International Journal of Climate Change Strategies and Management

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Constructing Ubudehe? Farmers' perceptions of drought impacts and resilience capacities in Bugesera, Rwanda

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Received 5 April 2023
Revised 22 September 2023
25 January 2024
14 June 2024
Accepted 10 September 2024

Abstract

Purpose – This paper analyses Rwandan farmers' perceptions of historical drivers of landscape vulnerability (past), current livelihood assets (present) and existing or potential capacities (future) to increase resilience to drought. The specific focus is on linking experiences from the past and present with ideas for a drought-resilient future. It explores how farmers' perceptions of past droughts and future visioning can contribute to rural development policy and multi-level collaborations.

Design/methodology/approach – This study was conducted in Bugesera, a drought-prone district in south-eastern Rwanda. Empirical data was collected through participatory observation, semi-structured interviews and focus groups. The analytical points of departure are based on sustainable landscapes and livelihood approaches, combining spatial and temporal perspectives on challenges and opportunities identified by farmers' communities in addressing droughts.

The authors would like to express their sincere gratitude to the key informants, interviewees and focus group participants for their active contribution and insights in this research. Special thanks to SMHI-NBDF Rwanda & RECOR for the interactions during the Training Course on "Promoting Sustainable Agriculture in a Changing Climate in Bugesera District".

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest: The authors declare no conflict of interest for this research.

International Journal of Climate Change Strategies and Management
Vol. 17 No. 1, 2025
pp. 91-110
Emerald Publishing Limited
1756-8692
DOI 10.1108/IJCCSM-04-2023-0046

Findings – All respondents had a high awareness of the impact of droughts. Perceived drivers of landscape change include historical climate events, such as droughts and floods, immigration and agricultural expansion, which have led to demographic pressure on land, deforestation and infringement on natural resources. Factors enhancing resilience capacities include access to diversified sources of livelihood, knowledge of appropriate irrigation techniques and availability of safety nets and credits. Furthermore, farmers identified collaborative opportunities as important for resilience capacity, including peer learning, and sharing best practices through knowledge exchange and on-field training. In addition, farmers brought up the need for innovative institutions that can facilitate access to markets and enable collaboration between different agricultural sectors.

Originality/value – This study analyses farmers' perceptions of resilience capacities to droughts through a spatiotemporal lens of past droughts, present capital and future challenges by linking scales, knowledge and human–environment nexus. This paper contributes to the knowledge of climate adaptation in Rwanda and to discussions about smallholder farming in the literature on climate change adaptation.

Keywords Drought vulnerability perceptions, Landscapes and livelihoods, Resilience capacities, Bugesera, Rwanda

Paper type Research paper

> We have to show solidarity among our neighbours during hardship times. A respondent in Bugesera, Rwanda.

1. Introduction

Climate change affects natural landscapes and livelihoods as the intensity and frequency of extreme weather events increase (Barnes *et al.*, 2020; Luo *et al.*, 2022). Droughts affect a majority of people across low-income countries and cause devastating impacts in rural communities (Sawadogo, 2022). Countries in sub-Saharan Africa (SSA) for example have experienced frequent and prolonged drought events that have challenged livelihood security, and have led to famine and forced migration (Hameso, 2018; Sanfo *et al.*, 2017). Migration from rural to urban areas due to drought places additional pressure on declining food production systems (Adaawen *et al.*, 2019; Xiao *et al.*, 2021). In the past 50 years, Africa experienced more than 400 droughts, affecting millions of people (Shiferaw *et al.*, 2014; Lindoso *et al.*, 2018). Herders can be forced to seek alternative sources of grazing land and water for animals, which sometimes creates conflicts with farming communities (Napogbong *et al.*, 2021).

This scenario is bound to worsen where climate change projections point to an increase in droughts, posing significant challenges to farmers' livelihoods (Tesfahunegn *et al.*, 2016). This can result in humanitarian crises such as those in the Horn of Africa and the Sahel regions in 2011 and 2012 (Thaler *et al.*, 2019). In Eastern Africa, climate projections indicate a decreased interannual rainfall and rising temperatures which may aggravate the adverse effects of drought across the region (Haile and Tang, 2020; Uwimbabazi *et al.*, 2022). The lack of adequate socio-economic entitlements such as safety nets exacerbates the vulnerabilities of both rural households and national economies to drought (Scheffran *et al.*, 2012; Wilhite *et al.*, 2014).

Short-term adaptive strategies to secure livelihoods are insufficient for farmers. The predicted magnitude of climate risks will require transformative changes (Scoones *et al.*, 2020; Antwi-Agyei and Nyantakyi-Frimpong, 2021; Clark, 2021). The knowledge that vulnerable communities possess about ecosystem services and long-term adaptive capacities is important for understanding the preconditions for such change.

Against this background, this paper explores farmers' perceptions of historical drivers of landscape vulnerability (past), current livelihood assets (present) and existing potential capacities (future) to increase resilience to drought. With empirical material collected in Bugesera (Rwanda), this paper aims to link research to policy by tapping on resilience

lessons from vulnerable drought-prone communities across SSA. The following research questions guide the analysis:

RQ1. How do smallholder farmers' communities perceive their vulnerability to droughts?

