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Climate change perceptions and adaptation by Sebei pastoralists in Mount Elgon, Uganda: a qualitative survey

Siya Aggrey[1,2*], Elsa Varela[3], Rodrigue Batumike[4,5,6] and Aida Cuni-Sanchez[6,7]

Abstract

Background Pastoralists' sedentarisation and agriculturalisation might increase their vulnerability to climate change impacts, but few studies have investigated if this is the case in mountain areas. In Uganda, little is known about how Sebei pastoralists have perceived and adapted to such changes. This study sought to establish perspectives of Sebei pastoralists on climate change in terms of its occurrence and impacts as well as access to livelihood assets and or opportunities to withstand such challenges.

Method This study was conducted in Mount Elgon areas of Uganda. A cross-sectional study design was employed using qualitative approaches. Data were collected using focus-group discussions with men and women village elders to assess their perceptions regarding climatic changes, impacts and adaption strategies used. Data were analysed using thematic and content analysis approaches. All analyses were done using NVivo version 14.

Results Respondents reported changes in the amount and distribution of rainfall, fog and temperatures, with negative impacts on fodder availability, milk production and pests and diseases. Study participants mentioned using several adaptation strategies with regard to animal rearing, crop farming and livelihood diversification. Among others, participants reduced herd size, migrated longer distances, stored wild grass, used crop residues as feed and increased 'self-medication' of their cattle.

Conclusions Access to funds, markets and technical advice were the main barriers to adaptation identified. Institutional support—now only focused on improved breeds—should consider the multiple strategies used by pastoralists, and the constraints they highlighted, including the need for mutual learning space.

Keywords Climatic changes, Adaptation, Pastoralists, Mountains

*Correspondence:
Siya Aggrey
siyaggrey@gmail.com
[1] Department of Environmental Management, Makerere University, P.O. Box 7062, Kampala, Uganda
[2] Uganda Wildlife Research and Training Institute, P.O. Box 173, Kasese, Uganda
[3] Department of Agricultural Economics and Rural Development, Georg-August-Universität, Platz Der Göttinger Sieben, 5, 37073 Göttingen, Germany
[4] Departement Des Sciences Agronomiques Et Environnementale, Université du Cinquantenaire de Lwiro, Kabare, Democratic Republic of the Congo
[5] Department of Wildlife Management, Faculty of Science and Engineering, Manchester Metropolitan University, Manchester M15 6BH, UK
[6] Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences (NMBU), Ås, Norway
[7] Department of Geography and Environment, York Institute for Tropical Ecosystems, University of York, York, North Yorkshire YO10 5NG, UK

Introduction

About 50 million pastoralists and up to 200 million agro-pastoralists live in the arid and semi-arid lands of Africa [1]. In general, pastoralism is a subsistence livelihood strategy focused on tending herds of large animals (e.g. cattle) in communal arid or semi-arid lands with limited productivity for agriculture [2]. For most pastoralists, mobility is a key strategy needed to take advantage of the seasonal resources (e.g. water, pasture) available in these 'less productive' landscapes [3, 4]. Pastoralism is now under pressure not only due to human population growth and deterioration of rangeland resources [5, 6], but also because of climate change and associated scarcity of water and pasture, and increased prevalence of livestock diseases [2, 7]. Managing climate variability and climate risk is not new to pastoralists since strategies such as nomadism have been used for generations in fragile environments with high temporal and spatial variations in rainfall, and therefore, fodder availability [8].

In Uganda, like in other countries in Africa, human population growth has led to increasing pressure on natural resources and the progressive privatisation of common lands has led to an increase in pastoralists' sedentarisation [9]. Sedentary pastoralism involves transforming pastoralists into agro-pastoralists living in permanent villages, improving their access to social services such education, health and water [8]. Notably, they cultivate the land for crops and or at least some forage crops to feed their animals. The Uganda Government has promoted this sedentarisation to reduce violent conflicts between pastoralists and the neighbouring farming communities e.g. in the Karamoja region [10]. This intervention has also become a key alternative pathway to limiting food insecurity in such areas with highly variable climate to support sufficient food production [11]. The livestock sector is ranked as one of the vital economic sectors in Uganda with census estimates indicating 14.2 million cattle, 16 million goats, 47.6 million poultry, 4.5 million sheep and 4.1 million pigs [12]. The sector accounts for 17% of agricultural value added and 4.3% of the Gross Domestic Product [13]. Cattle breeding is valued at USD 8.7 million per year [13]. About 90% of cattle are indigenous breeds, and the sector contributes 1.5 per cent to Uganda's export trade value [13]. Dairy products, including milk valued at USD 80 million, are exported to other countries including Kenya, making Uganda a net exporter along these sectors [13]. With over 90% of the national livestock herd, the 'Cattle Corridor' of Uganda (a semi-arid region which runs diagonally across Uganda) is the most important livestock herding region in the country [14]. Livestock has multiple values for pastoralists. Apart from food products (milk, meat and blood), it provides means of transport and draught power, a source of income to pay school fees or bride price; it has an insurance value in times of adversity [15]. Furthermore, the cultural value of cattle breeding is very relevant for it influences relationships and determines self-worth and existence in pastoralist communities; the role of livestock is central in stablishing social status and prestige, being part of traditional rituals and rites of passage [16].

