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Authors: R. Baderha, Ghislain Kabumba, Kamta Tchoffo, Romeo Omer, K. Ngute, Alain Senghor, Imani, Gérard, Batumike, Rodrigue, et al.

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Comparative Study of Climate Change Adaptation Practices in Conflict-Affected Mountain Areas of Africa

Ghislain Kabumba R. Baderha [1,2,3]*, ***Romeo Omer Kamta Tchoffo*** [4], ***Alain Senghor K. Ngute*** [5], ***Gérard Imani*** [3], ***Rodrigue Batumike*** [6,7], ***Noelia Zafra-Calvo*** [8], ***and Aida Cuni-Sanchez*** [9,10]

* *Corresponding author: ghislain.baderha@gmail.com*

[1] *Centre de Recherche en Ecologie et Gestion des Ecosystèmes Terrestres (CREGET), Faculty of Sciences, Université Officielle de Bukavu, PO Box 570, Bukavu, Democratic Republic of the Congo*
[2] *UN Academia International, PO Box 12286 Kin 1, Kinshasa, Democratic Republic of the Congo*
[3] *Department of Biology, Université Officielle de Bukavu, PO Box 570, Bukavu, Democratic Republic of the Congo*
[4] *Bristol Zoological Society, Bénoué National Park, 271 Garoua, Cameroon*
[5] *Tropical Forests and People Research Centre, Forest Research Institute, University of the Sunshine Coast, Sippy Downs, Queensland 4556, Australia*
[6] *Department of Wildlife Management, College of African Wildlife Mweka, PO Box 3031, Moshi, Tanzania*
[7] *Department of Wildlife Management, Faculty of Science and Engineering, Manchester Metropolitan University, Manchester M15 6BH, United Kingdom*
[8] *Basque Centre for Climate Change (BC3), Scientific Campus of the University of the Basque Country, 48940 Leioa, Spain*
[9] *Department of International Environmental and Development Studies (NORAGRIC), Norwegian University of Life Sciences, PO Box 5003, 1432 Ås, Norway*
[10] *Department of Environment and Geography, York Institute for Tropical Ecosystems, University of York, York YO10 5NG, United Kingdom*

People living in conflict-affected areas are particularly vulnerable to climate-related impacts. However, few comparative studies have examined differences in adaptation practices across different conflict-affected mountain areas in Africa. This study focuses on 2 mountain areas, the Bamboutos Mountains (western Cameroon, affected by sectarian conflict) and the Itombwe Mountains (eastern Democratic Republic of the Congo, affected by political instability). Semistructured interviews were conducted with 282 smallholder farmers living in these 2 mountainous areas. Farmers in both areas reported climatic changes and impacts on crops, animals, and human health. Some adaptation strategies were used across sites (eg increasing use of improved seeds and changing planting dates), but some differed (eg using inputs) in relation to differences in impacts observed, conflict characteristics, and farmers' cultural backgrounds. For example, in the Itombwe Mountains, herding was preferred over crop production (as cows could be moved when insecurity increased), whereas in the Bamboutos Mountains, crop production was preferred over rearing large animals (as these could be easily stolen by the separatists). We discuss the perceived major barriers to adaptation and their implications.

Keywords: *climate change; adaptation; mountain regions; Africa; insecurity; conflict.*

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Introduction

Although considerable academic inquiry has focused on the potential relationship between climate change and violent conflict (Sharifi et al 2020), less research has focused on the effects of conflict on farmers' adaptation strategies (but see Bob and Bronkhorst 2014). Smallholder farmers living in conflict-affected areas are particularly vulnerable to climate-related impacts. They have few resources to adapt (Marktanner et al 2015; ICRC 2020), because critical infrastructure (eg bridges) may be destroyed and state services (eg early warning systems) may be lacking (Bowles et al 2015). In the global South, there is a concentration of research in areas of preexisting conflict in Africa and Asia, where climate change links are often assumed from Intergovernmental Panel on Climate Change reports to compensate for a lack of field data (Nadiruzzaman et al 2022). Farming can be severely disrupted when movement restrictions are in place (Zickgraf 2019), and economic opportunities for livelihood diversification can be extremely limited (Jaspars and Maxwell 2009). Moreover, donors are risk-averse and prioritize climate change adaptation funding for countries with stable governance (Weiler et al 2018). In a recent study on adaptation to climate change in conflict-affected countries, Sitati et al (2021) showed that most work has focused on Nigeria and Mali, and few studies have compared differences between countries.

There are many types of violent conflict, including civil wars, sectarian conflict, territorial disputes, political instability, or transitional terrorism (Sitati et al 2021), that are likely to affect farmers' adaptation choices differently. Apart from the previously mentioned physical constraints

to adaptation (eg destroyed infrastructure), conflict-related changes in individual and cultural values also shape individuals' decision-making on adaptation. Place attachment, identity, and perceptions of what is a dignified life are important factors affecting decision-making on adaptation (Henrique and Tschakert 2022). For instance, smallholder farmers in Colombia practice value adaptation by shifting what they value and prioritize in life, constantly reconciling what is desired with what is feasible (Castro and Sen 2022).

Mountain socioecological systems are of particular interest when discussing the effects of violent conflict on farmers' adaptation to climate change impacts. First, mountains are often inaccessible because of complex terrains, poor infrastructural connections, and/or dense forests, so governments might only exert limited territorial control over them; they are often at the center of violent conflicts. Second, mountains experience more rapid changes in temperature than lower elevations, because the rate of warming is amplified with elevation (Pepin et al 2015), so mountain agriculture faces important challenges, as is the case on Mount Kilimanjaro (Kaganzi et al 2021). Third, increased temperatures can be compounded by important changes in rainfall amounts and distribution. This is the case in East Africa (Platts et al 2015). Fourth, mountain communities are frequently socioeconomically and politically marginalized (Klein et al 2019), and they often rely on autonomous adaptation interventions (Cuni-Sanchez et al 2022), a situation that can constrain adaptation options (McDowell et al 2021).