RQ2. What are perceived as historical landscape change drivers, current livelihood assets and potential capacities to increase resilience to future droughts?

Ubudehe is used in the title as a reflection of its empirical significance in this context. *Ubudehe* refers to a traditional community practice that consists of togetherness at the village level by joining forces for farming and supporting vulnerable members (Ezeanya, 2015). Policymakers and development partners in Rwanda have recognised this practice as participatory, enabling farmers to shape development options (Nabahungu and Visser, 2013).

1.1 Previous research

The literature on climate change and smallholder farmers' adaptation is extensive, spanning different disciplines, scales and regions in the Global South (Aldunce *et al.*, 2017; Jha and Gupta, 2021). In recent years, climate adaptation scholars have studied initiatives in smallholder farming communities (Bagagnan *et al.*, 2019; Silici *et al.*, 2022). Farmers' perceptions of climate adaptation have been analysed through the spectrum of incremental, transitional and transformational adaptation (Hadarits *et al.*, 2017; Pickson and He, 2021). Factors that influence smallholder resilience are often in focus, including access to natural resources, socio-economic assets and knowledge (Folke, 2016; Herrfahrdt-Pähle *et al.*, 2020; Koliou *et al.*, 2020). For example, the links between livelihood assets and climate resilience and adaptation have been explored through studies of agricultural water management and sustainable livestock production strategies (Lawson *et al.*, 2020; Guodaar *et al.*, 2021). The combination of quantitative and qualitative methods in analysing community resilience drivers is less common (Sullivan-Wiley and Teller, 2020; Tesfahunegn *et al.*, 2016).

The literature on SSA suggests that incremental adaptation strategies are more commonly in focus than transformational adaptation options. To study this topic, interviews, focus groups and surveys are commonly used, with emphasis being placed on short-term actions in coping with climate variability (Deubelli and Mechler, 2021; Likinaw *et al.*, 2022; Quandt *et al.*, 2019). In Eastern Africa, most studies on perceptions of farmers' resilience have focused on individual levels such as farms or households as units of analysis (Gbegbelegbe *et al.*, 2018; Wichern *et al.*, 2019). Some findings (Prokopová *et al.*, 2019; Barnes *et al.*, 2020) show that temporal migration and off-farm jobs can be short-term reactive coping strategies complemented with remittances through social networks.

The literature on transformational adaptation underlines the need for long-term and broad-based perspectives that foster systemic changes to address social vulnerability across scales and levels (Chung Tiam Fook, 2017; Magesa *et al.*, 2023; Rickards and Howden, 2012). This includes scaling up adaptive strategies across similar livelihood conditions, knowledge-based practices through collaborative learning platforms and landscape-based adaptation to balance the farmers' needs with the availability of and access to ecosystem goods and services (Reed *et al.*, 2015; Williams *et al.*, 2020; Silici *et al.*, 2022). Stated differently, it is essential to understand how farmer communities perceive past climate hazards, existing resources and potential opportunities to identify sustainable paths ahead.

Against the above background, this paper contributes to the literature addressing climate adaptation challenges for smallholder farmers. It applies spatial-temporal perspectives of historical drivers of landscape change, current livelihood assets and potential capacities to increase resilience to future droughts.

1.2 Analytical points of departure

Our analytical points of departure align with Silici *et al.* (2022) recognising that human-ecosystem contexts, knowledge and multiple scales are all key dimensions for increasing resilience and addressing the vulnerability of rural communities. As we recognise a mutual dependency between livelihood sources and landscape ecosystem services, the analysis is informed by theoretical underpinnings from the Integrated Landscape Approach (Reed *et al.*, 2016; Sayer *et al.*, 2017) and the Sustainable Livelihood Approach (DFID, 1999; Quandt *et al.*, 2019).

Anchored in conservation theory, the Integrated Landscape Approach is a framework that combines practices and policies in a given landscape and equally balances human needs with climate mitigation and adaptation options (Reed *et al.*, 2016). Farmers' adaptive strategies depend on landscape resources including land, water and forests which form the backbone of community livelihoods (FAO, 2018). Human agencies operate within landscape biophysical and socio-political contexts and shape livelihood capitals in times of hazard. Landscape ecosystems enable farmers' communities to obtain goods and services to sustain their livelihoods during droughts (Primdahl *et al.*, 2010; Reed *et al.*, 2015). As dynamic agencies, farmers' communities hold capabilities to address the impacts of climate change based on past experiences (Guodaar *et al.*, 2021; Zhang *et al.*, 2020). However, a multilevel dialogue with affected farmers is required to meet social and ecological goals simultaneously (Sayer *et al.*, 2017). Livelihood resilience capacities are therefore crucial to adapt to future climate hazards (Prokopová *et al.*, 2019; Ricart *et al.*, 2022; Opach *et al.*, 2020).

The Sustainable Livelihood Approach acknowledges that farming communities can be resilient to climate shocks and maintain long-term capabilities without undermining natural resources (DFID, 1999). Rwanda's *Ubudehe* is mirrored by similar practices in other East African countries, such as *Ikibiri* in Burundi, *Msragambo* in Tanzania, *Bulungi bwansi* in Uganda and *Harambe* in Kenya (Rutikanga, 2022). Examples from agropastoral communities in Kenya have shown the potential to foster long-term resilience based on livelihood capital and landscape stewardship (Weesie and García, 2018). These traditional practices are based on the mobilisation of resources by community leaders to withstand hardship and thrive.

