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# Conflicting interests over natural resource use: the case of interactions among livestock keepers, farmers, and wildlife at Kilombero Valley, Tanzania

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Conflicts over natural resources use among farmers, livestock keepers, and wildlife are escalating in the Kilombero Valley, Tanzania, posing significant threats to livelihoods, security, and sustainable development. This study investigated the types, drivers and impacts of these conflicts using a mix-methods approach, including questionnaire survey, key informant interviews, and focused group discussions. Descriptive statistics and content analysis revealed 16 distinct conflict types, with the most prevalent being crop raiding by livestock before harvest (farmers-pastoralist conflict) and disputes over farm boundaries (farmer-farmer conflict). Key drivers of conflicts varied between groups but commonly included an increasing number of livestock, inadequate supervision of herders, and seasonal flooding of grazing lands. The primary consequences identified were reduced crop yields, social tension, and emotional distress. To mitigate these conflicts, the study recommends enforcing adherence to village land use plans, promoting coexistence through community education, providing training in livestock management and good practice, and regulating livestock influx into the area.

## KEYWORDS

Kilombero Valley, farmer-pastoralist interactions, livestock management, land use planning, natural resource conflicts, sustainable resource use

## 1 Introduction

Conflicts over natural resources are widespread and increasingly complex. They are driven by a combination of factors including unequal access, competing interests, and weak governance structures, all of which contribute to tensions among various user groups (Hill et al., 2017; Redpath et al., 2015). In sub-Saharan Africa, numerous unresolved and multifaceted conflicts have emerged over time between different resource users. For example, between 2010 and 2015, Nigeria experienced 850 clashes resulting in approximately 6,500 fatalities (Tade and Yikwabs, 2020). Similarly, Benjaminsen and Ba (2021) reported 175 deaths following an attack by Dogon farmers on Fulani pastoralist villages in 2019. In Tanzania, one of the most notable incidents, known as the “Kilosa Killings,” was due to a conflict between farmers and livestock keepers in December 2000, when 38 people, including women and children were killed (Brehony et al., 2003). The drivers of such conflicts are diverse and include crop raiding by livestock, competition for access to grazing land and water, the weakening of state institutions, and appropriation of large tracts of land for alternative uses (Kircher, 2013; Wood, 2010).

Some scholars (e.g., Niamir-Fuller et al., 2012) argue that pastoralism can coexist with wildlife conservation minimizing herbivory competition during dry seasons and enhance habitat heterogeneity through livestock and wildlife mobility. Others contend that livestock often compete with wildlife for pasture, water, and space (Young et al., 2005). In many developing countries, conservation policies further complicate this dynamic by restricting livestock grazing in protected areas. For instance, the Wildlife Conservation Act (Cap. 283 R.E. 2022) of Tanzania restricts grazing and farming practices in protected areas (PAs) such as national parks and game reserves.

Shifting climatic conditions, increasing livestock populations, and limited natural resources have driven some pastoralists to migrate across borders in search of pasture and water [International Organisation for Migration Kenya, 2010]. Others have diversified their livelihoods by engaging in crop cultivation as an alternative to traditional livestock keeping (Majekodunmi et al., 2017; Woodhouse and McCabe, 2018). Meanwhile, farmers have been expanding both the number and size of their farms, driven by population growth, agricultural development, socioeconomic pressures, and climatic variability (Lowder et al., 2021).

While land is a finite natural resource, increasing demands from various user groups are intensifying competition and placing pressure on conservation areas. Pastoralists require more grazing land, farmers seek fertile land for cultivation, and wildlife authorities aim to preserve biodiversity by protecting dispersal areas, migratory routes, and buffer zones. These competing interests heighten the risk of conflicts between these groups. Government policies on livestock development and natural resource conservation are often shaped by conflicting priorities, which can lead to unintended consequences (Abebe et al., 2024). For instance, land-use policies that prioritize livestock development without considering ecological sustainability may result in land degradation, loss of wildlife habitat, and overgrazing. Conversely, conservation policies that overlook the needs of farmers and pastoralists can exacerbate tensions and reduce policy effectiveness (Abebe et al., 2024).

The Kilombero Valley in Tanzania exemplifies these challenges. The region faces rapid internal migration of agropastoralists from drought-affected neighboring areas, straining the valley's ecological carrying capacity and sustainability (Brehony, 2005; Nindi et al., 2014). The expansion of extensive farming and increase in livestock numbers continues to undermine conservation efforts and the ability of local communities to maintain their livelihoods, resulting in heightened competition for resources and increased conflict. Prior studies on the Kilombero Valley focused on farming systems (Gebrekidan et al., 2020), wetland livelihoods and degradation (Munishi-Kongo and Jewitt, 2019), the green economy, land-use conflicts, and degradation narratives (Bergius et al., 2020). There remains a gap in understanding interactions among farmers, livestock keepers, and wildlife within a shared landscape.

This study aims to fill this knowledge gap by examining the multiple and often-conflicting interests in the Kilombero Valley. To achieve this, the study assessed the types of natural resource use conflicts, the underlying drivers of these conflicts, and the effects of such conflicts on local communities.

This research was guided by two key hypotheses. First, it posited that farmers are more significantly affected by resource use conflicts than livestock keepers. Second, it suggested that population growth,

driven by immigration and influenced by the availability of water and fertile soils, is the primary catalyst for these conflicts. By addressing this knowledge gap, we aim to enhance policymakers' understanding, thereby increasing the likelihood of developing integrated strategies that reconcile conservation objectives with development goals and foster peaceful coexistence between human communities and wildlife.

## 2 Land-use conflicts

Land-use conflicts are often linked to population dynamics and governance challenges. From a neo-Malthusian perspective, population growth is seen as a key driver of scarcity-induced conflict. As demographic pressures mount, competition over essential resources intensifies, resulting in frustration and eventual conflict. Homer-Dixon (1999) categorizes environmental scarcity into three types: supply-induced scarcity, demand-induced scarcity (primarily driven by population growth), and structural scarcity arising from inequitable distribution that limits access for disadvantaged groups.

However, these neo-Malthusian views have faced scholarly criticism. Simon and Bartlett (1985) argue that despite resource limitations, market mechanisms and technological innovation can mitigate scarcity. Likewise, Goldstone et al. (2018) posits that population growth alone does not directly cause conflict; instead, it interacts with other factors such as rapid urbanization and education. Climate change further compounds resource scarcity as it reduces crop yields, degrades land, constrains water access, and increases pressure on food systems (Saleem et al., 2024).

In contrast, political ecologists emphasize that resource-related conflicts are deeply rooted in social justice issues including entitlements, access, control, representation, and meaning (Mildner et al., 2011). Peluso and Watts (2001) argue that the environment itself is not just a passive backdrop, but an active space where competing claims and cultural narratives unfold. Environmental conflicts, therefore, are not simply ecological—they are socially, politically, economically, and culturally embedded (Beckert et al., 2014; Straight et al., 2016).

Empirical evidence supports the notion that weak governance and flawed land policies play a central role in exacerbating land-use conflicts. Studies such as that by Massawe and Urassa (2016) demonstrate how the implementation and enforcement of land regulations frequently trigger disputes. Dysfunctional legal frameworks, ineffective land administration, and fragile tenure systems, both statutory and customary, are key contributors (Saruni et al., 2018). Corruption and elite capture, particularly in land administration, often marginalize vulnerable populations, including women and the poor, by limiting their ability to access and control land (Demeshko et al., 2024).

Additional drivers include sharp power imbalances, where national and foreign investors control vast tracts of land, sidelining local communities. Mismanagement, illegal resource exploitation, and contradictory policy objectives intensify the problem (Gwaleba and Silayo, 2019). Furthermore, diverging interests among stakeholders, such as government bodies, investors, and local populations, can lead to competing land agendas and escalated disputes (Ogola, 2013).

In some instances, illegal land appropriation by squatters, coupled with weak and corrupt local leadership, further aggravates conflict. Political actors may also inflame tensions by supporting unauthorized land seizures for personal or electoral gain (Ogola, 2013; Gwaleba and Silayo, 2019). The case of the Kilombero Valley exemplifies the growing demand for land and natural resources. Here, the interplay between agricultural expansion, livestock grazing, and conservation imperatives drives the need for a nuanced understanding of land-use dynamics, an essential step toward establishing sustainable and equitable land governance.