In East Africa, land use and land cover change dynamics are evident in privatisation of pastoral land and sedentarisation of pastoral communities [17]. The land use changes include the choices made by pastoralists on how they can utilise available land. Meanwhile, the land cover changes include alteration of the vegetation within a given area in this case cause by the pastoralists. Although numerous scholars have highlighted that sedentarisation exacerbates the vulnerability of pastoral groups to climatic changes through limiting resource access among other factors [18–20], numerous governments and NGOs continue to promote it. This can be because of the limited appreciation (by most development agencies) of the local solutions to the different challenges. In Uganda, with the aim of reducing food insecurity in the 'Cattle Corridor', the Government has strengthened direct support for crop cultivation through provision of seeds and tractors at zero or subsidised fees. Simultaneously, both local and international development organisations have also supported agriculturalisation of pastoralists through provision of planting materials, tools and seeds (e.g. in Karamoja region, [14]). While such interventions have been implemented, livestock rearing remains their major source of basic needs of milk, meat, income and savings [14]. Increased sedentarisation and agriculturalisation have also been reported outside the Cattle Corridor, in the Kiboga District (Central Uganda) [21] and Nakasongola District (Central Uganda) [22, 22]. Additionally, in the Karamoja region (North Eastern Uganda), increased engagement in crop farming has also been accelerated by persistent cattle rustling prior to the 2000 and the forceful disarmament of pastoralists the Government of Uganda (which limited further livestock raids that would facilitate restocking) [14]. Some scholars highlight that cultivation among pastoralists is largely conducted by the poorest pastoralists who are 'pushed' into diversification out of necessity rather than choice [23, 24].

Understanding local communities' perceptions of climatic changes, impacts and adaptation is a topic of increasing interest [25]. Perception is of key importance because it influences the motivation to take action [26]. Establishment of climate change perception and its impacts in pastoral communities is critical to inform decision makers and planners to take appropriate actions that will enhance pastoralists' capacity and adaptation to climate change [27–29]. Several factors are known

to influence climate change perceptions, and therefore, adaptation. For example, age (or farming/herding experience) is important because longer attachment to a place facilitates the identification of local environmental changes, with older people having accumulated greater knowledge [30]. Wealth and access to extension services affect perceptions as they can determine the capacity to respond to change [31, 32]. Previous information on climate change reveals that access to weather information can also influence perceptions of climatic changes and responses. For example, the use of weather forecasts increased the likelihood of the movement of pastoralists within Rwenzori Mountains of Uganda [3].

Local communities' knowledge can also be used to develop more effective and locally tailored strategies for adapting to climatic changes [24]. Although an important amount of the literature about local communities' perceptions of climatic changes and adaptation strategies used has been published in the past decade [33, 34], most literature has focused on farming communities [33]. In Africa, some studies have documented pastoralists' perceptions or adaptation (e.g. [1, 24, 25]), but most studies available focused on the dry lowlands of West or East Africa, with few insights from mountainous regions—even if such regions experience more rapid changes in temperature than lower elevations because the rate of warming is amplified with elevation [35]. Accordingly, this study focused on the Sebei pastoralists living around Mount Elgon with the objectives of (1) identifying the changes in climate and their impacts on the biophysical system as perceived by the Sebei and (2) determining which strategies they are using to adapt to these changes.