Building on the analytical points of departure discussed above, we explore farmers' perceptions of droughts and future adaptive capacities using a spatiotemporal model (Figure 1). This integrates past changes in the landscape with current existing livelihood assets to explore challenges and opportunities towards future community resilience.

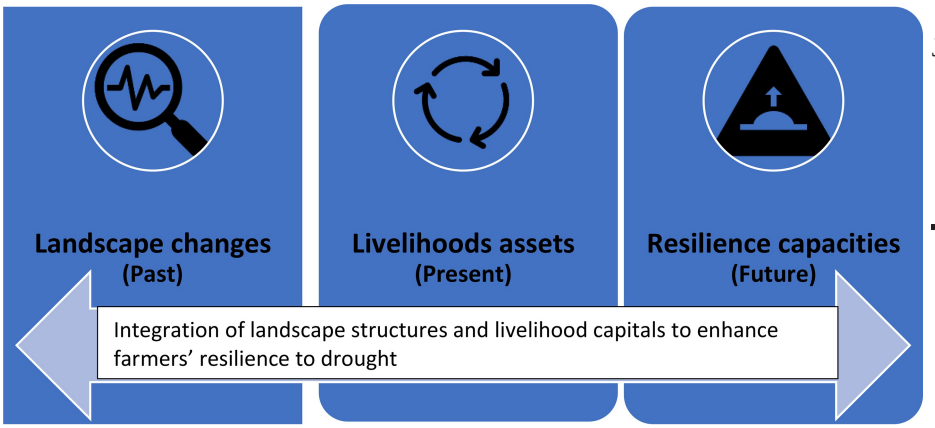
As a first step, an assessment of historical landscape change drivers was conducted to understand the context of drought in Bugesera, Rwanda. After this, livelihood assets were analysed to understand farmers' adaptive capacities to droughts. Key assets and opportunities for each aspect were identified. Finally, we analysed how farmers perceived potential challenges and opportunities to foster resilience.

2. Material and methodology

2.1 Study area

The study was conducted in Bugesera district, located in south-eastern Rwanda (latitudes 2°01′55″S and 2°24′45 ″'S, longitudes 29°56′50″E and 30°23′19″E). It covers a total area of 1,334 km^2 with an average altitude of 1,400 m above sea level (Manzi *et al.*, 2013). Smallholder farmers participating in the study are from the sectors of Rweru, Kamabuye, Ngeruka, Ruhuha, Nyarugenge, Mareba, Mayange and Rilima (Figure 2).

Bugesera district has a population of 450,000, of which 84% are under the age of 40 years and 51% are females (Irumva *et al.*, 2021). The population is scattered in farmlands and



Source: Created by authors

Figure 1. Model combining spatial and temporal perspectives of Sustainable Landscape and Livelihoods in the context of climate adaptation in smallholding farming

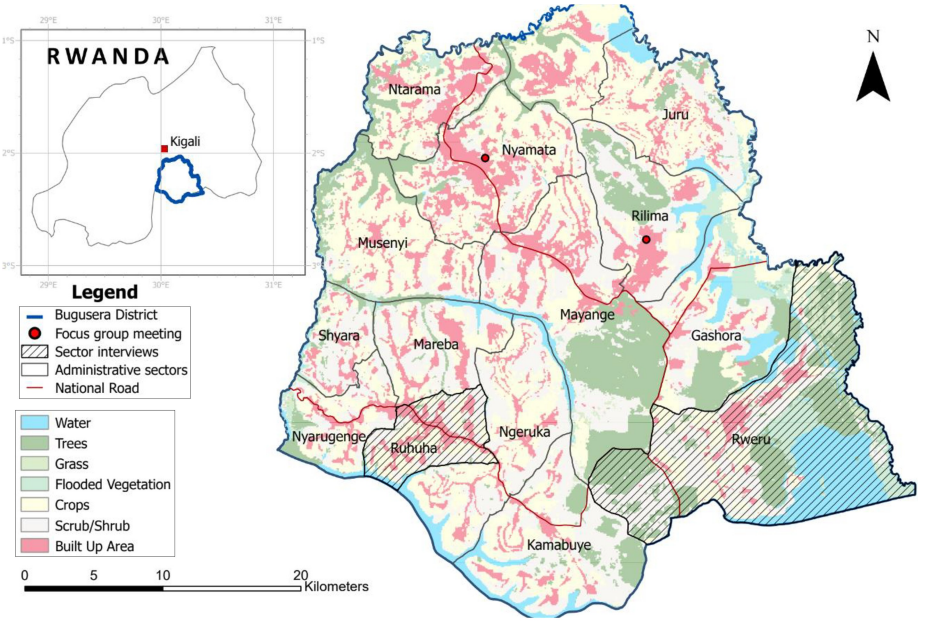


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Figure 2. The study area, Bugesera, and its localisation in Rwanda

savannah landscapes, with access to rivers, lakes and wetlands. The climate includes distinct wet and dry seasons controlled by the Intertropical Convergence Zone, with south-easterly and easterly wet winds and El Nino events. Precipitation is lower compared to the rest of the region, with an annual average of 800 mm and an average maximum temperature in dry seasons of 27°C (Uwimbabazi *et al.*, 2022).