### 3 Materials and methods

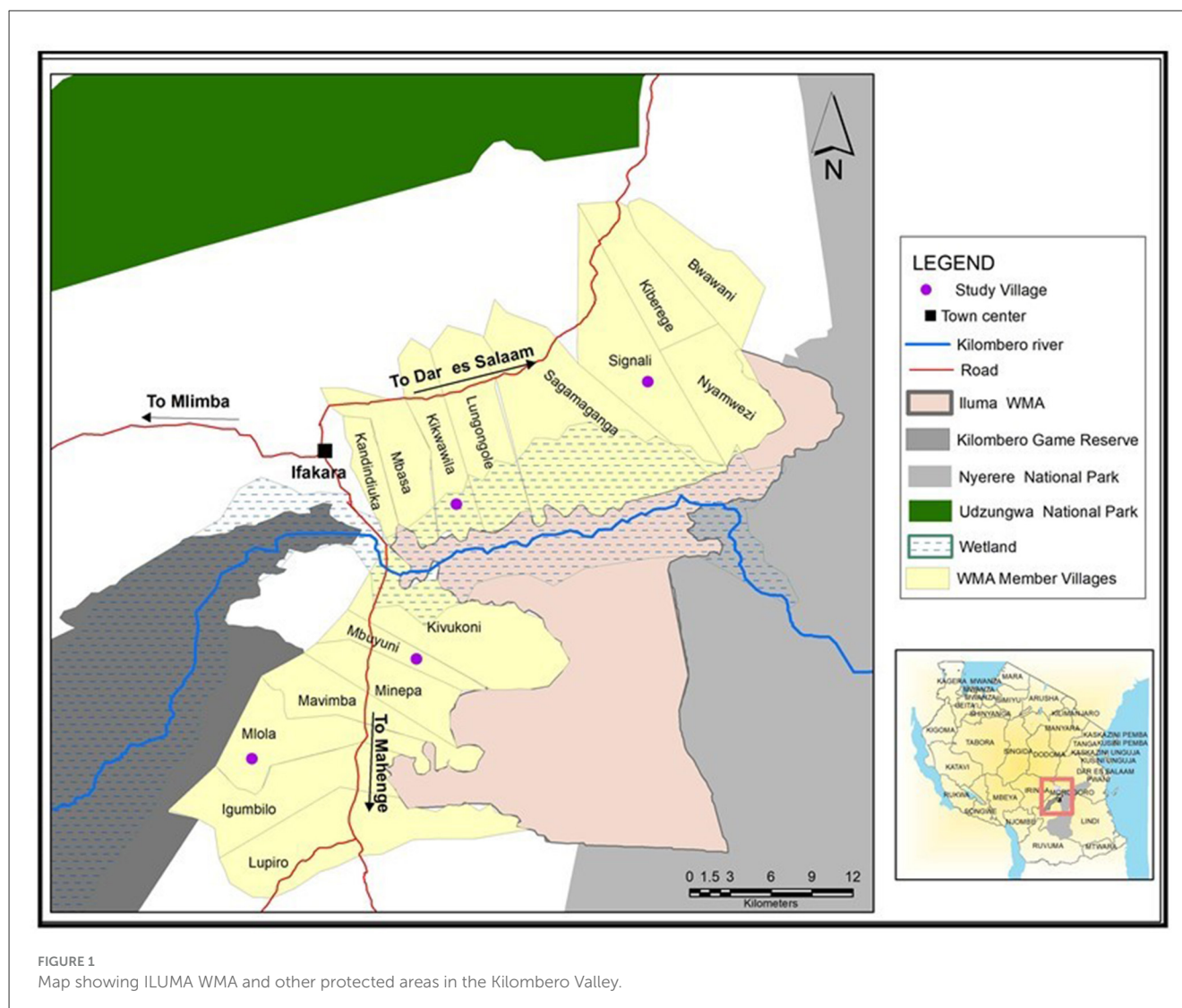
#### 3.1 Description of the study area

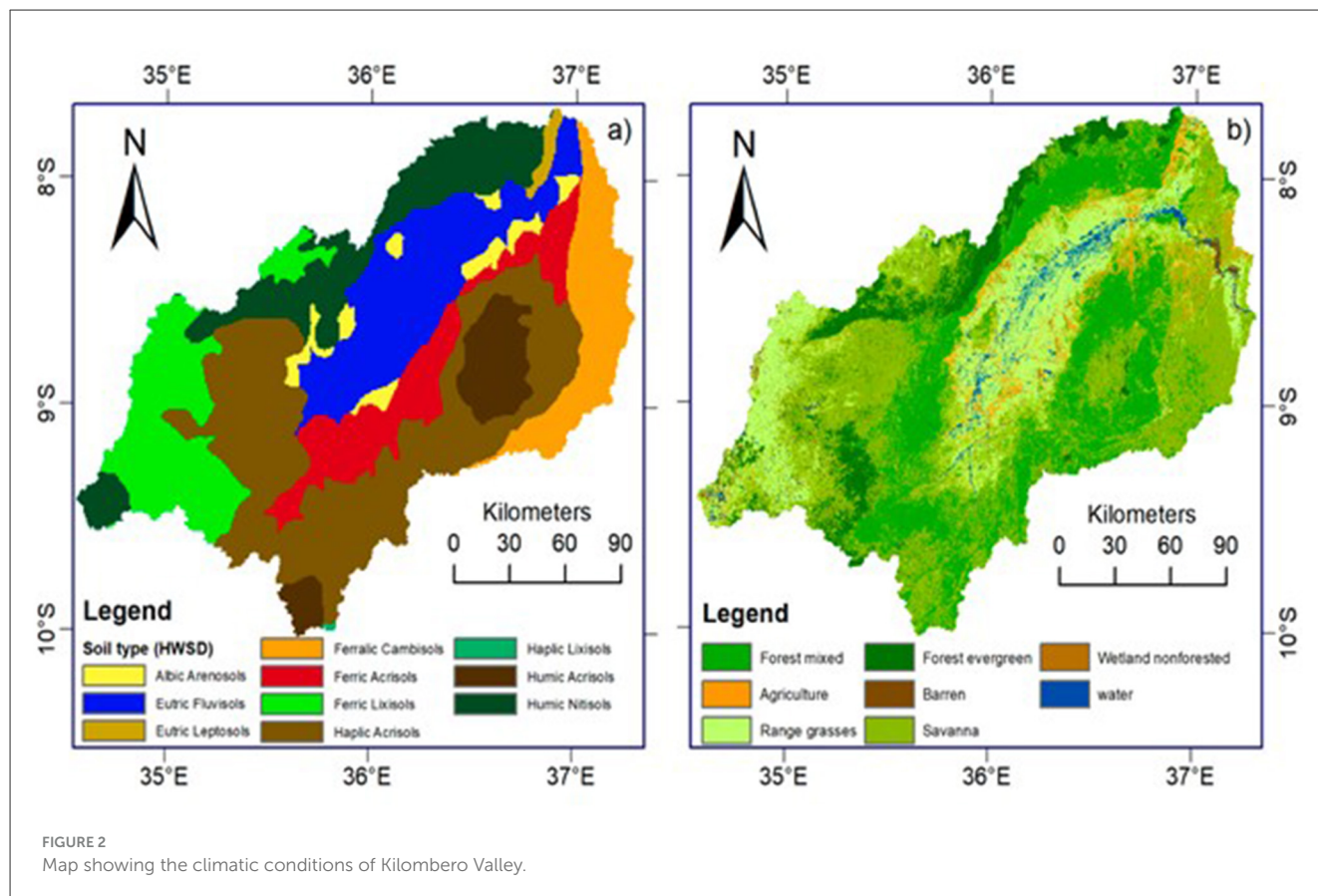
The study was conducted in four villages: Kikawila and Signali in Kilombero District, and Milola and Mbuyuni in Ulanga District, all located in the Morogoro Region of eastern Tanzania (Figure 1). These villages are among the 15 member communities of the Ifakara-Lupiro-Mangula (ILUMA) Wildlife Management

Area (WMA), which span 509 km<sup>2</sup> across Kilombero and Ulanga districts. ILUMA is part of the broader Selous ecosystem and forms a critical component of the Kilombero Valley Ramsar Site. It borders Nyerere National Park (NNP) (30,893 km<sup>2</sup>) to the east and the Kilombero River to the north, while its southern and western boundaries are adjacent to agricultural lands and village settlements.