Materials and methods

Description of the study area

This study was undertaken in Kween district (average elevation 1,900 m asl) located on the northern slopes of Mt Elgon (Fig. 1). Mt Elgon (4,321 m asl) is an extinct solitary shield volcano from the Miocene situated on the border between Uganda and Kenya [36]. In Mt Elgon, climate is affected by both elevation and aspect. Rainfall is lower on the northern and eastern slopes (about 1,500 mm year^{-1}) than in the southern and western slopes (about 2,000 mm year^{-1}) [35, 36]. Precipitation falls year-round but peaks in April–May and in September–November, January-March being the driest months [37]. The soils are predominantly volcanic [38].

Like in other African mountains, vegetation changes with increasing elevation from savanna-woodland (lower elevations) to montane forest with large areas of bamboo *Arundinaria alpina* (mid elevations) followed by heathers (e.g. *Erica* spp.) and high-altitude moorland

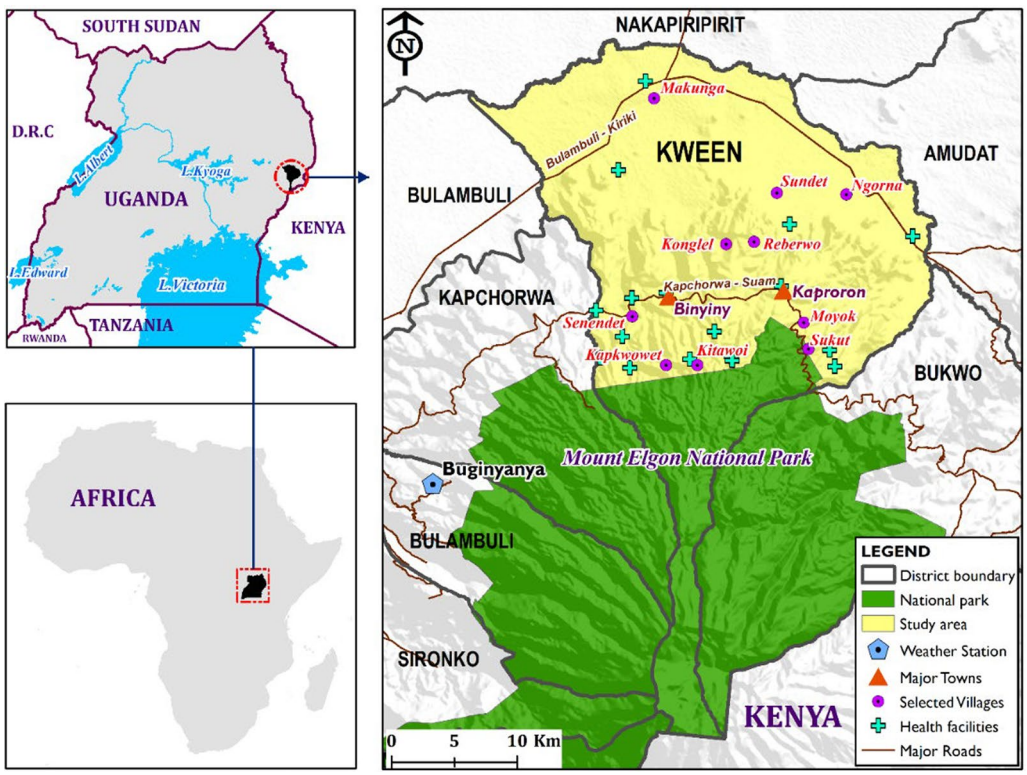

Fig. 1 Location of study area

(e.g. *Senecio* spp., *Lobelia* spp.) [37]. At family level, the plants cut across Fabaceae, Euphorbiaceae Asteraceae, Solanaceae, Agavaceae, Apiaceae, Bignoniaceae, Boraginaceae, Euphorbiaceae, Fabaceae and Liliaceae among others [39]. Meanwhile the different species include *Agave sisalana*, *Steganotaenia araliacea*, *Spathodea companulata*, *Cordia Africana*, *Croton macrostachyus*, *Entada abyssinica*, *Asparagus racemosus* [39]. The woody climbers and epiphytes are favoured by the wet and humid conditions experienced throughout the year [39, 40, 41]. In terms of climate, alternating seasonal air streams characterise the climate of Mount Elgon. The dry north-easterly and moist south-westerly air streams provide bimodal pattern of rainfall [41, 42]. Rains are experienced between April and October with short dry seasons in June and July. Dries periods are experienced from November to February. The annual rainfall received within the area is up to 2700 mm [42]. Maximum rainfall is experienced in the mid and higher altitudes. Temperature ranges vary between 27 and 30 °C at the higher limit and 15–17 ^{0}C at the lower limit. As the altitude increases, the climatic conditions become more temperate with less seasonality. Recent studies indicate climate-related hazards including floods, diseases landslides among others [43–45].