This paper aims to improve our understanding of the effects of violent conflict on smallholder farmers' adaptation to climate change impacts by comparing one mountain affected by sectarian conflict and one mountain affected by political instability. The study objectives are to investigate (1) which adaptation strategies are being used and (2) what factors are affecting farmers' adaptation choices. We hypothesize that differences in adaptation strategies will be observed because of differences in the conflicts' characteristics and in the farmers' cultural backgrounds. To ensure that differences in adaptation are not driven by divergent climate impacts, we also investigated climate change impacts as perceived by farmers.

Material and methods

Study areas

We selected the Bamboutos Mountains (Cameroon) and the Itombwe Mountains (Democratic Republic of the Congo, DRC) to exemplify different types of conflict and sociopolitical contexts in the same Central African region. One area was affected by sectarian conflict, and the other was affected by political instability. In Bamboutos, the conflict was sectarian and relatively recent. Infrastructure and market integration were high (at least before the conflict). In Itombwe, the conflict arose from political instability and had been going on for nearly 2 decades. Infrastructure and market integration were low (even before the conflict). We provide more information for these 2 contexts later. We also chose these sites because we had reliable local contacts to ensure the safety of researchers, because both conflicts were ongoing as of 2023.

The Bamboutos Mountains (1400–2740 masl) have a unimodal rainfall regime with a rainy season (*Mpfu-cû*, April–October) and a dry season (*Mpfu-ləu*, November–March), the latter being characterized by the influence of the Harmattan, a dry wind blowing south from the Sahara (Mbue et al 2016). With increasing elevation, mean annual rainfall ranges between 1800 and 2600 mm and mean annual temperature ranges between 21.6 and 12°C (Kengni et al 2009).

The Bamboutos Mountains are mostly populated by farmers belonging to the Bamileke ethnic group, which is part of the larger Grassfields' Bantoid group, claiming Tykar ancestry. The Bamileke are ruled by a divine king (*Fo'o*), respected by his people and recognized by the national government (Betga-Djenkwe 2017). About 450,000 Bamileke live in Bamboutos and the surrounding mountains (Joshua Project n.d.a). Most Bamileke practice rainfed crop production for subsistence and, to a lesser extent, animal husbandry. Most villages in Bamboutos have access to electricity, basic health care, and education. In Bamboutos, insecurity is related to the Anglophone Crisis, sparked in 2017 as a low-scale armed insurgency between the separatists seeking independence for their self-proclaimed state of Ambazonia (comprising the northwest and southwest English-speaking administrative regions) and the Francophone-led central government of Cameroon (Bang and Balgah 2022). This conflict has caused more than 6000 deaths and a major humanitarian crisis, with about 600,000 people internally displaced and 86,000 people forced to become refugees in Nigeria as of October 2022 (OCHA 2022). Among other issues, crop production activities are constrained by restricted access to "safe" land for farming (close to villages), fluctuating market prices, and limited availability of inputs (eg pesticides; Tchékoté et al 2018).

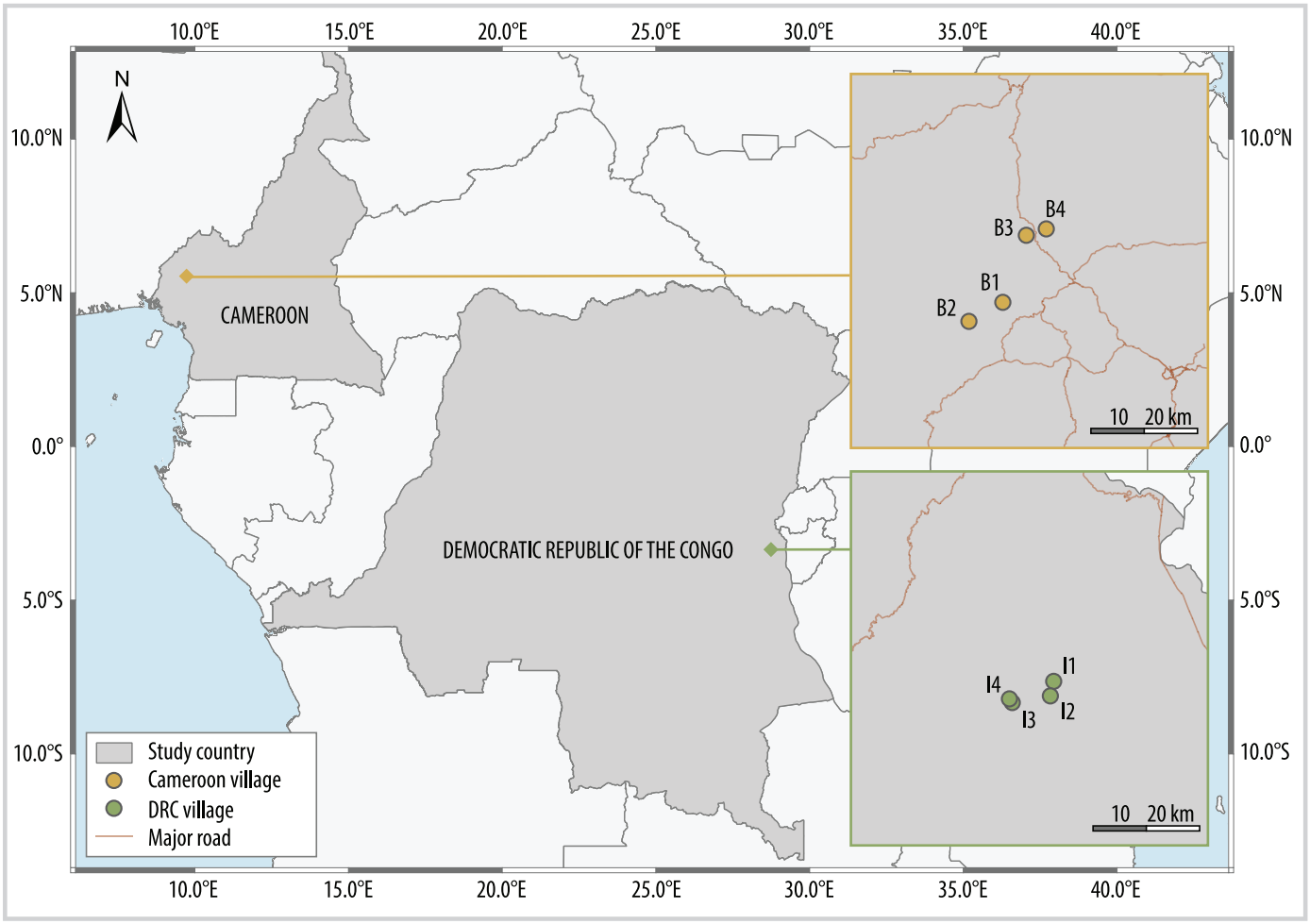
The Itombwe Mountains (1000–3475 masl) also have a unimodal rainfall regime with a rainy season (*Wakati ya vula*, September–May) and a dry season (*Kipwa*, June–August). Annual rainfall ranges between 1200 and 3000 mm (Doumenge 1998). Several ethnic groups inhabit these mountains, including the Lega, Babembe, Banyamulenge, Bashi, Bafuliro or Bafulero, and Banyindu or Nyindu; the Nyindu are in the majority at high elevations. The Nyindu, of Bantu origin, are ruled by a divine king, called *mohami*, respected by his people and by the administration. There are about 16,000 Nyindu (Joshua Project n.d.b).