ILUMA WMA was established in 2011 and officially granted user rights on 05 May 2015, making it the 18th registered WMA in Tanzania. Each member village is represented in a community-based organization, which is responsible for managing the ILUMA WMA.

The Kilombero Valley experiences an annual rainfall between 1,200 and 1,400 mm, with a rainy season from December to May and a dry season from June to November (Figure 2). The average temperature ranges from 20 to 23 °C, varying with topography, where open flood plains are hotter compared to forested mountain areas (RAMSAR, 2002). The soils of the Kilombero Valley are classified as inceptisols (cambisols) and entisols (fluvisols), with leptosols (entisols) on the lower slopes (Massawe, 2015).





Vegetation and land use in the Kilombero Valley transitions with altitude, with tall Miombo woodlands and evergreen forests at higher elevations and shrublands and grasslands dominating the lower areas. The lower valley is primarily used for agriculture, whereas the upper portion is designated as protected land, with only a few small patches allocated for cultivation (Alavaisha et al., 2022).

Ecologically, the Kilombero wetland remains a crucial water reservoir for the Rufiji River system (KVOC, 2017). It is sustained by three permanent rivers and 15 seasonal rivers, offering significant potential for irrigation. The WMA also functions as an ecological corridor, connecting Udzungwa and Nyerere national parks with the Kilombero Game Reserve (KGR). The region supports a rich diversity of wildlife, including elephants, buffaloes, puku, hippopotamus, sable antelope, warthogs, bushbucks, hartebeest, reedbucks, lions, leopards, hyena, reptiles, crocodiles, and migratory waterfowl.

The valley is home to a mix of indigenous and internal migrant communities. Indigenous groups include the Ndamba (traditionally riverine fishers), Mbunga, Hehe, Pogoro, Bena, Ngindo, Ndwee, and Ngoni. Internal migrant populations include the Sukuma, Maasai, Gogo, Chaga, Haya, and Yao (Nindi et al., 2014).

The main socioeconomic activities are agriculture, livestock keeping, fishing, small-scale trade, mining, and timber harvesting. Crops cultivated in the area include rice, maize, cashew nuts, palm trees (for palm oil), beans, bananas, bambara nuts (njugu mawe), pigeon peas (mbaazi), cowpea (kunde), cassava,

sunflower, sorghum, groundnuts, sesame seeds (ufuta), cocoa, coffee, bulrush/pearl millet, potatoes, and teak trees. Irrigated crops such as rice, sugarcane, onions, watermelon, tomatoes, and vegetables are grown year-round. Livestock include cattle, sheep, goats, pigs, donkeys, and poultry.

According to the 2012 national human population census, the Kilombero Valley floodplain had a population of 657,246 [United Republic of Tanzania (URT), 2012], with an annual growth rate of 3.4%, which is higher than the national average of 2.8%. In 2022, the population density was 43 persons per km<sup>2</sup>. Table 1 presents the population data for Kilombero and Ulanga/Malinyi districts.

The study area was selected purposively based on the presence of both farmers and livestock keepers/agropastoralists, proximity to wildlife PAs, and documented cases of resource use conflicts.

### 3.2 Research design and sampling strategy

A cross-sectional study design was employed, integrating both quantitative and qualitative methods. A stratified random sampling approach was used to categorize villagers into two groups, farmers and pastoralist, and to select participants for the questionnaire survey. The use of random sampling was based on the need to minimize selection bias and to ensure that each household had an equal probability of being selected. A total of 160 individuals were initially targeted. From each village, household lists were obtained from the updated village register, which served as a sampling

**TABLE 1** The population of Kilombero and Ulanga districts from 1967 to 2022.

| District           | Year    |         |         |         |         |
|--------------------|---------|---------|---------|---------|---------|
|                    | 1967    | 1988    | 2002    | 2012    | 2022    |
| Kilombero          | 74,222  | 187,593 | 321,611 | 407,180 | 617,032 |
| Ulanga and Malinyi | 100,000 | 138,642 | 193,286 | 265,203 | 458,021 |

frame. The total number of households was 6,018, comprising approximately 3,309 farmer households (55%) and 2,708 livestock keeper households (45%). To ensure proportional representation, the sample size for each group was determined based on its share of the overall population. Accordingly, 88 farmers and 72 livestock keepers were initially enrolled in the study.

### 3.3 Data collection methods

Primary data were collected through household questionnaires, focused group discussions, and key informant interviews. Secondary data were obtained from published journal articles and unpublished reports, legal documents (such as policy and legislation relevant to the study), and media sources.

#### 3.3.1 Household questionnaire survey

A semi-structured questionnaire comprising both open- and closed-ended questions was used to gather data on socioeconomic characteristics; crop production and livestock keeping; types and causes of conflicts among farmers, livestock keepers, and conservation authorities; and the effects of these conflicts. A total of 160 households were surveyed: 72 livestock keepers and 88 from the farming community. Following data collection, 18 questionnaires were excluded due to incomplete responses, resulting in a final sample of 142 valid questionnaires: 74 from farmers and 68 from livestock keepers. The questionnaire was pre-tested to ensure validity and reliability, and revisions were made based on the pre-test results. Data collection was conducted using Kobo Toolbox.

#### 3.3.2 Focused group discussion

One focus group discussion was conducted in each village, with 7–12 participants per group. Participants were purposively selected and included male and female residents aged 18 and above, village government (VG) leaders, village elders (aged 50+), ward livestock and agricultural officers, and livestock keepers and farmers. Village elders were specifically included due to their long-term lived experience in the area. Discussion topics included the types, drivers, and effects of conflicts. Participants were encouraged to express their views freely.

#### 3.3.3 Key informant interviews

A total of 30 key informants were interviewed based on their expertise and experience related to the study topic.

The informants were selected from various administrative and stakeholder levels, notably:

- Six village-level representatives from each studied village ( $n = 24$ ): the village chairperson, the village executive officer, a farmer, a livestock keeper, the Ward livestock officer, and the village Game Scout);
- Two district-level officials ( $n = 2$ ): District game officer and the District livestock or agricultural officer);
- Two ILUMA WMA representatives ( $n = 2$ ): chairperson and secretary;
- Two protected area staff ( $n = 2$ ): one each from Kilombero Game Reserve and Nyerere National Park.

Interviews were guided by a key informant checklist, which focused on several core themes: historical and current land-use changes in the area; the nature and drivers of conflicts involving farmers, livestock keepers, and protected areas; and the resulting impacts of these conflicts.

#### 3.3.4 Secondary data review

Secondary sources included legal documents, academic articles, government and NGO reports, media publications, and gray literature. These materials were reviewed to complement and contextualize the primary data.

### 3.4 Data analysis

The study employed both qualitative and quantitative data analysis techniques to address the research objectives.

#### 3.4.1 Qualitative data analysis

Qualitative data consisted of recorded verbal responses obtained through key informant interviews (KIIs) and focused group discussions (FGDs), alongside field notes derived from interviews and informal conversations. All interviews and discussions were conducted in Swahili, the original language of communication, and subsequently translated into English for analytical purposes.

A thematic analysis was employed to identify salient themes, recurring patterns, and emerging insights within the data. Transcripts were manually coded using color-coded highlights to categorize processes, thematic categories, and narrative elements. The coding framework was informed by the study's objectives and concentrated on themes such as the types of land-use conflict, underlying drivers, and associated impacts. Narrative analysis was applied to interpret the qualitative data, integrating insights from transcriptions, observational notes, and informal interviews. These qualitative findings were used to enrich and contextualize the quantitative results.

#### 3.4.2 Quantitative data analysis

Quantitative data, derived from household questionnaire surveys, were analyzed using SPSS software. Descriptive statistics,

including frequencies and percentages, were generated to summarize responses related to land-use practices, conflict typologies, conflict drivers, and perceived consequences.