On the Ugandan side of the mountain, the montane forest was first gazetted as a forest reserve in 1938 and became a national park in 1993 [36, 46]. No montane forest has survived the intense agriculture below 2,200 m asl, and people are settled right next to the national park boundary [47]. The Ugandan slopes of Mt Elgon are inhabited by two ethnic groups: i) the Bagisu of Bantu origin, who practise an intensive mixed agriculture dominated by coffee and banana on the south and south-west slopes, and ii) the Sebei or Sabiny, pastoralists of Nilo-Cushitic origin, who rear cattle and cultivate mostly maize and Irish potatoes on the north and north-east slopes [47]. This research focuses on the latter group. The Sebei, estimated to be 300,000 people in Uganda [48], are the dominant ethnic group in Kween, Kapchorwa and Bukwo districts (Fig. 1). In the past, the Sebei were nomadic pastoralists owning mostly cattle. They practised a livestock management system with families relying mainly on milk rather than meat for nutrition, selling animals to get cash for other economic needs and building herd sizes to accrue social status, wealth and provide a buffer against risks such as severe droughts [49]. Until they were resettled outside the forest reserve in the 1980s, they lived on open grassy areas inside the montane forest (see [47]). The Sebei have become increasingly sedentarised. Political drivers (including cattle rustling) and economic factors increased sedentarisation since colonial times 1894 to 1962 [50], while in the past few years changes from communal land to privatisation (mostly for growing crops) in the savanna zone have become important drivers [51]. Apart from rearing animals (mostly cows and goats), most families now practise small-scale rainfed agriculture, the crops being maize and Irish potatoes, used for both food and cash [47]. During the rainy season most livestock feeds on the communal grazing areas at lower savanna elevations but some livestock enter the park buffer zone. During the dry season (after crop harvest) some livestock graze on crop leftovers around villages and some enter the park buffer zone. Men, energetic youth locally known as *masowek*, are usually the ones in charge of seasonally moving livestock. Historically the Sebei have lagged behind in terms of education, transport, access to agricultural support and credit [52]. From 2003, a tarmac road from Kapchorwa to Mbale (large city in eastern Uganda) has improved their access to markets, but transport costs are high as many roads are unusable during heavy rains. The population of Kween district is 103,300 inhabitants, which translates to a density of 121 inhabitants/km^2 and a population growth of 4.5% [48].

Sampling and data collection

In April–May 2024, focus-group discussions (FGDs) were conducted with purposively selected elderly men and women from purposively selected villages across the different altitudinal zones of Mount Elgon within Kween district, Uganda. Village elevation ranged from 1,083 to 2,732 m asl. We focused on elders as these have been living and herding or farming in a given area for a longer period of time (there is little migration in the communities studied) and can potentially report a larger number of climatic changes and impacts [53]. These elders were identified by the local village chairpersons after sharing with them the nature of the respondents we expected. This included age and the length of time they lived in the area.

Participants were first informed of the aim of the study and decided to participate on a voluntary basis. Then informal discussions centred on the perceived changes in climate, impacts and strategies used to adapt to these changes. We used study participants' age (when they were teenagers and started farming) as baseline for their perceived climatic changes and impacts. We also asked about average household characteristics in each village (e.g. number adults, farm size, number livestock). The FGDs were facilitated in *Kupsabiny* (the language spoken by Sebei) by the first author. The FGD facilitator guided the groups to reach consensus; therefore, comments made in a single FGD were considered to be a general opinion in the FGD. This survey was largely guided by

the initial community engagement that was conducted in 2021 under Mountain Sentinels Fellowship Programme.

Sociodemographic characteristics of respondents that were engaged

A total of 25 meetings (FGDs) were held across altitudinal zones of Mount Elgon within Kween District, Uganda. This included a total of 215 respondents with men ($n=113$) and women ($n=102$). The number of respondents per FGD was 8 (±2) individuals. Donkeys are kept for transport and sheep are not common. Houses are generally made of mud walls and iron sheet roofs, with no access to electricity or running water, and fuelwood is the main source of energy. The main crops are maize and beans (main staple for Sebei). Some also cultivate plantain, wheat, sweet potatoes, sorghum, millet, Irish potatoes or barley—the latter two grown for cash. Milk is an important source of nutrition and income (to pay school fees). Most adults have not completed primary education. Wealth and education differences are limited among community members. Fencing to secure grazing land is not widespread, and livestock insurance mechanisms are not common.

