 2007. <https://www.wilsoncenter.org/event/book-discussion-people-the-move-reducing-the-impact-human-migration-biodiversity> (accessed May 7, 2024).
- [41] E.B. Barbier, Habitat loss and the risk of disease outbreak, *J. Environ. Econ. Manag.* 108 (2021) 102451, <https://doi.org/10.1016/j.jeem.2021.102451>.
- [42] K. Burns, Habitat Destruction and Biodiversity Loss at the Root of Emerging Infectious Diseases, UC Davis, 2020. <https://www.ucdavis.edu/one-health/habitat-destruction-and-biodiversity-loss-root-emerging-infectious-diseases> (accessed May 7, 2024).
- [43] M.M. Esposito, S. Turku, L. Lehrfield, A. Shoman, The impact of human activities on zoonotic infection transmissions, *Anim. Open Access. J. MDPI* 13 (2023) 1646, <https://doi.org/10.3390/ani13101646>.
- [44] F. Keesing, R.S. Ostfeld, Impacts of biodiversity and biodiversity loss on zoonotic diseases, *Proc. Natl. Acad. Sci.* 118 (2021) e2023540118, <https://doi.org/10.1073/pnas.2023540118>.
- [45] A.N. Desai, J.W. Ramatowski, N. Marano, L.C. Madoff, B. Lassmann, Infectious disease outbreaks among forcibly displaced persons: an analysis of ProMED reports 1996–2016, *Confl. Heal.* 14 (2020) 49, <https://doi.org/10.1186/s13031-020-00295-9>.
- [46] J. Saifee, C. Franco-Paredes, S.R. Lowenstein, Refugee health during COVID-19 and future pandemics, *Curr. Trop. Med. Rep.* 8 (2021) 1–4, <https://doi.org/10.1007/s40475-021-00245-2>.
- [47] Centre UWH, Emergency Appeal to Combat Militant Elephant Poaching in Democratic Republic of the Congo, UNESCO World Herit Cent, 2014. <https://whc.unesco.org/en/news/1182/> (accessed May 7, 2024).
- [48] Gutema G, Kaba M, Birhanu Z, Diribi J, Elemo I. Impact of armed conflicts on public health infrastructure and services in Oromia, Ethiopia, *Cureus n.d.*;15: e40653. Doi: <https://doi.org/10.7759/cureus.40653>.
- [49] M.E. Méndez-López, E. García-Frapolli, D.J. Pritchard, M.C. Sánchez González, I. Ruiz-Mallén, L. Porter-Bolland, et al., Local participation in biodiversity conservation initiatives: a comparative analysis of different models in south East Mexico, *J. Environ. Manag.* 145 (2014) 321–329, <https://doi.org/10.1016/j.jenvman.2014.06.028>.
- [50] C. Ward, G. Holmes, L. Stringer, Perceived barriers to and drivers of community participation in protected-area governance, *Conserv. Biol. J. Soc. Conserv. Biol.* 32 (2018) 437–446, <https://doi.org/10.1111/cobi.13000>.
- [51] IUCN, Local Community Engagement in Conservation Management - Blog, IUCN, 2022. <https://www.iucn.org/blog/202210/local-community-engagement-conservation-management>. accessed May 7, 2024.