## 4 Results and discussion

### 4.1 Socioeconomic characteristics of respondents

Among the livestock keepers interviewed, the majority were male (89.7%,  $n = 61$ ), with most falling within the age brackets of 49–63 (47%,  $n = 32$ ) and 34–48 (35.3%,  $n = 24$ ). Regarding educational attainment, 63% ( $n = 43$ ) had completed primary education. A substantial proportion (94%,  $n = 64$ ) were married. About 96% ( $n = 65$ ) of pastoral households were male headed, and few 4% ( $n = 3$ ) were female headed (see Table 2).

In contrast, 61% ( $n = 45$ ) of farmers surveyed were male, with the largest age groups being 34–48 years (35.1%,  $n = 26$ ) and 49–63 years (33.8%,  $n = 25$ ). Similar to the livestock keeper group, a majority of farmers (78.4%,  $n = 58$ ) had attained primary education, and about 82% ( $n = 61$ ) were married. About, 85% ( $n = 63$ ) of farmers' households were male headed and 15% ( $n = 11$ ) were female headed.

The high representation of female farmers compared to female livestock keepers underscores the male-dominated nature of pastoralist societies, where men typically served as household heads and primary decision-makers. Differences in educational attainment between farmers and livestock keepers may reflect cultural norms; in many pastoralist communities, children are primarily viewed as labor for herding, and formal education is often undervalued (cf. Saruni, 2011).

Household sizes tended to be larger among livestock keepers than farmers, likely due to the prevalence of polygyny in pastoralist communities (Table 3). In these societies, having numerous children is associated with social prestige and provides essential labor for herding and agricultural activities. Nearly all livestock keepers (98.5%,  $n = 67$ ) engaged in both livestock keeping and farming, while 98.6% ( $n = 73$ ) of farmers practiced mainly crop farming. This dual livelihood strategy for livestock keepers reflects the growing pressure on land resources for both cultivation and grazing.

A significant proportion of livestock keepers (74%,  $n = 50$ ), predominantly from the Sukuma ethnic group, were internal migrants, and only 26% ( $n = 18$ ) were born locally (Figure 3). The majority of internal migrants (67.7%,  $n = 46$ ) originated from the Mwanza, Tabora, and Shinyanga regions. Smaller proportions came from Singida, Kilimanjaro, Kilosa, Liwale, and Mahenge (10.5%,  $n = 7$ ), and Mbeya (5.9%,  $n = 4$ ).

Migration to the area was most prominent between 2001 and 2021 (69%,  $n = 47$ ), with fewer arrivals between 1975 and 2000 (13%,  $n = 9$ ). The primary motivation for relocation was the search for pasture and agricultural land (36.8%,  $n = 25$ ). In contrast, most farmers were indigenous to the area (59.5%,  $n = 44$ ), while 40.5% ( $n = 30$ ) were internal immigrants (Figure 4). The Ngindo ethnic group represented the largest share of respondents (37.8%,  $n = 28$ ), followed by Pogoro (17.4%,  $n = 13$ ), Ngoni (10.8%,  $n = 8$ ), Ndwewe (6.8%,  $n = 5$ ), Sukuma, Hehe, and Ndendeule (4.1%,  $n = 3$  each),

TABLE 2 Socio-economic characteristics of livestock keepers and farmers.

|                               | Livestock keepers |       | Farmers  |       |
|-------------------------------|-------------------|-------|----------|-------|
| Respondents per village       |                   |       |          |       |
| Village                       | <i>N</i>          | %     | <i>N</i> | %     |
| Kikwawila                     | 16                | 23.5  | 19       | 25.7  |
| Mbuyuni                       | 19                | 27.9  | 20       | 27.0  |
| Milola                        | 16                | 23.5  | 18       | 24.3  |
| Signalali                     | 17                | 25.0  | 17       | 23.0  |
| Total                         | 68                | 100.0 | 74       | 100.0 |
| Gender                        |                   |       |          |       |
| Men                           | 61                | 89.7  | 45       | 60.8  |
| Women                         | 7                 | 10.3  | 29       | 39.2  |
| Total                         | 68                | 100.0 | 74       | 100.0 |
| Age                           |                   |       |          |       |
| 18–33                         | 5                 | 7.4   | 9        | 12.2  |
| 34–48                         | 24                | 35.3  | 26       | 35.1  |
| 49–63                         | 32                | 47.1  | 25       | 33.8  |
| More than 64                  | 7                 | 10.3  | 14       | 18.9  |
| Total                         | 68                | 100.0 | 74       | 100.0 |
| Education level               |                   |       |          |       |
| College/university            | 1                 | 1.5   | 1        | 1.4   |
| Secondary school              | 6                 | 8.8   | 10       | 13.5  |
| Informal education            | 18                | 26.5  | 5        | 6.8   |
| Primary school                | 43                | 63.2  | 58       | 78.4  |
| Total                         | 68                | 100.0 | 74       | 100   |
| Marital status                |                   |       |          |       |
| Married                       | 64                | 94.1  | 61       | 82.4  |
| Not married/single            | 2                 | 2.9   | 3        | 4.1   |
| Separated/divorced            | 2                 | 2.9   | 7        | 9.5   |
| Cohabiting                    | –                 | –     | 3        | 4.1   |
| Total                         | 68                | 100.0 | 74       | 100.0 |
| Occupation                    |                   |       |          |       |
| Livestock keeping             | 1                 | 1.5   | –        | –     |
| Livestock keeping and farming | 67                | 98.5  | 1        | 1.4   |
| Crop farming                  | –                 | –     | 73       | 98.6  |
| Total                         | 68                | 100.0 | 74       | 100.0 |

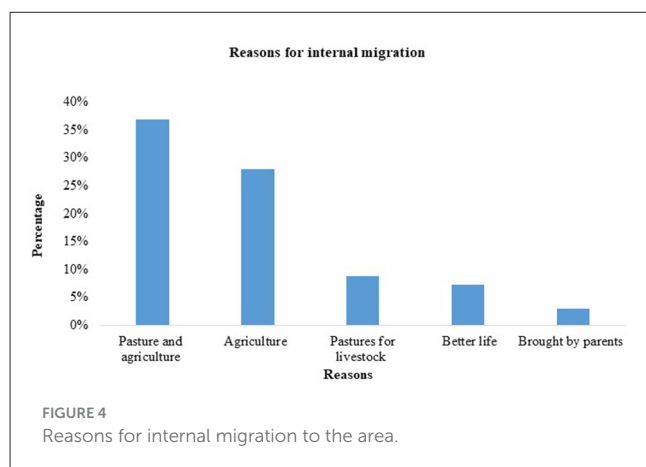
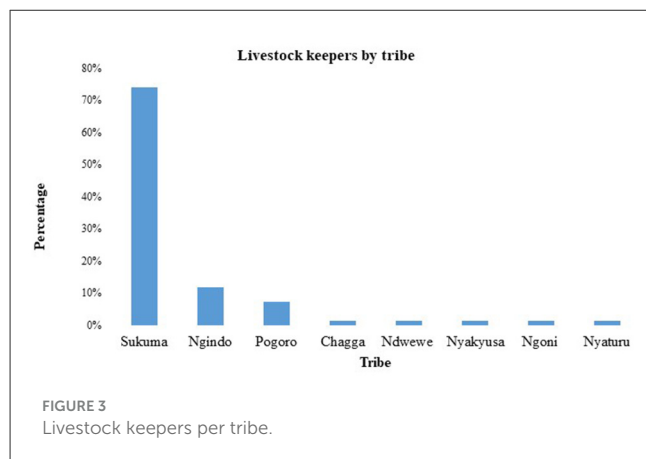
Ndamba and Yao (2.7%,  $n = 2$  each), Haya, Makua, Ha, Zaramo, Dengereko, Nyakyusa, and Nyamwezi (1.4%,  $n = 1$  each).