Itombwe has long been a region where the government's political, administrative, and military authority is weak and fragmented (Simpson and Pellegrini 2022). The mountains first served as a base for Laurent Kabila's rebel movement (1968–1988). Then, the Rwandan genocide and the advance of the *Alliance des Forces Démocratiques pour la Libération du Congo* rebel army caused vast numbers of refugees to flee into the area (1994–1996). The First and Second Congolese Wars (1996–1997 and 1998–2003) led to the rise of numerous armed groups, who controlled artisanal mines. To date, 9 armed groups still operate in these mountains (Verweijen et al 2021). Among other issues, cattle looting, banditry, and kidnapping are common. When conflict escalates, entire villages are abandoned. Access to markets and inputs is limited because of limited road infrastructure and, at high elevations, no cell phone network.

Data collection and analysis

In both study areas, 4 villages located at different elevations (1500–1900 masl in Bamboutos and 2400–2900 masl in

FIGURE 1 Study areas with the location of the villages sampled. (Map by Aida Cuni Sanchez)



Itombwe) within a safe zone for the researchers were targeted (Figure 1). In each village, we first conducted exploratory focus group discussions (FGDs) with 4–5 elders. These were used to customize a common semistructured questionnaire to each study context and to gather information on the factors affecting adaptation practices (due to conflict) and the main barriers to adaptation. For the latter, we paraphrased questions according to Klein et al (2019), whose approach not only provides a global assessment of the obstacles and threats facing mountain systems but also addresses knowledge gaps in mountains while focusing on critical issues of poverty and food security. Then, in the same 4 villages, we administered semistructured questionnaires to 37–38 randomly selected households targeting 50% male and 50% female respondents ($n = 150$ in Bamboutos and $n = 132$ in Itombwe; the reduced sample size in Itombwe resulted from escalating insecurity). The 4 villages sampled in Bamboutos consisted of between 100 and 400 households, whereas in Itombwe they consisted of between 30 and 50 households.

Questionnaires addressed household characteristics and assets, climatic changes observed in the past 30 years, impacts in the biophysical domain, and adaptive strategies used to cope with or adapt to them (Appendix S1, *Supplemental material,* https://doi.org/10.1659/mrd.2023.00014.S1). The collection of locally relevant but cross-culturally comparable information using a common protocol allowed us to simultaneously identify common trends and context-specific singularities of individual sites (Reyes-García et al 2020). The protocol enabled the systematic documentation and analysis of the patterned distribution of local indicators of climate change impacts across climate types and livelihood activities. In response to suggestions during FGDs, conflict issues were not included in the questionnaire, because conflicts were still ongoing and, for some respondents, discussing such issues might have been a cause of great distress.

Exploratory FGDs and interviews were carried out in Ngombale (Bamboutos) or Swahili (Itombwe) and were facilitated by the first 2 authors in April 2021 and January 2022, respectively. All study participants were informed of the study aim and then volunteered for selection. We reported responses as frequencies of respondents in each study area reporting each climate change observation, impact, or adaptation strategy. We used multivariate analysis of variance to explore significant differences between study sites or between genders within one study site and to investigate the effects of the study site (Bamboutos or Itombwe) on the responses. We used a significance level of $P < 0.01$. SPSS v29 (IBM, Armonk, NY, USA) was used for all data analyses to verify significant differences observed between study sites, and Excel (Microsoft, Redmond, WA, USA) was for processing.

TABLE 1 Overview of household characteristics and assets in each study area.

Household characteristic	Bamboutos (Cameroon)	Itombwe (DRC)
Average adults per household	4.3	4.6
Farm size (ha)	1.4	1.9
House owner (%)	92	100
Livestock owner (%)	60	96
TV owner (%)	68	0
Motorbike owner (%)	38	0
Car owner (%)	8	0
Completed primary school (%)	80	18

Results

Household characteristics

Although adults per household, farm size, and house and livestock ownership did not differ significantly across study areas, owning other assets (TV, motorbike, or car), education, and type of livestock were significantly different (Table 1). In Bamboutos, 4% of the households were female-headed, and this was 2% in Itombwe. This low proportion of female-headed households is likely to be related to cultural norms, because widows often have one of their male sons living with them in the house.

Most Nyindu practiced slash-and-burn rainfed crop production for subsistence and, at higher elevations, cattle herding. The major crops at high elevations were maize and Irish potatoes; at lower elevations, cassava was also cultivated. Crops were mostly cultivated for home consumption because of a lack of road infrastructure and market access. Most Nyindu villages had no access to electricity, basic health care, or education.

Climatic changes and impacts

Most climatic changes reported in Bamboutos were also reported in Itombwe, except for reduced frost (only cited in the latter, because villages were located at higher elevations). Significant differences in the percentage of respondents reporting each climatic change were observed between study sites for most variables (except temperature and late onset of rains). The climatic changes reported most often were increased temperatures during both dry and rainy seasons, reduced rainfall, fewer foggy days, and fewer hailstorms (Figure 2).