Data analysis

During data analysis, data were pooled per FGD and therefore the FGD was the main unit of analysis. Thematic and content analysis was used to identify the main themes of the discussions [54]. In line with the study objectives, a determination was made of the emerging themes. A coding frame was then developed followed by the mapping and interpretation of the data. During this, attention was paid to the context, comments and words in order to improve on the consistency of the data. In this paper, we report observations with regard to number of FGDs citing them. All analyses were conducted using NVivo version 14 [55]. The results on the occurrence and impacts of climate change as well as adaptation strategies are presented using the local indicators of climate change impacts (LICCI) approach [25].

Results

Perceptions about climate hazards, risks and impacts on local livelihood resources

Respondents (78%) acknowledged the occurrence of climate change with various indicators. These indicators mainly included changing patterns and intensities of rain (97%) as well as temperature (94%). In terms of rainfall, it was indicated that during the onset, cessation and the length are now very variable.

> *"The rains these days are unpredictable… sometimes you buy cows early when the prices are low but the rain delays to come and yet they need fresh grass… such delays affect us a lot", one elderly man noted*
> *"The rains can at times be very heavy that it causes flooding and brings diseases from other areas and our animals get sick…also sometimes it may not be there and the water is very little and dirty. All these are climate change", another elderly man added*
> *"Climate change can be in form of too much sunshine and rain," another member added*

Regarding temperature, it was indicated to have changed in terms of intensities and seasonality (62%). This was indicated to affect animals through diseases and reduced feed resources.

> *"The drought can be so much that it affects our animals.. sometimes it becomes so cold with a lot of wind and little grass", one elderly man added*
> *"Prolonged dry spell never used to be the case in the last five (5) years but because of too much destruction of forests and swamps, this has led to increased frequency and duration of dry spell. This is part of climate change," said by one of the elderly male participants.*
> *"There has been a change in climate, it used to rain in February but now it starts in March. These changes have been there because of clearing of the swamps and cutting down trees", another elderly male respondent noted*

Respondents listed climate change impacts with links to their livelihoods (83%). According to the respondents, destruction of forests was attributed to the occurrence of climate change and related impacts. Climate change was noted to affect water resources, animal health and infrastructure. Women were noted to be more (71%) affected by climate change compared to men as they are mainly involved in more than three-quarters of household work. Below are people's perceptions about some of the identified climate hazards and risks.

(i) *Increase in animal and crop pests and diseases*

Pests were noted to be mainly (87%) associated with climate change events. Climate change was noted to influence the nature of habitats for pests including resistance to acaricides.

> *"Climate change has led to an increase in the number and distribution of pests. This increases the use of pesticides increasing the cost of production", noted by one elderly male respondent.*

Respondents (52%) noted increasing livestock and crop pests and diseases which undermined agricultural production.

> *"Kutyet" pest (fall armyworms) in maize is also*

affecting us and we are not near the extension services, in fact, we have never had any government agriculture person come to us", One elderly participant recounted.

(ii) *Increase in vermin attacks*

Due to habitat destruction, there was an increase in vermin attacks. Respondents (77%) indicated that vermin have expanded their range ensuing into increased attacks particularly monkeys. Some of the vermin were noted to come from the neighbouring forest affecting human life in some cases.

"Wild animals were attacking crops and animals because they had nowhere to hide", one elderly male respondent indicated

(iii) *Reduction and contamination of water resources*

Respondents (83%) noted climate change to cause drying of water source points which are used in both crop and animal production.

One elderly male respondent noted that, "The previous and the current drought are serious as rivers like River Sundet have dried up"

One elderly male respondent added that "*Too much wind contaminates water sources making it unfit for home use and women are affected as their role is to look for clean water*".

(iv) *Dry spells and drought*

Drought was noted by respondents (64%) to be increasing in terms of frequency and severity, thus undermining crop and livestock production. They attributed increasing famine to '*too much sunshine*'.

One elderly female respondent echoed out that "We, as a community, have too much sunshine which affects crop growers and animal rearing families mostly in the whole district".