### 4.2 Crop production, livestock keeping, and land acquisition

The Kilombero Valley's fertile soils and abundant water resources support diverse crop cultivation. The most commonly

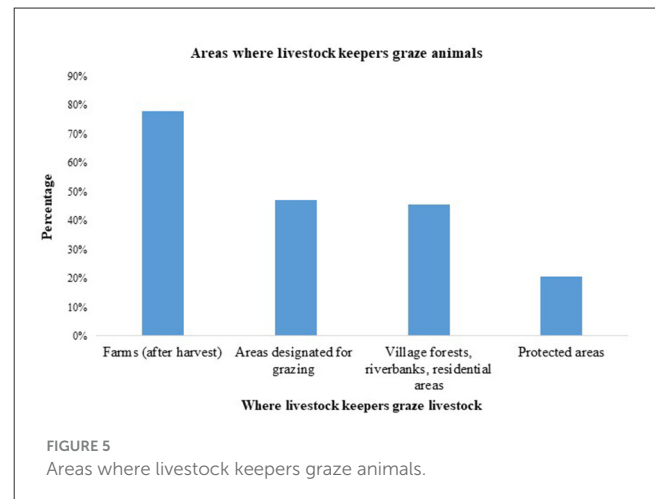
TABLE 3 Household size.

|                                   | Livestock keepers |                    | Farmers |                    |
|-----------------------------------|-------------------|--------------------|---------|--------------------|
|                                   | Mean              | Standard deviation | Mean    | Standard deviation |
| Number of people in the household | 10.94             | 7.956              | 6.33    | 3.358              |
| Number of children                | 7.79              | 5.774              | 4.11    | 2.917              |



grown crops were rice (100%,  $n = 74$ ) and maize (59.5%,  $n = 44$ ), followed by cassava (39.2%,  $n = 29$ ), potatoes (10.8%,  $n = 8$ ), banana (9.5%,  $n = 7$ ), and groundnuts, vegetables, and sesame (8.1%,  $n = 6$  each). Other crops included sunflower and cashew nuts (4.1%,  $n = 3$  each), oil palm trees (2.7%,  $n = 2$ ), and beans, bulrush millet (Uwele), pumpkin, and taro root (1.4%,  $n = 1$  each). Rice was both the dominant cash crop and staple food, with over 90% of production relying on rain-fed agriculture.

Although villages have designated grazing areas, most livestock keepers graze their animals on post-harvest farmland (77.9%,  $n = 53$ ) and in other areas such as forests, residential zones, riverbanks, and PAs. These practices suggest that designated grazing lands maybe insufficient, livestock may exceed the land's carrying capacity, or village land-use plans are not being adhered to (see Figure 5). While 55.9% ( $n = 38$ ) of livestock keepers owned

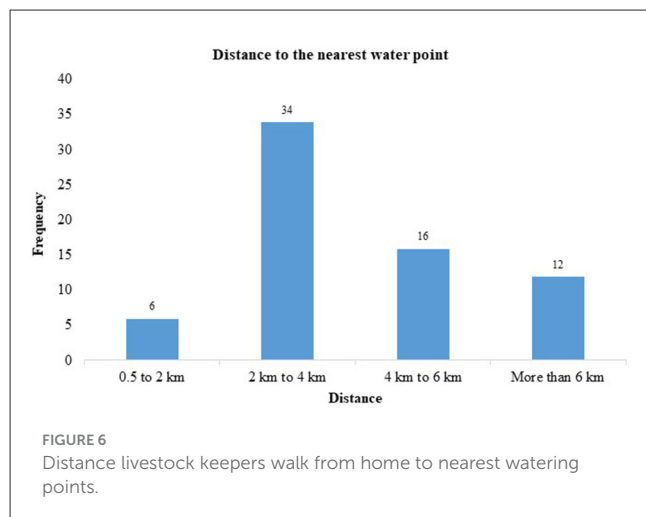


grazing land, 44.1% ( $n = 30$ ) did not, leading to grazing in restricted zones. Focused group discussions (FGDs) revealed that livestock keeping was primarily practiced by the Sukuma, with limited participation from the Maasai and other ethnic groups.

The majority of livestock herders were children under 18 years of age (73.5%,  $n = 50$ ), with adults comprising only 26.5% ( $n = 18$ ). Free-range grazing was the predominant practice (97.1%,  $n = 66$ ), while semi-zero grazing was rare (2.9%,  $n = 2$ ). Over half of respondents (54%,  $n = 37$ ) reported insufficient grazing land, whereas 46% ( $n = 31$ ) considered it adequate. Most farmers acquired land through inheritance (50%,  $n = 37$ ) or purchase (48.6%,  $n = 36$ ), with smaller proportions renting land (14.9%,  $n = 11$ ), occupying unclaimed areas/bushes (10.8%,  $n = 8$ ), or receiving land from village governments (VG) (1.4%,  $n = 1$ ). In contrast, livestock keepers primarily acquired land through purchase (79.4%,  $n = 54$ ), followed by inheritance (11.8%,  $n = 8$ ), occupation of unclaimed land (4.4%,  $n = 3$ ), and VG allocation (2.9%,  $n = 2$ ). These patterns reflect the indigenous status of most farmers, whereas livestock keepers, largely internal migrants, are more likely to purchase land. This dynamic may contribute to the subdivision of indigenous land, potentially reducing the area available for farming.

FGDs revealed that many local residents lack formal land documentation (e.g., title deeds), and are unaware of farm physical boundaries. In Kikwawila Village, land allocation for farming requires a payment of 12,000 TZS (\$5) per acre for locals and 22,000 TZS (\$9.3) per acre for outsiders, who must also contribute to village development projects. An annual fee/tax of 2000 TZS (\$0.80) per acre is charged thereafter. If a plot remains uncultivated for three consecutive years, VG leadership may reallocate it without prior notice. In other villages, land allocated by the VG is granted permanently.

Regarding irrigation, 70.3% ( $n = 52$ ) of farmers reported access to water sources, while 29.7% ( $n = 22$ ) did not. Reported water sources included Kilama, Kiburubutu, Aramba, Chemchem, Mnyoamach, Sururu, Kihansi, Kikwawila, Kilombero, Makatete, Ngurunguru, Ruli, and Ulala rivers, and Mdaba Dam, among others. Most farmers (64.9%,  $n = 48$ ) indicated that these sources were located on village land, while a small proportion (10.8%,  $n = 8$ ) reported sources within PAs.



In terms of sharing, 62.2% ( $n = 46$ ) of farmers shared water sources with fishers and livestock keepers, while 33.8% ( $n = 25$ ) did not. Among livestock keepers, 97.1% ( $n = 66$ ) reported water sources on village land, 38.2% ( $n = 26$ ) within PAs, and 5.9% ( $n = 4$ ) in wetland areas. A majority (82.4%,  $n = 56$ ) shared water sources with farmers, fishers, and stonecutters; 17.6% ( $n = 12$ ) did not (Figure 6).

These findings suggest that water resources are generally accessible to multiple community groups, reducing the need to enter PAs for water. The presence of shared water sources appears to mitigate conflicts and competition between farmers and livestock keepers. Research indicates that when water is readily available, pressure on existing sources diminishes, thereby lowering the likelihood of disputes over access (Kratli and Toulmin, 2020).

### 4.3 Nature and dynamics of land-use conflicts

The study identified 16 distinct forms of conflict involving a range of actors, including farmer–farmer disputes, farmer–livestock keeper tensions, conflicts between villagers and protected area (PAs) authorities, and disputes between villagers and VGs. The diversity of conflict types exceeds those documented by Saruni et al. (2018), who reported eight forms of conflicts between farmers and pastoralists in Kilosa and Kiteto districts. The broader spectrum observed in the Kilombero Valley may be attributed to its complex land-use mosaic, which encompasses conservation areas (e.g., ILUMA WMA, Kilombero Game Reserve, Nyerere National Park), forested zones (including teak plantations, village forests, and smallholder forest plots), agricultural lands, grazing areas, and fishing grounds. This multiplicity of overlapping land uses increases the potential claims and disputes.

The most frequently reported conflicts included: (i) farmer–pastoralist disputes over crop raiding prior to the main harvest, commonly referred to as a “national song” due to its prevalence; (ii) farmer–farmer disputes over unclear or contested farm boundaries; (iii) human–wildlife conflicts, particularly involving crop damage

and livestock predation; and (iv) farmer–pastoralist tensions over livestock trampling fields post-harvest, which affects soil quality and crop regeneration (Table 4).