People's livelihoods mainly depend on agriculture. Long dry spells and droughts have significant impacts on livelihoods and welfare with people dying of famine as well as temporarily needing to migrate within or outside the country. Bugesera has been affected by severe droughts in 1984, 1989, 1996, 1999, 2000, 2006, 2008, 2010, 2016 and 2017 (Clay, 2022; Haile *et al.*, 2020). This had enormous impacts on livelihood security. These droughts were all related to El Nino and La Nina weather episodes (Benimana *et al.*, 2015; Ngarukiyimana *et al.*, 2021).

2.2 Study design and data collection methodology

Following the analytical points of departure and the model in Figure 1, data were collected using qualitative methods based on participatory observation, semi-structured interviews and focus groups to enable access to experiential and contextual knowledge and provide nuanced insights (Burnard, 1991; Quick and Hall, 2015). This methodological approach enabled an understanding of major drivers and responses to social and ecological vulnerabilities that have occurred in Bugesera from the 1960s until 2021.

2.2.1 Participatory observation. An immersive and moderate participatory observation method was applied to assess a first understanding of the local drought context and existing challenges (Burnad, 1991; Meuwissen *et al.*, 2019). To understand landscape changes and livelihood assets in Bugesera, participatory observation and informal conversations were used to gain an understanding of the biophysical and socio-economic settings that condition farmers' and local institutions' responses to past droughts. In November 2015, under the facilitation of agricultural extension officers and the local administration, informal conversations were held with farmers (individuals and in small groups of three to six persons) in the sectors of Gashora, Rweru, Ruhuha, Kamabuye, Ngeruka, Nyarugenge and Mareba (Figure 2) to discuss issues related to drought resilience. The results assisted in refining the questionnaire for interviews and focus groups where the landscape and livelihoods sections included questions on issues such as infrastructures and resilience capacities.

The approach enabled us to contextualise a narrative around drought, social vulnerability and resilience capacities in the region. This entailed follow-up visits to smallholders working together in cooperatives or with innovative solutions to cope with drought. Furthermore, it provided foresight on farmers' engagement in drought resilience strategies such as rainwater harvesting, land consolidation and cropping with drought-resistant varieties as well as technical assistance through farmer field schools.

2.2.2 Interviews and focus groups. Interviews are effective for tapping into households' stories and experiences of drought (Lawson *et al.*, 2020; Wolf and Moser, 2011). Interviews included semi-structured questions as a means of effectively engaging people from diverse backgrounds in rural areas. Individual semi-structured interviews were conducted in the Ruhuha and Rweru sectors (Figure 2) to collect the farmers 'views and perceptions of past droughts and their adaptive capacities. These sectors had been the most severely hit by previous droughts. Rwanda Government initiated programs within this region aiming to ensure food security through farmer field schools (Ministry of Agriculture and Animal Resources, 2015). Respondents' sampling was designed with the assistance of the community leaders. The data collection methods used premeditated and open questions with follow-up questions. Interviews were held in Kinyarwanda. All interviews were digitally

recorded and afterwards transcribed by native speakers. Data consistency was verified by listening to all recordings and comparing them with the transcripts.

The first round of interviews with farmers was conducted in April 2016. A total of 20 respondents were interviewed, including 18 men and two women (Table 1). They were all heads of families and aged between 40 and 80. Interviews were completed with key informants to understand the context of droughts. A second round of interviews was conducted in September 2021 with other key informants in Bugesera district to update the data collected in 2016, including assessment of possible new perspectives as an outcome of the COVID-19 pandemic.

Focus groups are useful for exploring people's experiences, opinions, wishes and concerns (Powell and Single, 1996; Gibbs, 1997; Wibeck *et al.*, 2007). Focus group meetings were held in December 2017 and March 2018 in Rilima and Nyamata, respectively, with representatives of farmers' cooperatives from the sectors of Juru, Rilima, Ruhuha, Gashora, Rweru, Ngeruka, Kamabuye and Nyarugenge (Figure 2). The main purpose was to explore the perception of vulnerability to drought and the potential capacities to enhance drought resilience. The use of focus groups was familiar to the participants because the community has a collective traditional way of dealing with social challenges through meetings and discussions at village levels. Participants were farmers and heads of cooperatives. They were all active in a climate resilience project labelled "Promoting Sustainable Agriculture in a Changing Climate in Bugesera district", conducted by two local organisations (RECOR and NBDF) in 2017–2018. Discussions were held in Kinyarwanda, based on a questionnaire. Respondents were asked to recall specific climate shocks based on their experiences and reflections on how to withstand droughts in the future.