Significant differences in the percentage of respondents mentioning each impact were also observed between study sites (Figure 3). The impacts reported most often were reduced crop yields, an increase in pests and diseases for maize and Irish potatoes, and reduced human health. Within one study area, there were no significant differences in responses across genders, which is likely because although we interviewed about 50% females, most were not heads of

FIGURE 2 Observed changes in climate in terms of the percentage of respondents in each study area (Bamboutos $n = 150$, Itombwe $n = 132$). *Significant differences across study sites at $P < 0.01$.

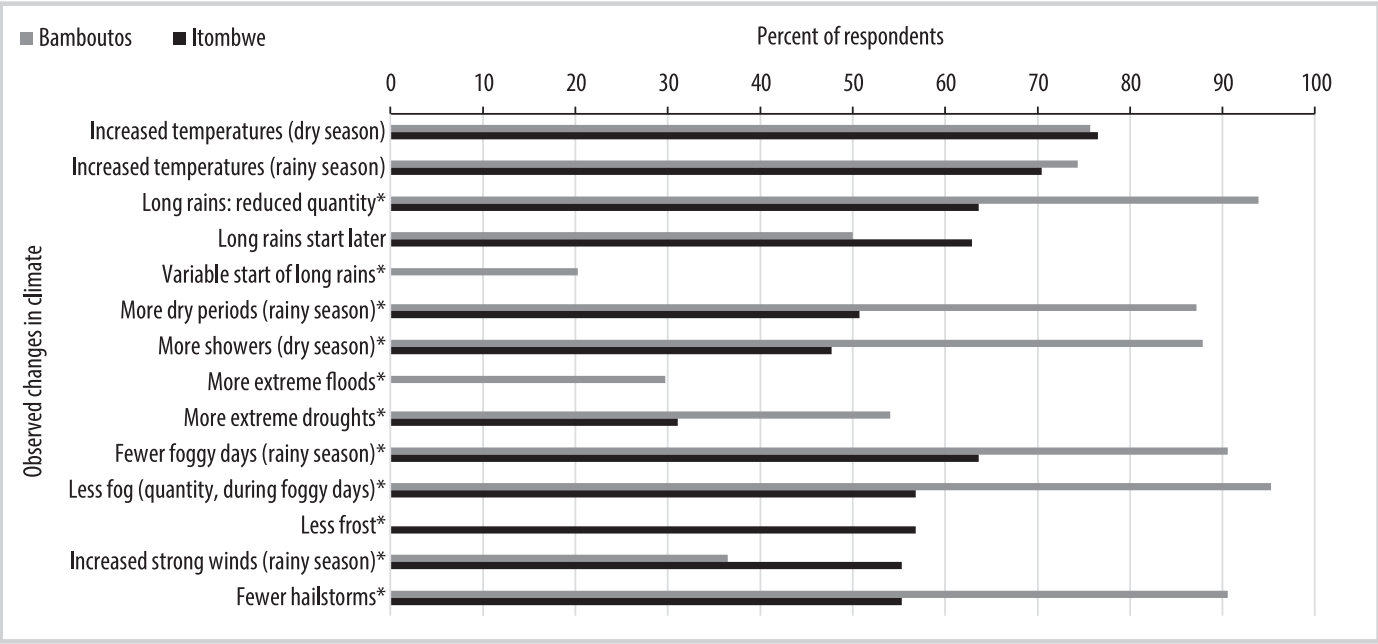


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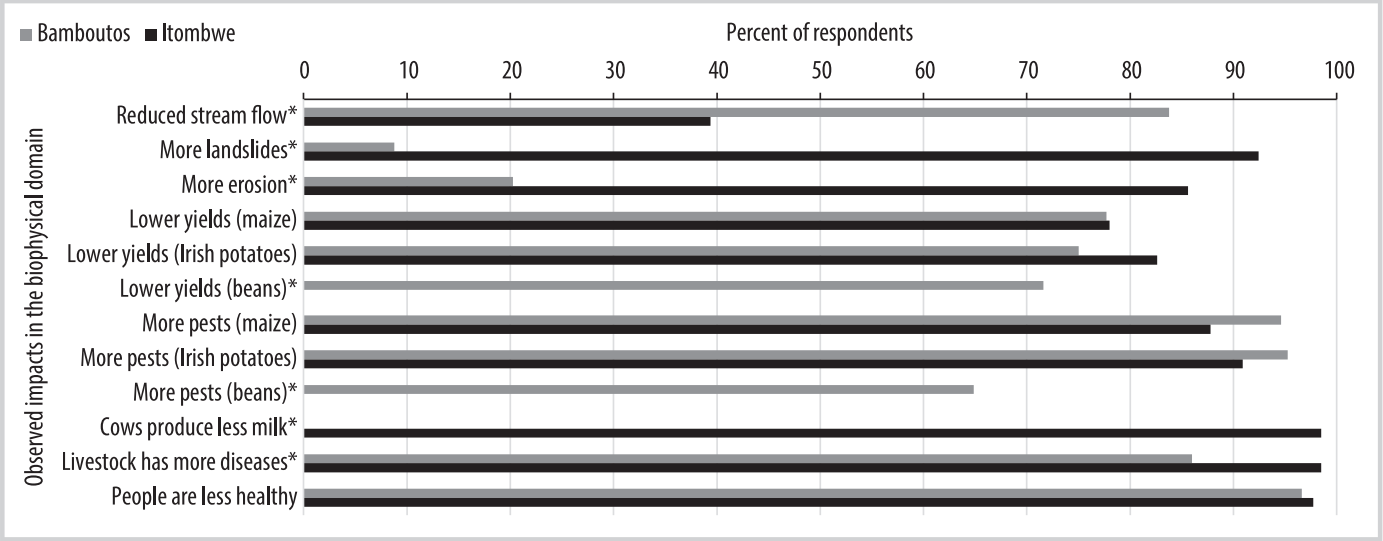
FIGURE 3 Observed impacts in the biophysical domain regarding the percentage of respondents in each study area (Bamboutos $n = 150$, Itombwe $n = 132$). *Significant differences across study sites at $P < 0.01$. Beans are not commonly cultivated in Itombwe. The main pests and diseases reported were fall armyworm for maize, rust and sooty mold for beans, potato blight for Irish potatoes, sore mouth disease for goats, foot-and-mouth disease for cows, and African swine fever for pigs.



households and therefore were not the ones deciding about adaptation strategies.