FGDs revealed that some crop-raiding incidences were either accidental or deliberate. One woman from Signali recounted: “There was a herder who drove his cattle into my rice farm while I was harvesting. When I confronted him, he threatened me saying, woman, we’ve already killed two people, if you want, you’ll be the third. Their cattle destroyed my entire farm. It was difficult to trace them because they concealed their identities, making compensation impossible. Another time, I drew the cattle’s brand and took it to the VG. They traced the owners, and I was compensated” (FGD—Signali Village).

Although designated livestock paths exist, the findings indicate that livestock often stray into cultivated fields due to inadequate herding practices. These narratives underscore that conflicts are not solely about resource access but also reflect broader issues of power, intimidation, and the erosion of traditional farming norms. One of the KIIs at regional level acknowledged the role of state policy in intensifying tensions: “the government’s decision to allow agro-livestock keepers to migrate into the region in search of pasture has significantly contributed to the rise in conflicts between farmers and livestock keepers” (Former RC, 2024).

Another recurring conflict involved livestock entering farms post-harvest, consuming residual crops and compacting the soil, which impedes future cultivation. A respondent from Signali Village explained: “After we finish harvesting, livestock enter our farms, trample the soil, and eat the shoots (*machipukizi*). In the past, we harvested twice, but now it’s impossible. The soil becomes hard, water dries up, and we can’t catch fish in our fields, only in the river. If you complain, they say, ‘What are you doing here? How do you expect our cows to produce milk?’” (FGD—Signali Village). Similar findings are reported by Gwaleba and Silayo (2019) and Bluwstein et al. (2018).

Boundary disputes among farmers were also prevalent, often due to the absence of permanent physical markers (identifiers). A participant from Milola Village noted: “Although government surveyors recorded GPS coordinates for all farm boundaries, they did not install physical markers. Many villagers now fight over boundaries because they don’t know their land ends. Others exploit this by pretending not to know the boundaries” (FGD—Milola Village). Similar accounts were reported across all four study villages (c.f. Ringo, 2023).

Conflicts between farmers and conservation authorities were also reported, particularly regarding unauthorized cultivation within PAs. One KII from KGR stated: “Since 2021, farmers have been sneaking into the reserve to cultivate secretly at night. During harvest, they use political figures to request permission to collect their crops.” A KII from ILUMA WMA added: “When game scouts attempt to destroy crops grown in the WMA, the VG intervenes, saying: ‘leave the crops, the villagers will stop farming after harvest.’ But this has become a habitual, villagers know they will be allowed to harvest if they plant.”

One of the most prominent conflicts identified in this research was between agropastoralists and conservation authorities, particularly concerning unauthorized farming, grazing, and settlement within PAs. This included the construction of

TABLE 4 Multiple responses and forms of natural resource conflicts experienced across the study areas.

| Forms of conflict                                                                            | Responses |      |            |                   |      |            |
|----------------------------------------------------------------------------------------------|-----------|------|------------|-------------------|------|------------|
|                                                                                              | Farmers   |      |            | Livestock keepers |      |            |
|                                                                                              | Count     | %    | % of cases | Count             | %    | % of cases |
| Farmers vs. livestock keepers on crop raiding before harvest                                 | 71        | 14.5 | 95.9       | 67                | 14.7 | 98.6       |
| Farmers vs. farmers on farm boundary                                                         | 67        | 13.7 | 90.5       | 58                | 12.7 | 85.3       |
| Farmers vs. livestock keepers on farm trampling after main harvest                           | 58        | 11.9 | 78.4       | 61                | 13.3 | 89.7       |
| Human–wildlife conflict                                                                      | 59        | 12.1 | 79.7       | 53                | 11.6 | 77.9       |
| Farmers vs. livestock keepers on grazing livestock on crop residues and sprouts              | 53        | 10.8 | 71.6       | 55                | 12.0 | 80.9       |
| PAs vs. fishers on fishing inside PAs without a permit                                       | 34        | 7.0  | 45.9       | 25                | 5.5  | 36.8       |
| PAs vs. villagers on illegal activities in the PAs, e.g., tree cutting, charcoal burning     | 30        | 6.1  | 40.5       | 31                | 6.8  | 45.6       |
| Agropastoralists vs. PAs on farming, grazing, and settlement in the PAs                      | 30        | 6.1  | 40.5       | 19                | 4.2  | 27.9       |
| Farmers vs. livestock keepers on rate of payment for crop damage                             | 26        | 5.3  | 35.1       | 25                | 5.5  | 36.8       |
| Farmers vs. PAs on farming inside PAs                                                        | 19        | 3.9  | 25.7       | 21                | 4.6  | 30.9       |
| Villagers vs. VG leaders for not adhering to the village land-use plans                      | 21        | 4.3  | 28.4       | 15                | 3.3  | 22.1       |
| Farmers vs. fishers on fishing on their farms during rainy season                            | 9         | 1.8  | 12.2       | 8                 | 1.8  | 11.8       |
| PA vs. VG on selling PA land to agropastoralists                                             | 6         | 1.2  | 8.1        | 8                 | 1.8  | 11.8       |
| Livestock keepers vs. farmers on driving livestock to their farms to claim more compensation | 4         | 0.8  | 5.4        | 11                | 2.4  | 16.2       |
| Muslims vs. VG over land allocation                                                          | 1         | 0.2  | 1.4        | –                 | 0.0  | –          |
| Farmers vs. livestock keepers on invading grazing areas                                      | 1         | 0.2  | 1.4        | –                 | 0.0  | –          |
| Total                                                                                        | 489       | 100  | 660.7      | 457               | 100  | 672.3      |

permanent structures, such as iron sheet-roofed houses, within conservation zones. The encroachers comprised both outsiders and residents of adjacent villages. According to the ILUMA WMA management, approximately 2,500 cattle are confiscated annually due to illegal grazing, averaging around 208 cattle per month. This form of conflict was notably influenced by political dynamics. Although the ILUMA WMA was formally established in 2011 and granted user rights as an authorized association on 5 May 2015, political leaders have reportedly encouraged villagers to claim land within the WMA as part of campaign promises (c.f. [Saruni et al., 2018](#); [Bluwstein et al., 2018](#)).

Another recurring conflict involved farmers' responses to livestock incursion into their fields. A pastoralist leader from Signali Village explained: "When a farmer sees livestock in their field, they immediately call the vigilante without first identifying the owner. This creates hostility, as the livestock keeper must pay substantial fees to the vigilante and navigate complex government procedures to retrieve their animals" (FGD—Signali Village).

Farmers often resort to vigilante intervention because they are unable to manage large herds alone, and herders frequently refuse to disclose their family affiliations. However, findings also revealed that some farmers exploit the situation deliberately driving livestock into their fields to claim compensation. In both Signal Village and Milola Village, it was reported that farmers receive compensation for crop damage regardless of the crop's maturity stage, incentivizing such behavior.

Conflicts between villagers and VGs were also prevalent, particularly regarding non-compliance with village land-use plans

(VLUPs). Villagers were found to cultivate and graze livestock in areas designated for other purposes, such as burial grounds, pasturelands, and conservation zones (FGD—Milola Village). Moreover, VG leaders themselves were implicated in violating VLUPs by selling land allocated for conservation or grazing for agricultural use (FGD—Milola Village). For example, in 2022, individuals purchased land within the WMA and possessed receipts and documentation. The matter was taken to court, which ruled in favor of the WMA (KII—ILUMA WMA). Similar findings are reported by [Ringo \(2023\)](#).

Conflicts also arose between PA authorities and fishers, particularly regarding unauthorized fishing within protected zones. A WMA representative from Mbuyuni stated: "When fishers are caught fishing inside the WMA, they are punished. This makes them feel mistreated and resentful, believing the WMA belongs to them and they have the right to fish whenever they choose" (FGD—Mbuyuni Village). A similar study by [Moshy et al. \(2015\)](#) found that restrictions and bans on fishing in certain areas of Jibondo Island were viewed as excessively harsh and socially disruptive, leading to resentment and animosity toward park authorities.