2.3 Analysis

All the empirical material was analysed using qualitative content analysis to identify patterns emerging from the interviews and focus groups such as landscape change drivers, livelihood

Table 1. Timeline and focus for the collection of empirical material

Time	Activity	Sectors of Bugesera	No. of farmers (females/ males)	Purpose
November 2015	Participatory observation	Gashora, Rweru, Nyarugenge, Ruhuha, Ngeruka	12 farmer field schools	Understand local context and community responses to droughts in a spatial-temporal perspective
April 2016	Interview with farmers	Ruhuha and Rweru	20 (2/18)	Explore community perceptions and coping mechanisms during previous droughts
December 2017	Focus group I	Juru, Rilima, Ruhuha and Mareba	36 (12/24)	Understand climate hazards and potential capacities for drought resilience
March 2018	Focus group II	Rweru, Ngeruka, Kamabuye, Nyarugenge	21 (6/15)	Same as above in focus group I
September 2021	Interview with key informants	Ruhuha and Rweru	7 (4/3)	Insights on new perspectives in community resilience in the aftermath of COVID-19

Source: Created by authors

capitals and potential capacities (Bazeley, 2009, Elo and Kyngäs, 2008; Kuckartz, 2019). Transcripts were coded and the codes were systematically mapped in Excel spreadsheets, facilitating the identification of themes. The empirical material was sorted based on a past, present and future time-scale perspective. The use of historical narratives enabled the capturing of landscape and socio-demographic changes that occurred from 1950 to 1980. Farmers´ views were categorised in relation to significant drivers and subsequent potential areas for building drought resilience (Table 2).

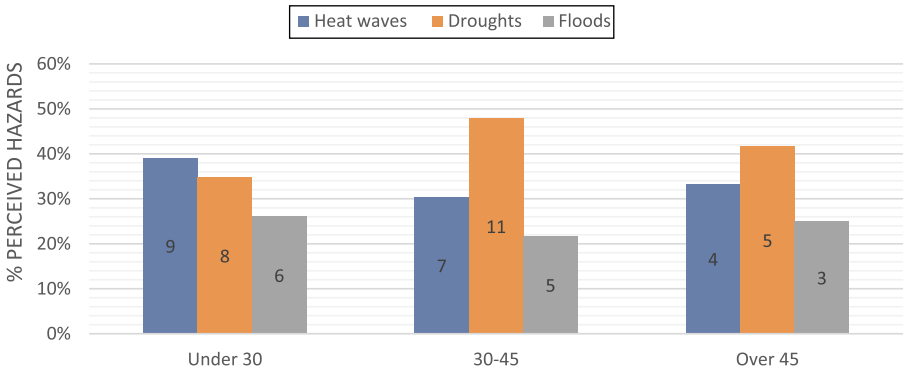
3. Results and discussion

Historical drivers identified by the farmers include phenomena such as drought hazards, immigration and agricultural expansion that have led to landscape degradation (Table 2 and Figure 3). Present livelihood assets that form the foundation for adapting to droughts are highlighted in Table 2. Identified possible pathways for the future can be related to what we *analytically* label as transformative leadership with values of continual learning and multi-scale collaborations at the community level (Table 3). Gender- and age-differentiated views highlighted potential areas that need

Table 2. Farmers' perceptions of drivers for drought vulnerability, present livelihood assets and ways to strengthen future resilience capacities through the perspective of the sustainable landscape and livelihood model

Time perspective	Significant factors	Perceived historical factors to drought vulnerability, present assets and potential future resilience
Past landscape changes	• Climate hazards	• Droughts, floods and heatwaves
	• Immigration	• Demographic pressure, land issues
	• Agricultural expansion	• Deforestation
Present livelihood assets	• Natural capital	• Farmland, water and biodiversity
	• Physical capital	• Irrigation technologies
	• Human capital	• Skilled labour force
	• Social capital	• Safety nets, mutual assistance
	• Financial capital	• Saving cooperatives, trade
Future resilience capacities	• Continual learning	• Rainwater/irrigation, agroforestry practices and skills sharing
	• Visionary institutions	• Markets, livelihood security and multi-functional landscapes
	• Transformative collaborations	• Leadership, behavioural change and cooperatives

Source: Created by authors



Source: Created by authors

Figure 3. Perceptions of climate hazards in Bugesera by age group, Rwanda

strengthening to increase drought resilience by ensuring equal power and access to resources.

3.1 Historical drivers of landscape changes as perceived by farmers

The respondents perceived that climate hazards, migration and agricultural expansion in a drought-prone area have led to deforestation and pressure on available natural resources changing the Bugesera landscape. On the question "How can you describe the changes that have occurred in the last 50 years?", all interviewees recalled historical droughts and famines that have impacted the region. Respondents at the Rilima workshop also mentioned that water levels in lakes Rweru and Cyohoha had shrunk during the drought period of 1998–2000.

Reflecting on the question "How can you describe past climate hazards in Bugesera?", several participants ranked droughts very high (Figure 3). In the *Kinyarwanda* language, the word drought is interchangeably used for both hot sunny days and long-lasting dry periods. Some respondents, particularly younger participants (aged under 30), did not clearly set the boundaries between drought and heat as more heat often leads to vegetation stress which could be interpreted as drought.