(v) *Heavy and erratic rains*

Erratic rainfall was associated (73%) with diseases like malaria and livestock diseases. These diseases were causing the death of people and livestock. Livestock loss ensued into food scarcity and loss of income to animal farmers. Road damage (96%) was also linked to erratic rains, hence resulting into the difficulty to get to the markets to sell agricultural produce, to access schools and hospitals.

"We usually have so many animal diseases during the rainy season especially at the start. These diseases include 'Ngoriontеd' (foot and mouth disease), 'Kawumburu' (Nagana), 'Sakek' (East Coast Fever), 'Kaketey' (Anthrax), 'Bortap c'ekko' (Brucellosis), 'Chekwon' (Contagious bovine Pleuropneumonia) among others. These diseases kill our animals and leave us poor", one elderly male member noted

Coping and adaptive strategies

Study participants mentioned using several adaptation strategies with regard to animal rearing, crop farming and livelihood diversification. In terms of animal rearing, study participants mentioned: reducing herd size (98%), changing livestock breeds (74%), using complementary feed (72%), harvesting and storing wild grass (52%), increasing veterinary care (52%), migrating longer distances (in search of fodder and 'safe' water points) (63%) and selling weak cattle (73%) at the onset of drought events. For study participants, complementary feed refers to maize husks and banana suckers. As access to formal veterinary services provided by extension workers is expensive, participants mentioned that people generally 'self-medicate' their animals to prevent potential disease infection and treat those that are already sick.

With regard to agriculture, the strategies cited included: changing planting dates, using improved seed varieties; increasing the use of soil/water conservation techniques (e.g. mulching), using inorganic fertiliser and pesticides, and agroforestry and increased irrigation. The latter was only practised by richer households who could afford to construct small canals. Inorganic fertilisers were mostly bought from small-scale traders who import them from Kenya (because they are cheaper). In some villages, increasing livelihood diversification was also mentioned, with activities such as selling firewood or honey, labour, borrowing money and educating children.

'I am sending my eldest son to school so he can get a job in town and send us money later when there is a drought,' FGDs' elderly male participant commented

Discussion

Our findings point to changes in the amount and distribution of rainfall, fog and temperatures to be associated with climate change. These changes were noted pose negative impacts on fodder availability, milk production and pests and diseases. This result is in agreement with previous studies in nearby regions. In the Karamoja region (located north of our study area) pastoralists also reported increased temperatures, more erratic rainfall patterns, increased numbers of extreme drought and flood events and more hailstorms [15]. In two other districts in Mt Elgon (east and south of our study area) farmers also reported increased temperatures, a late onset of the rainy season, increased drought events, more hailstorms and greater winds [45]. Contrary to our study participants, these farmers reported that the amount of

rainfall during the rainy season had increased, because of fewer but heavier rainfall events [45]. In another district in Mt Elgon, farmers reported increased temperatures, more dry spells but overall more rainfall [56]. Meteorological data available from Buginyanya (located at 2000 m asl, 50 km west of our study district, *see* Fig. 1) show a statistically significant increasing trend in seasonal precipitation but no statistically significant trend in annual precipitation or mean temperature for the period 1993–2013 [45]. We were unable to obtain data from this meteorological station to confirm if trends change when computed up to January 2021. It is known that local communities are better at perceiving changing seasonality in rainy seasons (e.g. late onset, early cessation) rather than other rainfall patterns such as annual totals [57]. It may be that study participants' perceptions of an overall rainfall decline, despite there being no evidence in the climate data available (up to 2013), is related to the combined effects of increasing temperatures and higher evapotranspiration on soil moisture [58]. It is also possible that there are important site-specific changes in rainfall trends on different parts of Mt Elgon, as shown by Salerno and colleagues [59] for Kibale National Park in western Uganda. Most study participants related the observed changes in climate and impacts to God's will (e.g. God was angry at them because of changing tradition and had sent them drought spells), but some related it to local deforestation [59]. No study participant mentioned climate change—a global phenomenon caused by increased greenhouse gases. The same was observed among pastoralists in northern Kenya [60].