#### 4.4 Drivers of natural resource use conflicts

The study identified multiple, interrelated drivers of conflict in the Kilombero Valley (see [Table 5](#)). No single factor emerged as the sole cause; rather, conflicts were driven by a combination of issues. The primary causes of conflicts cited by farmers were increased

TABLE 5 Drivers of natural resource use conflicts and associated multiple responses.

| Drivers/causes of conflicts                                                                                 | Responses |      |            |                   |      |            |
|-------------------------------------------------------------------------------------------------------------|-----------|------|------------|-------------------|------|------------|
|                                                                                                             | Farmers   |      |            | Livestock keepers |      |            |
|                                                                                                             | Count     | %    | % of cases | Count             | %    | % of cases |
| Increased number of livestock                                                                               | 72        | 20.6 | 97.3       | 62                | 16.4 | 91.2       |
| Poor supervision of livestock herders                                                                       | 62        | 17.8 | 83.8       | 46                | 12.1 | 67.6       |
| Climate change effects (force herders/farmers to move into the area)                                        | 40        | 11.5 | 54.1       | 45                | 11.9 | 66.2       |
| Grazing land flooded with water during rainy season making livestock keepers moving to farming land         | 36        | 10.3 | 48.6       | 51                | 13.5 | 75.0       |
| Population increase                                                                                         | 35        | 10.0 | 47.3       | 35                | 9.2  | 51.5       |
| Inadequate education on livestock keeping and modern farming                                                | 35        | 10.0 | 47.3       | 27                | 7.1  | 39.7       |
| Livestock trampling and raiding farms on the way to their grazing area                                      | 31        | 8.9  | 41.9       | 20                | 5.3  | 29.5       |
| Lack of physical features/markers to show farm boundaries                                                   | 23        | 6.6  | 31.1       | 24                | 6.3  | 35.3       |
| Expansion of farms                                                                                          | 4         | 1.1  | 5.4        | 22                | 5.8  | 32.4       |
| Political interference, e.g., promises to give villagers land set aside for conservation areas if voted for | 4         | 1.1  | 5.4        | 11                | 2.9  | 16.2       |
| Corrupt VG leaders—selling land set aside for conservation/grazing and allow big livestock herds            | 5         | 1.4  | 6.8        | 6                 | 1.6  | 8.8        |
| Living or farming in wildlife corridors                                                                     | 2         | 0.6  | 2.7        | 8                 | 2.1  | 11.8       |
| Livestock not being put into kraals at night                                                                | –         | –    | –          | 9                 | 2.4  | 13.3       |
| Farmers refuse to stop livestock from invading farms                                                        | –         | –    | –          | 5                 | 1.3  | 7.4        |
| Unfair treatment by the police when reporting cases                                                         | –         | –    | –          | 5                 | 1.3  | 7.4        |
| Farmers' invasion into grazing areas                                                                        | –         | –    | –          | 3                 | 0.8  | 4.5        |
| Total                                                                                                       | 349       | 100  | 476.2      | 379               | 100  | 557.8      |

livestock populations, inadequate supervision of livestock herders, and climate change effects, which compel both farmers and herders to migrate in search of viable land. Livestock keepers reported similar drivers, although the relative importance of each varied.

FGDs and KIIs indicate that the primary driver of land-use conflicts in Kilombero Valley is population growth, largely fueled by the migration of people from Lake Zone, Mahenge, Lupilo, Ifakara, and Malinyi. This demographic expansion, coupled with an increase in livestock numbers and farm expansion, has intensified competition over land and natural resources (cf. Nassef et al., 2023; Masanja, 2013). Msigwa and Mvena (2014) linked livestock populations exceeding the land's carrying capacity to heightened conflicts. Agropastoralists, in particular, require extensive tracts of land to sustain large herds and agricultural activities, which often leads to competition with other resource users (Msuya, 2009; Hagberg, 1998).

While some livestock keepers have adopted improved practices, such as selecting high-quality conventional breeds that yield superior quantities and quality of milk, meat, and other dairy products, thereby enabling a reduction in herd sizes, many have not embraced these changes due to limited access to livestock management education (FGD—Kikwawila Village). As livestock numbers continue to rise, some herders have resorted to grazing within PAs, including NNP and KGR (FGD—Mbuyuni Village). The government's 2012 Operation Save Kilombero, which aimed to evict livestock keepers from the valley, failed to produce

lasting results. Many livestock keepers returned to the area, partly due to leaked information that allowed them to relocate their livestock before enforcement began (c.f. Matejcek and Verne, 2021). Compared to the robust anti-poaching units in NNP and KGR, ILUMA WMA has limited enforcement capacity, making it more vulnerable to encroachment.

Climate change has intensified conflicts by causing more frequent and severe droughts, leading pastoralists to seek new grazing and farming lands and resulting in competition for resources (Nassef et al., 2023; Lowder et al., 2021). Extreme weather events, such as the heavy rains of 2023, flooded designated grazing lands, forcing herders to move livestock to higher elevations, often where farms are located or within PAs. The spatial arrangement of grazing lands, farms, and herder settlements necessitates livestock movement through cultivated fields. Although designated livestock paths exist, the absence of fencing and the size of herds make containment difficult, increasing the risk of crop damage.

FGDs and KIIs revealed that herders often reside in grazing areas rather than returning to their settlements. Without kraals (bomas) to contain livestock overnight, animals roam freely in the early morning, frequently entering farms and PAs, thereby exacerbating tensions (cf. Saruni et al., 2018). The age of herders was also identified as a contributing factor: most were under 18 years old, lacking the maturity and skills to manage large herds effectively (see The Citizen, 2021). In Mbuyuni Village, it was reported that young herders sometimes abandoned their

duties to play or climb trees, leaving livestock unattended (FGD—Mbuyuni Village).

Another driver of conflict is the strategic exploitation of compensation mechanisms. One respondent noted: *“Some farmers intentionally allow livestock to graze on their fields or delay intervention to maximize compensation claims”* (FGD—Signal Village). Another respondent from Mbuyuni stated: *“If two cows enter, they will drive more into the farm so they will receive more compensation”* (FGD—Mbuyuni Village).

Instead of maintaining a healthy resource balance by regulating livestock herds, VG leaders engage in corruption. They accept bribes to permit excessive livestock influx, exceeding the village's carrying capacity and illegally allocating land intended for other purposes, like farming or grazing. One individual stated, *“Big farmers bribe VG and sub-village leaders so as to be allocated land in areas that are not allowed for such use and to allow big herds of livestock beyond village capacity”* (FGD—Mbuyuni Village). Another farmer said, *“when we go to the police station, we don't win because many livestock keepers have a lot of money they easily bribe the police”* (FGD—Milola Village). Unfair treatment by the police when reporting cases of crop raiding fueled anger, leading people to resort to taking matters into their own hands (cf. Saruni et al., 2018). Maganga et al. (2007) found that corruption eroded public trust in authorities and diminished their motivation to prevent conflicts (see also Nuhu and Mpambije, 2017). FGDs show that farms located in wildlife corridors, near and inside PAs, increased the frequency of crop raiding, injury, and death of people. The main culprits include elephants, birds, and buffalo (see Mariki et al., 2015). Moreover, ineffective law enforcement, particularly in ILUMA WMA, resulted in people invading the area, causing conflicts (Saruni et al., 2018).

## 4.5 Effects of natural resource use conflicts

The effects of land-use conflicts in Kilombero Valley were categorized into four domains: physical, economic, social, and psychological (Table 6). These impacts were documented through questionnaire survey, FGSs, and key informant interviews (KIIs).

The most commonly reported physical effects included crop destruction, human injury, and loss of life. A farmer from Milola Village described the tension: *“When you find livestock grazing on our farms, livestock keepers would say, “where else will our livestock graze?” They want their livestock to be full while we lose our crops. Because of this, farmers injure cows by cutting blood vessels on their limbs”* (FGD—Milola Village).

Cases of body harm were also reported. For example, a woman sustained a broken arm during a confrontation between farmers and herders. Physical assaults were common, particularly by young herders carrying sticks. As one respondent noted: *“Some herders are young men who carry sticks, if you argue with them, you will receive beatings of your life”* (FGD—Signal Village).