Migration and population growth during the 1950s and 1960s were perceived as the major drivers of landscape changes. Respondents aged between 40 and 80 recall that the region has been facing important migration fluxes from the period of late 1950s until the late 1990s. Many people immigrated to Bugesera, a region previously used mainly for livestock but now dominated by agriculture. Based on interviewees' personal data in the sectors of Rweru and Ruhuha, it was noted that only seven of the 20 respondents were born in Bugesera. An 80-year-old man from the Ruhuha Sector said:

> Only a few people were settled here. Due to overpopulation and land scarcity prevailing in the Western and Southern provinces, a flow of rural-to-rural migration movements was targeting the Eastern part of Rwanda in search of available farming lands. By then, only cattleholders were settled there practising little farming (NN1).

A farmer from the Ruhuha sector (aged 70) recalled:

> I moved from Butare to search for new farming areas as we were experiencing arable land. We were a big family, and we were told that there were still some lands in Bugesera which is why we moved here (NN9).

Table 3. Farmers´ perceptions of needs and actions for building future drought resilience in Bugesera

Perceived needs	Suggested resilience pathways
Minimise impacts of droughts	*Improve crop production and forestry*
• Scale-up irrigation • Diversify crops for food production • Grow more trees and protect forests • Protect the soil and its moisture	• Rainwater harvesting for supplemental irrigation on farms • Regular fruit tree planting, practice crop rotation to diversify risks • Mulching practices to keep soil moisture on seasonal crops and scale up agroforestry with big leaves to enable shadow • Avoid overgrazing and push for zero-grazing
Development of livelihood assets	*Suggested actions to increase drought resilience*
• Small businesses, trade different items • Agriculture for self-reliance in food supply • Livestock for manure to boost crop production • Raising cattle (goats, sheep and pigs) • Small business in vegetable and fruit production	• Create farmers´ cooperatives, • Use of selected seeds and fertilisers, land preparation and planting on time • Livestock for manure to boost crop production • Kitchen garden at each household using rainwater
Actions in cooperation with others	*Collaboration opportunities*
• Work and harvest together in cooperatives • Conduct study tours to get inspired by others and learn from each other • Support for irrigation equipment and a meeting facility for sharing knowledge • Regular meetings for brainstorming, set up goals, and perform according to plans	• Extended market-oriented agriculture • Farmers on-field training • Creation of diversified cooperatives • Growing crops based on the market's needs • Sharing ideas and best practices among others for common understanding • Values of trust and honesty

Source: Created by authors

Through individual and collective memory, farmers recall the landscape changes that had occurred in the region which led to more exposure to droughts. This includes land distribution and fragmentation associated with excessive tree cutting and animal hunting which led to fewer water bodies and forest cover. For example, a man born in 1932 in Bugesera mentioned:

> I was born and raised here in Bugesera. I do remember that during our childhood, there were many forest trees and wild animals such as elephants, lions, hyenas, antelopes, etc (NN2).

Another interviewee who had migrated from Ruhengeri noted:

> There were few settlers when we moved here and most of the land was occupied by trees. We came because we heard from our friends that Bugesera had farming lands that were generously provided to new immigrants (NN4).

A farmer from the Rweru sector mentioned: "With the paysannats systems, the government provided us land for planting cash crops such as coffee" (NN5).

Participants stated that the development of Bugesera has entailed structural changes within the ecosystem landscape during the past seven decades. Immigration led to forest clearing for new settlements and farming land. More importantly, the use of fuel wood in the form of firewood and charcoal as a commercial commodity and energy source for cooking in Kigali city has led to increased forest clearance. NN6 said "The landscape here used to include big trees from which they made charcoal". Historically, the region was inhabited by cattle holders for which the savanna and access to water bodies offered grazing lands even in times of droughts (Manzi *et al.*, 2013; Ford, 1990; Prokopová *et al.*, 2019).

In the late 1950s, colonial authorities introduced an agricultural policy called the "Paysannat programme" in savanna land to enable cash-crop production of coffee (Ford, 1990; Ansoms *et al.*, 2018; Rwanyiziri *et al.*, 2020). Such new land-settlement plans led to natural resource consumption and demographic pressure with negative consequences for Bugesera ecosystems (Mikwa *et al.*, 2014). Ford (1990) found that the major migrants' destinations between 1940 and 1980, in addition to cities, focused on the search for farming land in the pristine, water-endowed landscapes of Bugesera. From the 1950s until early 2000, agricultural activities and deforestation led to more than two-thirds of forest cover loss (Habiyaremye *et al.*, 2011). Furthermore, this region was the major energy supplier through charcoal production, thereby providing additional income and employment for unskilled youth. Consequently, cutting trees leads to ecosystem depletion and hence disturbance of natural functions in the landscape (Johnson *et al.*, 2018). This type of in-country migration was observed in other neighbouring countries such as Burundi, Uganda and Tanzania where farmers' communities were forced by colonial powers to migrate to other regions for cash-crop projects (Pittock *et al.*, 2020; Tubi, 2020). These landscape changes drivers have shaped the farmers' communities' livelihoods today.