Adaptation strategies

Significant differences in the percentage of respondents mentioning each adaptation strategy were also observed between study sites for most strategies reported (except sowing seeds earlier and sowing seeds twice; Figure 4). Most respondents had increased the use of improved crop varieties, sowed seeds earlier, sowed seeds twice if they died, and increased veterinary care (Figure 4). In Bamboutos, most respondents had also increased the use of fertilizer and pesticides. Few respondents in both sites had increased irrigation or soil conservation techniques. In Bamboutos, small-scale simple pipes were used for irrigation. There was free access to water, but the cost of establishing the pipe system was high. In Itombwe, irrigation refers to handmade canals that were individually managed, so irrigating land far from streams was challenging.

FIGURE 4 Adaptation strategies used regarding the percentage of respondents in each study (Bamboutos $n = 150$, Itombwe $n = 132$). *Significant differences across study sites at $P < 0.01$. Beans are not commonly cultivated in Itombwe. Minibreeding mostly refers to the breeding of a few chickens, which households can sell in times of need.

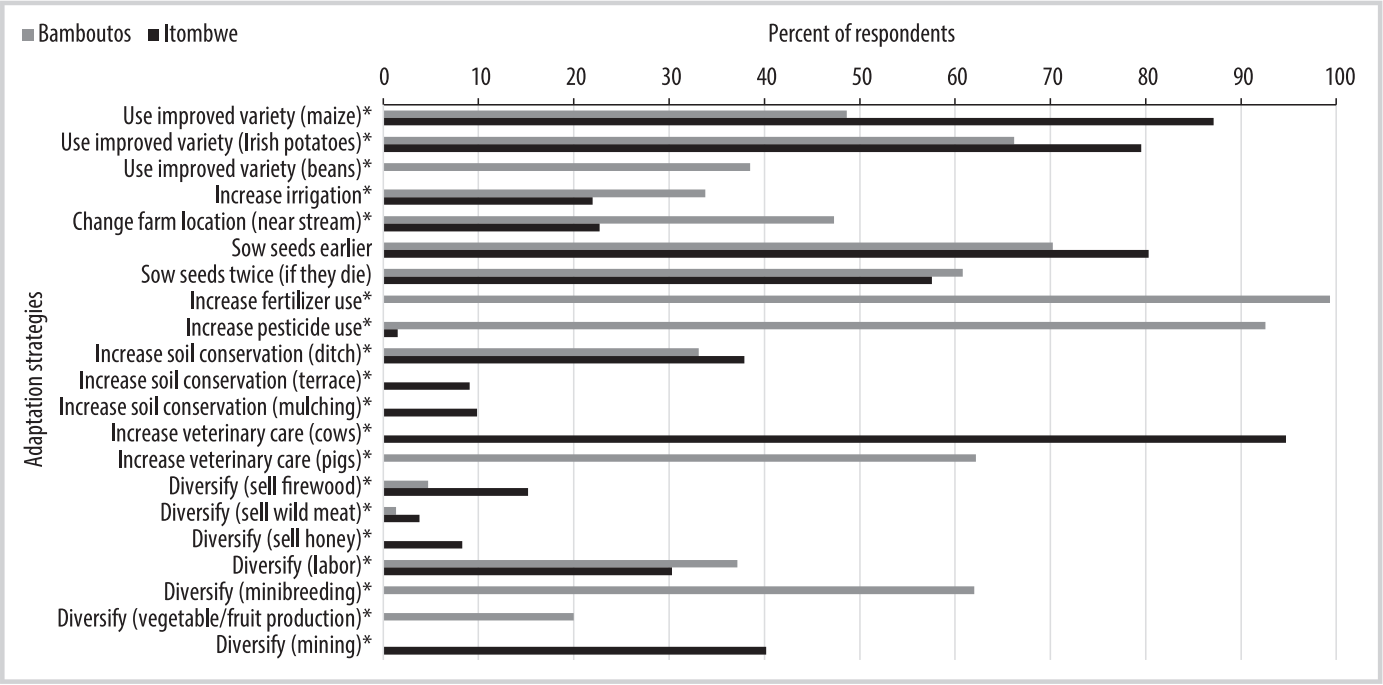


TABLE 2 Typical farmers' choices related to insecurity and conflict, as well as conditions likely affecting these choices, as mentioned in the FGDs.

Item mentioned	Bamboutos (Cameroon)	Itombwe (DRC)
Farmers' choices		
Only live in "safe" villages		X
Prefer herding over crop production (as cows can be moved)		X
Prefer crop production over rearing large animals (as animals can be stolen)	X	
Only farm near the village (for safety)	X	
Only choose crops that can be harvested quickly (avoid eg coffee)	X	X
Limit investment in terracing, agroforestry, etc (slow return)	X	X
No investment in cash crops (unreliable market prices)	X (no longer)	X
Little use of inputs (expensive and unreliable access)		X
Conditions likely affecting choices		
No functioning farmers' associations	X (no longer)	X
No NGOs working on agriculture	X (no longer)	X
No access to government extension workers	X (no longer)	X
No access to microfinance mechanisms	X (no longer)	X
Little off-farm livelihood diversification (no options)	X (no longer)	X
Little room for experimentation or innovation	X (no longer)	X

In Bamboutos, the main livelihood diversification strategies were minibreeding (breeding a few chicken) and labor, whereas in Itombwe, these were labor and mining. The latter was related not only to lower crop yields by some respondents but also to increased opportunities for income generation, because new mining sites had been established near the villages studied. Within each study area, there were no significant differences in responses across genders ($P > 0.01$).

In both sites, participants in FGDs mentioned that all adaptation strategies had been initiated by local communities without external support from nongovernmental organizations (NGOs) or government extension services. In Bamboutos, farmers highlighted that government extension services had helped them in the past but that access to their services was no longer free of charge. They also mentioned that to get government support, farmers had to be grouped into associations, which were complicated to create and maintain over time.