Fatalities have occurred across different types conflicts. In 2022, a farmer named Mtindi from Kikwawila Village was killed during a farmer–pastoralist dispute. Another fatality was reported in Mbuyuni Village due to a farmer–farmer boundary conflict. Clashes between villagers and PAs have also resulted in injuries and

deaths. In 2023, pastoralists attacked village game scouts, seriously injuring one who required hospitalization at Muhimbili Referral Hospital (KII—ILUMA WMA). Approximately 40% of livestock incursions in KGR have resulted in a range of injuries requiring medical attention. For example, *“on November 28, 2022, 180 cattle were confiscated in KGR. During a confrontation, two rangers were injured and hospitalized. In February 2023, a ranger lost his life while intervening in a conflict attempting to reclaim confiscated livestock”* (KII—KGR).

Economic consequences included loss of income due to reduced crop yields and livestock numbers, medical expenses, fines, and disputes over compensation. One agropastoralist expressed frustration: *“When farmers cut the blood vessels of our cattle, some die, and we are forced to sell the injured ones at very low prices. Imagine losing 20 cattle at once when they are only grazing on one acre of maize! The costs we incur are incomparable to the crops our cows have eaten”* (FGD—Milola Village).

Compensation disputes were frequent. A respondent noted: *“The compensation is unrealistic. Imagine a farmer demanding 1 million TZS (\$384.17) for a quarter of an acre, while the livestock keeper wants to pay only 100,000 TZS (\$38.42)”* (FGD—Milola Village). Additionally, livestock keepers are fined 100,000 TZS (\$38.45) per cow when animals are confiscated by wildlife authorities, further straining their finances. These findings indicate that both farmers and livestock keepers suffer substantial economic losses.

Social impacts included enmity, hostility, resentment, and a breakdown in community cohesion. One farmer from Milola Village shared: *“We are angry and full of hatred. There is enmity between us. We are not happy. We are afraid of livestock keepers. We are chased like dogs. You cannot compete with them”* (FGD—Milola Village). Another stated, *“Imagine being beaten by livestock keepers, and when we report the case to the police, we lose. This leads to resentment”* (FGD—Milola Village). Hostility has led to retaliatory actions. As one participant explained: *“Some livestock are confiscated and fined without any offence because of the hostility and enmity. In response, livestock keepers become hostile”* (FGD—Mbuyuni Village).

Psychological consequences reported included fear, anger, intimidation, reduced sleep, and emotional distress. A farmer from Mbuyuni Village stated: *“some of us are afraid to chase livestock from our farms. Sometimes we are afraid to be alone in the field, we don't know what might happen”* (FGD—Mbuyuni Village). Another respondent from Kikwawila Village described the fear of retaliation: *“people are afraid to mention or direct the VG or affected farmer to the offender's kraal (boma). Doing so leads to hatred, beatings and hostility. We are afraid to confront livestock keepers or report them to the VG. This makes us very angry”* (FGD—Kikwawila Village). Similar findings are reported by Oluwaleye (2020), where loss of lives and properties, displacement, insecurity, increased unemployment, hatred and fear, insecurity, poverty, and underdevelopment were the main effects of herder–farmer conflicts.

## 5 Conclusion and recommendations

Conflicts over natural resource use in sub-Saharan Africa, including the in Kilombero Valley, are widespread and

TABLE 6 Effects of land-use conflicts.

| Effects/responses                                         | Farmers |       |            | Livestock keepers |       |            |
|-----------------------------------------------------------|---------|-------|------------|-------------------|-------|------------|
|                                                           | Count   | %     | % of cases | Count             | %     | % of cases |
| <b>Physical effects</b>                                   |         |       |            |                   |       |            |
| Loss of human life                                        | 44      | 21.5  | 59.5       | 29                | 16.9  | 42.6       |
| Human injury/wound                                        | 65      | 31.7  | 87.8       | 58                | 33.7  | 85.3       |
| Destruction of crops                                      | 74      | 36.1  | 100.0      | 64                | 37.2  | 94.1       |
| Killing of livestock                                      | 17      | 8.3   | 23.0       | 17                | 9.9   | 25.0       |
| Retaliation (killing wild animal)                         | 5       | 2.4   | 6.8        | 4                 | 2.3   | 5.9        |
| Total                                                     | 205     | 100.0 | 277.1      | 172               | 100.0 | 252.9      |
| <b>Economic effects</b>                                   |         |       |            |                   |       |            |
| Loss of income due to reduced crop yield/no. of livestock | 74      | 52.5  | 100.0      | 65                | 45.8  | 95.6       |
| Money loss due to hospital bills/fines                    | 67      | 47.5  | 90.5       | 77                | 54.2  | 113.2      |
| Total                                                     | 141     | 100.0 | 190.5      | 142               | 100.0 | 208.8      |
| <b>Social effects</b>                                     |         |       |            |                   |       |            |
| Hatred                                                    | 73      | 38.2  | 98.6       | 64                | 44.8  | 94.1       |
| Vengeance                                                 | 47      | 24.6  | 63.5       | 30                | 21.0  | 44.1       |
| Enmity/hostility                                          | 71      | 37.2  | 95.9       | 49                | 34.3  | 72.1       |
| Total                                                     | 191     | 100.0 | 258        | 143               | 100.0 | 210.3      |
| <b>Emotional/psychological effects</b>                    |         |       |            |                   |       |            |
| Anger                                                     | 72      | 30.8  | 97.3       | 65                | 30.0  | 95.6       |
| Fear                                                      | 69      | 29.5  | 93.2       | 47                | 21.7  | 69.1       |
| Reduced sleep                                             | 34      | 14.5  | 45.9       | 30                | 13.8  | 44.1       |
| Intimidation                                              | 59      | 25.2  | 79.7       | 40                | 18.4  | 58.8       |
| Anxiety                                                   | 0       | 0.0   | 0.0        | 35                | 16.1  | 51.5       |
| Total                                                     | 234     | 100.0 | 316.1      | 217               | 100.0 | 319.1      |

multifaceted, with poor governance emerging as a central driver. These conflicts are classified into intragroup disputes (e.g., farmer–farmer) and intergroup disputes (e.g., farmer–pastoralist, village–PA, villager–VG). They typically arise from contested farm boundaries, crop damage, encroachment into PAs, and governance failures such as corruption.

Key underlying drivers include rapid population growth, particularly due to agropastoralist internal migration, increased livestock populations exceeding land carrying capacity, inadequate supervision of herders, climate change impacts, including drought and floods, and limited education on sustainable agricultural and livestock practices. The consequences of these conflicts, physical, economic, social, and psychological, disproportionately affect farmers compared to livestock keepers and PAs.

Based on the study's findings, this study recommends that policy and community-level interventions include the following: (i) farm boundary demarcation: government authorities should support farmers in establishing permanent and clearly marked farm boundaries to reduce disputes and

enhance land tenure security; (ii) education and capacity building: targeted training should be provided to both farmers and livestock keepers on peaceful coexistence, sustainable agriculture, livestock management, and appropriate practices such as selecting high-quality conventional breeds thereby enabling a reduction in herd sizes and efficient rangeland utilization; (iii) livestock management reform: livestock keepers should be encouraged to adopt more efficient practices, including maintaining smaller but more productive herds, to reduce pressure on land and minimize conflict; (iv) village governance and land-use regulations: village governments must enforce VLUPs, regulate livestock influx, and manage land according to its ecological carrying capacity. Addressing governance challenges, particularly corruption, is essential for equitable resource distribution; (v) stakeholder collaboration: communities should work collaboratively with local authorities, conservation agencies, and civil society organizations to promote inclusive and sustainable resource management; and (vi) compensation framework: a standardized and transparent compensation mechanism should be developed to address crop

and property damage, ensuring fairness for both farmers and livestock keepers.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

This study received ethical approval from the Sokoine University of Agriculture Research Clearance and the Tanzanian Ministry of Regional Administration and Local Government (Ref. no. AB. 307/323/01/221). Approval was also obtained from local authorities. Informed consent was sought from all participants, and their privacy and confidentiality were assured throughout the research process.

## Author contributions

LB: Validation, Methodology, Writing – original draft, Writing – review & editing, Conceptualization. SM: Writing – original draft, Formal analysis, Validation, Data curation, Methodology, Conceptualization.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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