3.2 Present livelihood assets as perceived by farmers

Interview results concerning the present illustrate a variety of livelihood assets that form the foundation for adaptation to droughts. On the question "How do communities adapt to drought impacts?", the respondents place human capital in the centre as an interaction point with other types of capital in everyday livelihood security. Identified enabling factors include education, leadership, institutions and technologies. Communities indicated that educating farmers on the use of water-related technologies, such as irrigation, has been considered particularly important in mitigating drought. This may include non-skilled labour that is available for on-and off-farm work such as small-scale businesses and financial services. One interviewee said: "As a member of Farmer Field School, I got training that provided me the knowledge to practise irrigation and now I grow vegetables to be sold in Kigali" (NN4). Technical skills were identified as another important asset to increase resilience to drought. For example, a former bicycle mechanic mentioned:

> Before drought events, I was working as a bike mechanic. When drought erupted and there was no bicycle to repair, I turned into a water business by biking to remote areas to fetch water and sell it to households (NN2).

However, according to the focus groups, there are challenges related to keeping skilled staff in Bugesera. Farmers expressed concerns over the brain-drain of talented personnel who leave the region for more attractive and better-paying opportunities.

Related to *natural capital*, farmer communities value the diversified resources from lakes, rivers, farming and grazing lands as well as forests that are scattered within the Bugesera

landscape (Figure 2). Respondents stated that livelihood sources are mainly based on agricultural and livestock sources which are both highly dependent on rainfall availability. Food supplies include different crops such as beans, cassava, banana maize, tomatoes and sorghum. Even though there are fish stocks in water bodies, farmers who migrated from the highlands do not see fishing as another source of income. The settlers brought along their original food cultures that did not include fish. However, given the context of drought vulnerability, food supply from the lakes could increase farmers' resilience.

Respondents identified *physical capital* as material goods and fixed assets that contribute to production and sustain livelihoods. For example, some respondents expressed that they have access to a few motor pumps for irrigation, and a couple of rainwater-harvesting facilities such as valley dams, while others highlighted the importance of bicycles and motorcycles to facilitate trade and transportation of goods and people. Examples of short-term solutions to address drought included income from selling iron sheets from households' rooftops.

Farmers identified that another important asset was *social capital*. Several respondents highlighted that the historical development of communities in Bugesera created a sense of solidarity to cope with hazards and hardship by setting up formal and informal organisations for mutual assistance. Safety nets (*ubudehe*) and membership in informal networks are perceived as true pillars necessary in times of hardship such as drought periods. As an illustration, one respondent said:

> We have to show solidarity among our neighbours during hardship times. When you have a farm close to the water bodies, you will have to share the harvest with others or at least employ the people to ensure access to food for the community members (NN9).

The governmental program of the social security system that provides economic support to poor households was considered of high value for achieving self-reliance. Such types of networks, whether based on family kinship or ties by class, connect and bridge new or existing relationships (Nabahungu and Visser, 2013). Adger (2006) argued that communities with both types of networks have a better capacity to confront natural hazards and reduce vulnerability.

As for *financial capital*, both interviews and focus group respondents acknowledge that economic activities such as trade, saving and lending schemes are very important in sustaining livelihood security in times of droughts. Income generated through financial assets determines the extent to which natural, human, physical and social capital is managed. Transboundary trade and small businesses such as taxi-bicycles are income sources that complement the farming activities:

> I have three bicycles as so many people in this region use them for transportation purposes and as a reliable source of income as they are easy to sell (NN6).

Farmers also acknowledged that saving and credit schemes empower cooperative members by ensuring credits are available to all members in times of need and have raised their coping capacities to eventual droughts. Working in cooperatives has the benefit of collective effort and, hence, mutual benefits. Members can save money and have the possibility to borrow, which provides a financial buffer in times of drought.

> Members of our Saving and Credit Cooperative meet every month to collect their savings and, at the same time, decide how much money they can borrow. After one month, the money is returned to the cooperative with interest (NN6).

This is in line with previous studies which find that livelihood diversity can enhance resilience at both the household and community levels (Singh, 2020). Lessons from previous droughts have shown a differentiated vulnerability depending on income sources in people's

livelihood assets (Mugambiwa, 2021). For example, crop failure during the 2000–2006 drought in Rwanda entailed that the entire region depended increasingly on external food supplies (Mikwa *et al.*, 2014). Diversification of resources, such as crops and sources of income, is one of the most recommended measures by resilience studies.

3.3 Towards drought-resilient communities

The results from the focus groups highlight both challenges and opportunities for improving resilience to future droughts. The findings focus on leadership, based on continual learning, and multi-scale collaborations across sectors and levels. Based on the question "How do you perceive Bugesera's local capacities to address future climate hazards?", focus group participants had to reflect on existing challenges and opportunities by answering the questions: "What do you do to minimise the impacts of drought? What additional would you do if you had resources? and What actions would be facilitated if made in cooperation with others?" The farmers' responses are summarised in Table 3.

Continual learning from peers and sharing ideas among farmers on different agricultural practices were highly mentioned as providing substantial positive changes. Examples included brainstorming on farming goals, study visits for inspiration and training for trainers. Areas devoted to agroforestry, rainwater harvesting and supplemental irrigation were ranked as most important. While findings are not generalisable, there were some gender-differentiated perceptions. For example, men expressed that "planting trees that combine food production and minimise soil erosion is very important", while women expressed that "Kitchen gardens and fruit trees such as mango, papayas, avocadoes, … will enhance food quality and be supplied through the market" (Focus Group Nyamata, March 2018). Farmers expressed that drought-resistant crops such as cassava had enabled them to cope with droughts. Ideas from focus groups emerged seeking to increase knowledge "Know how to collect rainwater during dry periods and also diversify crops. We shall also plant trees to minimise erosion and protect the soil."