In this study, participants mentioned a reduction of stream flow during the rainy season, increased soil erosion and landslides during the rainy season. More landslides were also reported by farmers in other parts of Mt Elgon [45]. In Mt Elgon, such phenomenon has been attributed to both: i) increased numbers of settlements and farms on steep slopes, and ii) prolonged rainfall of low intensities [49, 50]. In all villages studied it was stated that fodder availability and quality in the dry season had reduced (this refers to the park buffer zone), and in six villages a reduction in the quality of fodder in the rainy season was also mentioned. Study participants related reduced fodder availability to two factors: increased temperatures and changing rainfall patterns and increased numbers of livestock in certain areas. Reduced fodder availability was also reported in two other districts in Mt Elgon [45] and in central Uganda [21].

Study participants also highlighted a decrease in milk production and an increase in some diseases like Brucellosis, Animal trypanosomiasis and tick-borne diseases (due to increased prevalence of ticks in the grazing areas around permanent water points in the dry season). In the Karamoja region, pastoralists also noted increased prevalence of ticks in certain grazing areas and increased diseases including e.g. Anaplasmosis (a tick-borne disease) and foot and mouth disease—FMD [15]. Higher temperatures and changing rainfall patterns have potential of leading to increased vector-borne diseases and macroparasites transmission [61]. Study participants also mentioned a reduction in crop yields (maize, beans, Irish potatoes), which they mainly linked to changes in rainfall patterns, and an increase in crop pests (particularly fall army worm for maize and aphids for all crops). Notably, our study participants did not identify reduced soil fertility as another driver of reduced crop yields, even if such reason was cited by farmers in e.g. Kibale NP [62]. Reduced crop yields have been reported by farmers elsewhere in Mt Elgon region [56], Kibale region (western Uganda) [62] and the Kigezi Highlands (southern Uganda, [63]). Reduced human health was indicated to be happening and it was linked to climatic changes, which was also mentioned in other studies: e.g. in central Uganda [21]. Increased prevalence of waterborne diseases (cholera, typhoid, dysentery and amoebic diseases) might occur when there is limited access to potable water in the dry season [64]. Another explanation could be increased malaria prevalence related to increased temperatures [56]. Beyond Uganda, the results obtained in this study are consistent with that from studies conducted in some communities in Kenya. For instance, a survey in communities around the lower Tana Delta as well as those around Yala wetland of Kenya indicated communities perceive climate in terms of weather variables (e.g. rainfall and temperature) [65, 66]. Similarly in developed countries like USA, community members have been shown to associate global warming to increased heat and extreme drought [67]. While there could be differences in how people perceive climate change, such perspectives support design of local specific climate change interventions as well as policies [68, 69].

In terms of adaptation strategies, what was mentioned in this study have been reported by other studies on pastoralists communities in Uganda, except using maize husks and banana suckers as fodder. However, the use of crop residue for livestock feeding was mentioned by pastoralists in e.g. Ethiopia [70]. Remarkably, combining pastoralism with tourism, an important income diversification strategy by pastoralists in eastern and southern Africa (see [1]) was not mentioned by study participants, possibly because Sebei tend to be less educated than Bagisu (a neighbouring Bantu speaking tribe in Mount Elgon)—and therefore have no access to certain jobs such as tourist guides. Seasonal or permanent migration to urban areas in search of jobs (mentioned by pastoralists in e.g. Tanzania, [71]) was not cited in this study most

likely because of cultural attachments to pastoralism and low chances of finding a job in a city if uneducated. The use of livestock insurance mechanisms e.g. [72] was not mentioned, because of their prohibitive high cost (participants' comments during FGDs). More relationships of the results in this study with that in the existing literature are shown in Table 1 (in Supplementary Material).

Notably, most study participants mentioned using indigenous knowledge to determine planting dates and livestock migration. Only some mentioned using Kenya Broadcasting Cooperation (KBC) radio forecasts (usually richer households with better radios). KBC radio was used as it was believed to be more accurate than Ugandan radios. This is different from e.g. pastoralists in the Rwenzori Mountains, where weather forecasts were used to inform livestock migration [3]. Study participants mentioned that lack of access to funds, markets (poor road conditions and high transportation costs) and access to technical support (e.g. veterinary care), were their main challenges to adaptation. Several factors are known to influence the choice of adaptation strategies among pastoralists, the most important being household income, access to information and markets, labour availability and institutional/government support [25, 56]. The latter two were not cited in our study, although access to technical support could be provided by the government (or other organisations). In countries like Kenya, similar results have been found in communities around Yala wetland. Notably, community members indicated the wetland to play a crucial role in enhancing their adaptation [66]. Such natural assets provide opportunities for accessing livelihood assets [73]. Climate change occurrence alters the market and non-market benefits that people derive from nature [74–77]. Therefore in order to enhance adaptation interventions, actions ought to target this resource so as to realise adequate resilience of communities to climate change. This includes use of available resources as indicated by respondents in this study.