Farmers' choices

Some farmers' choices related to insecurity and conflict are shared between the study sites (Table 2). In Bamboutos, respondents highlighted the importance of crop production as a safety net, even for people with formal jobs: "Even if you lose everything, at least you have your own small farm and you can't sleep hungry" (participant comment during FGD). Respondents also mentioned that they preferred crop production over rearing large animals, because "animals can die or be stolen" (participant comment during FGD). In Itombwe, respondents highlighted the importance of owning cows as a safety net, with comments such as "even if other things do not work [crop failure or no gold found during mining] you can always make some money by selling your cows" (participant comment during FGD). Respondents also mentioned that they preferred herding over crop production, because "you can move your cows to another village during insecurity, but you can't move your crops" (participant comment during FGD). Although some of these different views are likely to be related to cultural differences between the ethnic groups studied, conflict characteristics (eg unpredictable waves of insecurity because of numerous armed groups) and existing underdevelopment before conflict (eg no phone network and lack of farmers' associations in Itombwe), might also explain some of these differences.

Discussion

Climatic changes and impacts

The study sites differed in climatic changes and impacts, suggesting that some differences in the adaptation practices discussed later might be driven by divergent climate impacts. Across sites, though, respondents mentioned increased temperatures, reduced rainfall amounts and changes in its distribution, fewer foggy days, and fewer hailstorms. Increased temperatures, a shorter rainy season, increased variability in rainfall, and reduced fog were also reported by farmers elsewhere in the northwest region of Cameroon (Ngute et al 2021). Historical data from the Bamenda meteorological station (about 30 km north of Bamboutos) indicated increased temperatures and an increase in extreme events (very wet and very dry years; Mbue et al 2016). Increased temperatures, reduced rainfall amounts and changes in its distribution, fewer foggy days, and increased strong winds during the rainy season have also been reported by farmers around Mt Kahuzi and the

Bukavu area in DRC (about 60 km north of Itombwe; Bele et al 2014; Batumike et al 2020). Historical meteorological data available from Kamembe (next to Bukavu) showed a decrease in rainfall during the rainy season and increased temperatures during the dry season (Batumike et al 2020).

In terms of impacts, reduced crop yields and increased pests were also reported by farmers elsewhere in the northwest region of Cameroon (Ngute et al 2021) and around Mt Kahuzi and the Bukavu area in DRC (Bele et al 2014; Batumike et al 2020). Reduced livestock or human health were not investigated in these previous studies. Health is an unrepresented sector in observed climate change impacts in conflict areas (Sitati et al 2021). In Bamboutos, perceived changes in crop yields could also be related to nutrient depletion in the soils, related to shorter fallow rotations. This is not the case in Itombwe, where farmers still practiced fallow rotations (personal observation, 2022). As highlighted by other authors (eg Junqueira et al 2021), local perceptions can help identify impacts that may be largely overlooked by government and development agencies. For example, the integration of farmers' perceptions of drivers of cattle or pig disease could help investigate these problems in more detail.

Adaptation strategies

As we hypothesized, some differences in adaptation strategies were observed across study areas. They might be related to differences in impacts observed across study sites (eg droughts or floods), as well as differences in conflict characteristics and farmers' cultural backgrounds, as we discuss later.

Respondents changed planting dates, increased the use of improved crop varieties, and in Bamboutos, increased the use of fertilizer and pesticide. All of these strategies were mentioned by farmers in Mt Oku in Cameroon (Ngute et al 2021). Farmers in Oku also engaged in livelihood diversification through wood carving (for tourists) and honey production; these were not employed by our respondents, probably because of lack of market access (due to insecurity). In addition, fewer respondents in Bamboutos than Oku engaged in labor because of the lack of labor jobs (due to insecurity).

In Mt Kahuzi, farmers used improved crop varieties, as in Itombwe, but they also mentioned cultivating larger farms (to compensate for lower yields), growing new crops (pineapple and soya), and diversifying livelihoods into timber harvesting or charcoal production (Batumike et al 2020). In Itombwe, farmers were not interested in engaging in such strategies, probably because of the security situation in the area and lack of road infrastructure. In Itombwe, farmers only mentioned one adaptive strategy concerning animal rearing: increasing veterinary care. Other studies documented, for example, migrating, reducing herd size, changing herd composition, growing fodder grass, or using fodder trees (eg in Kenya; Cuni-Sanchez et al 2018). It is possible that because the Nyindu only started cattle rearing in the past few decades (they are traditionally not pastoralists but slash-and-burn agriculturalists; Yamada 1999), they have not yet developed such a range of adaptive strategies. Without external support, it is unlikely that Nyindu farmers would engage in such strategies, because access to information, markets, and institutional or government support influences the choice of adaptation strategy among agropastoralists (Tilahun et al 2017; Menghistu et al 2020).

Overall, our findings highlight the reduced number of adaptation strategies used in both study areas compared with other mountain areas in Africa (eg in Tanzania; Kaganzi et al 2021). As highlighted in FGDs, farmers' choices are affected by the ongoing armed conflicts, and farmers have little room for experimentation or innovation during conflict (as exemplified in Table 2). Remarkably, migration to urban centers (described in Tanzania; Kaganzi et al 2021) was not mentioned in either study area. Possibly, high place attachment to their land and limited income-generating opportunities for unskilled labor in nearby urban centers explain the lack of migration as an adaptive strategy. Other studies have highlighted how place attachment limits smallholder farmers' migration in rural areas (Castro and Sen 2022).

Our results from FGDs also pinpointed 2 major barriers to adaptation in these conflict-affected areas: the farmers' limited organizational capacity and limited market access. These are known to be major barriers to adaptation even outside conflict-affected areas (Klein et al 2014). Both could be tackled with external support if donors were less risk-averse. As some farmers noted in Itombwe, "Sometimes there are more pressing issues than climate change impacts" (referring to everyday survival). Other mountain communities have previously highlighted the same (eg Batumike et al 2020). We cannot deny the urgency of everyday survival and the constraints this places on midterm planning, including adaptation to climate change. When considering climate change adaptation, support for these farmers should be jointly designed with measures in support of peacekeeping, as suggested by Cappelli et al (2022).