The importance of developing skills to collect, store and use rainwater for crop irrigation was discussed. Farmers using rainwater-harvesting facilities have a supplemental irrigation capacity, which enables more food production and hence increased income. This is in line with literature stating that agroforestry, land management, micro-credits, safety nets and off-farm jobs are among the powerful tools that increase resilience capacity in rural communities and that learning from peers through farmer field schools empowers farmers by providing skills, confidence and belief to become agents of change (Napogbong *et al.*, 2021).

Some respondents highlighted the need for national governmental institutions that foster innovation and flexible strategies that encourage the growth of markets such as small businesses, commerce and cooperatives. In the Bugesera district, national institutions empower local communities' livelihoods by diversifying sources of income through cooperatives and land consolidation programs (Etongo *et al.*, 2022; Ntihinyurwa *et al.*, 2019). At the same time, people are finding ways to meet their basic needs. For example, a few of the respondents had small businesses and engaged in farming with collected rainwater. One respondent recognised that during COVID-19, businesses were run differently to adjust to the travel restrictions but still sustain their lives.

Several respondents expressed a strong belief in the idea that government institutions should promote leadership, skills sharing and entrepreneurship to increase resilience in local communities. Previous studies suggest that behavioural changes and eagerness to acquire new knowledge are important for transforming existing practices that may otherwise hamper resilience to droughts (c.f. Tesfahun and Chawla, 2020). This was highlighted by key informants in the aftermath of COVID-19 in September 2021. "We had to adjust our

activities during the lockdown and find ways of collaboration with truck drivers and food stores in Kigali" (NNKI2). The need for collaborations across sectors such as agriculture, livestock husbandry, transport infrastructures, education, nature conservation and markets was highlighted during interviews and focus group discussions.

The above results are in line with findings in previous research, emphasising that a mindset shift is required to address drought hazards based on innovative thinking and clear leadership (Jones and Diepart, 2015). Smallholder agricultural water management that combines technical solutions, institutional flexibility and individual transformations is likely to be successful in building drought resilience (Silici *et al.*, 2022). Assets, flexibility, organisation, learning and agency are thus among the key factors in increasing long-term adaptation to climate change in poor communities (Barnes *et al.*, 2020).

Consequently, farmers need sufficient empowerment in decision-making to implement initiatives and engage in change. This requires learning from past experiences and engagement in sharing new knowledge (Baudoin and Ziervogel, 2017; Devisscher *et al.*, 2016). Some authors argue that a flexible platform, that integrates local needs and national policy targets, can increase cross-cutting interactions (Choko *et al.*, 2019; Singh, 2020). For example, governmental land consolidation policies instigate potential for cooperative settings and micro-credit schemes, which enable access to larger markets and more off-farm jobs creation (Weesie and García, 2018). Furthermore, tapping into socio-cultural assets provides more room to generate non-traditional sources of income such as tourism by providing jobs for guides, restaurant workers, cleaning services in hostels and handicrafts (Chung Tiam Fook, 2017).

4. Conclusion

This paper analysed farmers' perceptions of vulnerability to drought impacts and potential opportunities opportunities in building community resilience. Findings indicate that experiences of past landscape changes are significant to how adaptation strategies are shaped in the present to harness livelihood challenges in times of climate variability. Drought was perceived as the most severe climate hazard with vulnerability driving roots being linked to forced migration, demographic pressure, deforestation and land issues. Farmers also identified factors enhancing resilience capacities, including access to diversified capitals, knowledge of supplemental irrigation and safety nets and credits. To build resilience to future droughts, farmers underscored the need for continuous learning, innovative leadership and cross-sectoral collaborations at both local and national levels. Furthermore, the study suggests that *Ubudehe* practices in Rwanda are central to rural development and for continuing to build resilience to drought.

Aligning with previous research on climate adaptation in SSA, our findings show evidence of incremental actions conducted in a short-term perspective to reactively respond to vulnerability in the aftermath of drought periods. Examples include supplemental irrigation, diversification of livelihood income sources and lack of institutional collaboration for climate interventions at the local levels. Based on insights in the literature on transformative adaptation, institutions and farmer communities could be increasingly proactive by building longer-term adaptive strategies. This may include for instance integrated national climate policy and cross-sectoral collaborations between institutions at local levels during project implementations in the areas of water, agriculture and road infrastructures.

Finally, we recognise a need for further research on how to facilitate the integration of farmers' perspectives on resilience to drought alongside scientific knowledge with policymaking processes. This would entail increasingly tangible policy actions relevant to drought governance and management across scales and, hence, leading to transformational adaptation options. In future climate adaptation policy planning processes, farmers'

participation and local knowledge could thereby be increasingly acknowledged, supporting homegrown solutions and practices such as *Ubudehe*.

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