Future research perspectives can be focused on deepening the knowledge gathered in this study by incorporating the view of females and collecting more detailed data through household or individual questionnaires using the information from the FGD as a departure point. This would be relevant to get more detailed insights, particularly regarding the determinants of adaptation options. Finally, future studies should also evaluate the effectiveness of adaptation strategies.

Conclusion and recommendations

This study shows that Sebei pastoralists communities in Mt. Elgon are experiencing climatic changes and deploying several strategies related to animal rearing, crop farming and livelihoods diversification to adapt to it and counteract its negative effects. Livestock rearing beyond being a way of life, plays a crucial role in accruing social status and wealth. This cultural value spans beyond being merely a business transaction to negotiate [61, 78, 79]. However, only one externally initiated intervention focused on animal rearing. As highlighted by other authors e.g. [80], institutions should recognise the cultural value of cattle for pastoralists and support interventions which enable the continuation of pastoralism. In our study area, external support could also focus on improved access to veterinary care (e.g. technical advice to avoid 'self-medication') and support for alternative fodder (e.g. using fodder trees in agroforestry programmes, currently mostly focused on fruit trees). Facilitating the creation of a milk-processing company in the region, could also help the Sebei get better prices for the milk they produce.

Even if cattle rearing is culturally important, livelihood diversification was already happening in all villages—to complement, rather than substitute, cattle rearing. However, the low levels of education and organisational skills, as well as limited access to markets and microfinance mechanisms, hampered greater diversification. Currently, external interventions are not focused on pastoralists—and therefore, overlook the lower levels of farming skills, education in general and their limited access to information (including language barriers). During the fieldwork, we realised that e.g. some study participants keep improved seeds for two years before sowing them—limiting the potential benefit of using them. Greater awareness of technical aspects of agricultural practices is needed, ideally through participative approaches which create space for feedback and mutual learning. We recommend the use of a 'science with society' participative, transdisciplinary approach [81], an iterative process that brings together actors to engage in knowledge co-production.

Apart from strategies already used by Sebei, strategies used by pastoralists elsewhere could also be adapted to the context of our study region. Tourism was not mentioned as a livelihood alternative by study participants, but there is a potential as the road network is being improved and there is Mt Elgon national park nearby. Given Sebei rich cultural tradition, cultural activities could be organised for tourists (e.g. music and dances)—something which does not require formal training like for being a tourist guide.

This study shows how Sebei pastoralists in Mt Elgon have already observed climate change impacts, and how they are using a wide range of adaptation strategies, most of which focus on modifying their herding practices—even if most external support focuses on farming. As highlighted by [15], there is a need to help pastoralists to organise their response options while

maintaining their pastoral livelihoods. Understanding the local context is of key importance in mountain regions [82], and tailoring interventions to the culture(s) of pastoralists in these regions is crucial if we are to help them adapt to predicted changes in climate [80].

Abbreviations

KBC	Kenya Broadcasting Cooperation
Mt	Mountain
FGD	Focus-group discussion
FMD	Foot and mouth disease
NGO	Non-government organisation
PWDs	Persons with disabilities

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13002-024-00743-3.

Additional file1.

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Author contributions
S.A., A.C.-S. helped in conceptualisation and methodology and formal analysis; S.A. was involved in data gathering; S.A., A.C.-S., E.V and R.B contributed to writing—review & editing.

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Availability of data and materials
As a lot of the data utilised in this study have sensitive information for the respondents, it will not be placed in open sources. However, it is available upon reasonable request. Requests can be placed to the corresponding author.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the 1964 Helsinki Declaration. The study was approved by the Research Ethics Committee of Makerere University College of Veterinary Medicine, Animal Resources and Biosecurity (Reference number SBLS.SA.2018). The study followed guidelines and regulations stated in the approval document. Written and informed consent was also obtained from participants to participate in this study. Written and informed consent was sought from the participants to publish and disseminate the research findings. There were no illiterate participants; thus, there was no need to seek consent for this group.

Consent to publish
While this work does not contain parts that can enable identification of respondents, they consented to publication of the work with some quotes made during the engagements.

Competing interests
The authors declare no competing interests.

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