Conclusion

Our study aimed to document differences in climate change adaptation in 2 conflict-affected areas, the Itombwe Mountains (eastern DRC, affected by political instability) and the Bamboutos Mountains (western Cameroon, affected by sectarian conflict). We found that some adaptation strategies were used across sites (eg increased use of improved seeds and changing planting dates) but some differed (eg use of inputs), related to differences in impacts observed, conflict characteristics, and farmers' cultural backgrounds. Although we did not investigate the efficiency or sustainability of the adaptation strategies mentioned (eg the potential negative ecological impacts of firewood collection), our list of adaptation strategies used could help guide future interventions in other conflict-affected regions. Following Chambers et al (2021), we highlight the importance of engaging with local farmers if we are to produce knowledge, action, and societal change with regard to climate change adaptation.

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REFERENCES

Bang HN, Balgah RA. 2022. The ramification of Cameroon's Anglophone crisis: Conceptual analysis of a looming "complex disaster emergency." *Journal of International Humanitarian Action* 7:6. https://doi.org/10.1186/s41018-022-00114-1.

Batumike R, Bulonvu F, Imani G, Akonkwa D, Gahigi A, Klein JA, Marchant R, Cuni-Sanchez A. 2020. Climate change and hunter-gatherers in montane eastern DR Congo. *Climate and Development* 14(5):431–442. https://doi.org/10.1080/17565529.2021.1930987.

Bele MY, Sonwa DJ, Tiani AM. 2014. Vulnérabilité des communautés locales au changement climatique et stratégies d'adaptation à Bukavu en RD Congo. *Journal de l'environnement et du développement* 23(3):331–357. https://doi.org/10.1177/1070496514536395.

Betga-Djenkwe NL. 2017. Les techniques de défense des chefferies bamiléké de l'Ouest-Cameroun, du XVI^{e} au début du XX^{e} siècle. *e-Phaïstos* VI-2. https://doi.org/10.4000/ephaistos.3289.

Bob U, Bronkhorst S, editors. 2014. *Conflict-Sensitive Adaptation to Climate Change in Africa.* Climate Diplomacy Series. Berlin, Germany: Berliner Wissenschafts-Verlag.

Bowles DC, Butler CD, Morisetti N. 2015. Climate change, conflict and health. *Journal of the Royal Society of Medicine* 108(10):390–395. https://doi.org/10.1177/0141076815603234.

Cappelli F, Conigliani C, Consoli D, Constantini V, Paglialunga E. 2022. Climate change and armed conflicts in Africa: Temporal persistence, non-linear climate impact and geographical spillovers. *Economia Politica* 40:517–560. https://doi.org/10.1007/s40888-022-00271-x.

Castro B, Sen R. 2022. Everyday adaptation: Theorizing climate change adaptation in daily life. *Global Environmental Change* 75:102555. https://doi.org/10.1016/j.gloenvcha.2022.102555.

Chambers JM, Wyborn C, Ryan E, Reid RS, Riechers M, Serban A, Bennett NJ, Cvitanovic C, Fernández-Giménez ME, Galvin KA, et al. 2021. Six modes of co-production for sustainability. *Nature Sustainability* 4:983–996. https://doi.org/10.1038/s41893-021-00755-x.

Cuni-Sanchez A, Omeny P, Pfeifer M, Olaka L, Mamo MB, Burgess RM. 2018. Climate change and pastoralists: Perceptions and adaptation in montane Kenya. *Climate and Development* 11(6):513–524. https://doi.org/10.1080/17565529.2018.1454880.

Cuni-Sanchez A, Twinomuhangi I, Aneseyee AB, Mwangi B, Bitariho R, Soromessa T, Olaka L, Castro B, Zafra-Calvo N. 2022. Everyday adaptation practices by coffee farmers in three mountain regions in Africa. *Ecology and Society* 27(4):32. https://doi.org/10.5751/ES-13622-270432.

Doumenge C. 1998. Forest diversity, distribution, and dynamique in the Itombwe Mountains, South-Kivu, Democratic Republic of Congo. *Mountain Research and Development* 18(3):249–264. https://doi.org/10.2307/3674036.

Henrique KP, Tschakert P. 2022. Everyday limits to adaptation. *Oxford Open Climate Change* 2(1):kgab013. https://doi.org/10.1093/oxfclm/kgab013.

ICRC [International Committee of the Red Cross]. 2020. *When Rain Turns to Dust: Understanding and Responding to the Combined Impact of Armed Conflicts and the Climate and Environment Crisis on People's Lives*. Geneva, Switzerland: ICRC. https://www.icrc.org/sites/default/files/topic/file_plus_list/rain_turns_to_dust_climate_change_conflict.pdf; accessed on 13 June 2023.

Jaspars S, Maxwell D. 2009. *Food Security and Livelihoods Programming in Conflict: A Review*. HPN [Humanitarian Practice Network] Paper 65. London, United Kingdom: Overseas Development Institute. https://www.files.ethz.ch/isn/101157/networkpaper065.pdf; accessed on 12 May 2023.

Joshua Project. n.d.a. Bamileke-Batcham in Cameroon. *Joshua Project*. Colorado Springs, CO: Joshua Project. https://joshuaproject.net/people_groups/10625/CM; accessed on 16 June 2023.

Joshua Project. n.d.b. Nyindu in Congo, Democratic Republic of. *Joshua Project*. Colorado Springs, CO: Joshua Project. https://joshuaproject.net/people_groups/14100/CG; accessed on 16 June 2023.

Junqueira AB, Fernandez-Llamazares A, Torrents-Ticó M, Haira PL, Nasak JG, Burgas D, Fraixedas S, Cabeza M, Reyes-García V. 2021. Interactions between climate change and infrastructure projects in changing water resources: An ethnobiological perspective from the Daasanach, Kenya. *Journal of Ethnobiology* 41(3):331–348. https://doi.org/10.2993/0278-0771-41.3.331.

Kaganzi KR, Cuni-Sanchez A, Mcharazo F, Martin EH, Marchant RA, Thorn JPR. 2021. Local perceptions of climate change and adaptation responses from two mountain regions in Tanzania. *Land* 10:999. https://doi.org/10.3390/land10100999.

Kengni L, Tekoudjou H, Tematio P, Pamo E, Mubeteneh Tankou C, Lucas Y, Probst J. 2009. Rainfall variability along the southern flank of the Bambouto Mountain (West-Cameroon). *Journal of the Cameroon Academy of Sciences* 8:45–52. https://www.ajol.info/index.php/jcas/article/view/87038; accessed on 24 June 2023.

Klein JA, Tucker CM, Nolin AW, Hopping KA, Reid RS, Steger C, Boone RB, Grêt-Regamey A, Lavorel S, Müller B, et al. 2019. Catalyzing transformations to sustainability in the world's mountains. *Earth's Future* 7(5):547–557. https://doi.org/10.1002/eft2.508.

Klein RJT, Midgley GF, Preston BL, Alam M, Berkhout FGH, Dow K, Shaw MR. 2014. Adaptation opportunities, constraints, and limits. *In:* Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, et al, editors. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press, pp 899–943.

Marktanner M, Mienie E, Noiset L. 2015. From armed conflict to disaster vulnerability. *Disaster Prevention and Management* 24:53–69. https://doi.org/10.1108/DPM-04-2013-0077.

Mbue NI, Bitondo D, Azibo BR. 2016. Climate variability and change in the Bamenda highlands of northwestern Cameroon: Perceptions, impacts and coping mechanisms. *Journal of Applied Science and Technology* 12:1–18. https://doi.org/10.9734/BJAST/2016/21818.

McDowell G, Stevens M, Lesnikowski A, Huggel C, Harden A, DiBella J, Morecroft M, Kumar P, Joe ET, Bhatt ID, et al. 2021. Closing the adaptation gap in mountains. *Mountain Research and Development* 41(3):A1–A10. https://doi.org/10.1659/MRD-JOURNAL-D-21-00033.1.

Menghistu H-T, Abraha A, Tesfay G, Mawcha G. 2020. Determinant factors of climate change adaptation by pastoral/agro-pastoral communities and smallholder farmers in sub-Saharan Africa: A systematic review. *International Journal of Climate Change Strategies and Management* 12(3):305–321. https://doi.org/10.1108/IJCCSM-07-2019-0049.

Nadiruzzaman M, Scheffran J, Shewly HJ, Kley S. 2022. Conflict-sensitive climate change adaptation: A review. *Sustainability* 14:8060. https://doi.org/10.3390/su14138060.

Ngute A, Marchant R, Cuni-Sanchez A. 2021. Climate change, perceptions, and adaptation responses among farmers and pastoralists in the Cameroon Highlands. *In:* Leal Filho W, Luetz J, Ayal D, editors. *Handbook of Climate Change Management*. Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-030-22759-3_311-1.

OCHA [United Nations Office for the Coordination of Humanitarian Affairs]. 2022. Cameroon: North-West and South-West Situation Report No. 46 (August and September 2022). *OCHA Cameroon*. https://reliefweb.int/report/cameroon/cameroon-north-west-and-south-west-situation-report-no-46-august-and-september-2022; accessed on 15 July 2023.

Pepin N, Bradley RS, Diaz HF. 2015. Elevation-dependent warming in mountain regions of the world. *Nature Climate Change* 5:424–430. https://doi.org/10.1038/nclimate2563.

Platts PJ, Omeny PA, Marchant R. 2015. Africlim: High-resolution climate projections for ecological applications in Africa. *African Journal of Ecology* 53(1):103–108. https://doi.org/10.1111/aje.12180.

Reyes-García V, García Del Amo D, Benyei P, Junqueira AB, Labeyrie V, Li X, Porcuna-Ferrer A, Schlingmann A, Soleymani-Fard R, Porcher V. 2020. *LICCI Local Indicators of Climate Change Impacts. Master Manual Version 1.4 (Updated on January 1, 2020). Data Collection Protocol*. Barcelona, Spain: Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona. https://doi.org/10.6084/m9.figshare.11513511.v3; accessed on 24 April 2023.

Sharifi A, Simangan D, Kaneko S. 2020. Three decades of research on climate change and peace: A bibliometrics analysis. *Sustainability Science* 16:1079–1095. https://doi.org/10.1007/s11625-020-00853-3.

Simpson FO'L, Pellegrini L. 2022. Conservation, extraction and social contracts at a violent frontier: Evidence from eastern DRC's Itombwe Nature Reserve. *Political Geography* 92:102519. https://doi.org/10.1016/j.polgeo.2021.102519.

Sitati A, Joe E, Pentz B, Grayson C, Jaime C, Gilmore E, Galappaththi E, Hudson A, Nagle Alverio G, et al. 2021. Climate change adaptation in conflict-affected countries: A systematic assessment of evidence. *Discover Sustainability* 2:42. https://doi.org/10.1007/s43621-021-00052-9.

Tchékoté H, Nguedia MM, Siyapdje EC. 2018. Appropriation foncière, pratiques agricoles et enjeux environnementaux à Bafou-Nord dans les monts Bamboutos (Ouest Cameroun). *Belgeo* 2018(2). https://doi.org/10.4000/belgeo.21085.

Tilahun M, Angassa A, Abebe A. 2017. Community-based knowledge towards rangeland condition, climate change, and adaptation strategies: The case of Afar pastoralists. *Ecological Processes* 6:29. https://doi.org/10.1186/s13717-017-0094-4.

Verweijen J, Twaibu J, Ribakare M, Bulambo P, Mwambi F. 2021. *Mayhem in the Mountains. How Violent Conflict on the Hauts Plateaux of South Kivu Escalated*. Insecure Livelihoods Series. Ghent, Belgium: Governance in Conflict Network, Ghent University. https://eprints.whiterose.ac.uk/174098/; accessed on 19 July 2023.

Weiler F, Klöck C, Dornan M. 2018. Vulnerability, good governance, or donor interests? The allocation of aid for climate change adaptation. *World Development* 104:6577. https://doi.org/10.1016/j.worlddev.2017.11.001.

Yamada T. 1999. A report on the ethnobotany of the Nyindu in the eastern part of the former Zaire. *African Study Monographs* 20(1):1–72. https://doi.org/10.14989/68181.

Zickgraf C. 2019. Climate change and migration crisis in Africa. *In:* Menjívar C, Ruiz M, Ness I, editors. *The Oxford Handbook of Migration Crises*. Oxford, United Kingdom: Oxford Handbooks, pp 347–364. https://doi.org/10.1093/oxfordhb/9780190856908.013.33.

Supplemental material

APPENDIX S1 Semistructured questionnaires.

Found at: https://doi.org/10.1659/mrd.2023.00014.S1.