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Drought and flood impacts on agricultural water availability in smallholder farms in the Overberg District, Western Cape Province, South Africa

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Abstract: Climate change-driven disasters are among the major problems facing the agricultural sector globally. This study examined the impacts of drought and floods on water availability and agricultural productivity in smallholder farms within the Overberg District Municipality in the Western Cape, South Africa. It further assessed the farmers' coping and adaptive capacity in response to these disasters. A concurrent mixed-methods approach was adopted for the study. Data were collected through a survey of smallholder farmers (n = 100), focus group discussions with smallholder farmers (n = 37), and semi-structured interviews with key informants (n = 13). The results revealed that smallholder farmers perceived drought (33.1%) and floods (29.1%), driven by increasing climate unpredictability, as having reduced water access in smallholder agriculture. Additionally, the results showed that droughts dried up water sources and floods damaged critical infrastructure, affecting water availability and agricultural production. Most farmers lacked a coping strategy (57%), and a significant number (37%) reported having no adaptation strategy. The smallholder farmers received limited institutional support. The study concludes that smallholder farmers require coordinated support to enhance their adaptive capacity and farm productively in the face of climate variability.

Keywords: Climate resilience, smallholder farmers, vulnerability assessment, water governance, South Africa.

1. Introduction

Climate change poses a threat to both natural and human ecosystems worldwide (Hartfield et al., 2020). Many regions are already experiencing its effects (IPCC, 2021). The increase in temperature is expected to intensify over the next 50 years unless measures are taken to reduce greenhouse gas emissions (IPCC, 2021). This rise in global warming is anticipated to impact crop productivity and food security (Mekonnen et al., 2021), particularly in Africa, where inadequate adaptation measures are in place (Mutengwa et al., 2023). The frequency and severity of climate extremes, such as droughts, heatwaves, and floods, are reportedly increasing with global warming (IPCC, 2021). This suggests that as warming continues, climatic hazards become more frequent, severe, and prolonged. A selection of studies from across Africa indicates that climate change is characterised by decreasing rainfall and rising temperatures, leading to droughts, floods, and pest outbreaks, all of which contribute to a decline in agricultural production (Nega, 2025; Bedeke, 2023; Onyeaka et al., 2024). The agricultural sector in Africa is particularly vulnerable to climate change due to its heavy reliance on rainfall for crop production (Mutengwa et al., 2023). Estimates suggest that crop production may decline by 60% in rain-fed agricultural systems because of climate change-induced reductions in rainfall (Ali et al., 2022). Therefore, while water resources are crucial for enhancing agricultural productivity, they remain a concern in the context of climate change.

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South Africa, as an arid country, faces a greater risk of water scarcity due to increased warming, variability in rainfall, and exposure to regular climate disasters, including extensive droughts and floods (Schilling et al., 2020; Mafongoya et al., 2022; Shayanmehr et al., 2022). The Overberg District and the entire Western Province are particularly vulnerable to drought, a common feature of the region's climate (Botai et al., 2017), which is likely to intensify with the rise in global temperatures (He & Ding, 2023). Climate-related disasters, including drought, threaten farm productivity, especially for smallholder farmers with limited access to water for irrigation. These farmers are also vulnerable to extreme weather events due to their relatively low adaptive capacity (Ruwanza et al., 2022). Water shortages have diminished productivity in smallholder agriculture, exacerbating this low adaptive capacity (Ncube, 2018). Projections indicate that as global warming intensifies, the Western Cape is expected to become hotter and drier, with an increased risk of extreme drought (Naik & Abiodun, 2020). This could replicate past water crises that led to shortages and a decline in farm productivity (Zwane, 2019).

The seasonal rivers and small dams that smallholder farmers depend on diminish during drought (Popoola et al., 2018; Louis & Mathew, 2020; Maluleke, Tshabalala, & Barkhuizen, 2020). These challenges are compounded by weak adaptations and inefficiencies in government policy interventions (Carelsen et al., 2023). Okolie (2023) notes that smallholder farmers are at risk of losing their means of subsistence due to a decrease in water resource availability induced by climate change. According to the World Bank (2021), a reduction in water availability will extend beyond decreased crop yields to changes in land suitability for cultivation due to inadequate soil moisture. Smallholder farming in South Africa contributes to achieving Sustainable Development Goals 1 (No Poverty) and 2 (Zero Hunger) by creating employment opportunities, providing income, and enhancing household food security (Carelsen et al., 2021; Pili & Ncube, 2022). However, climate-related disasters threaten smallholders' efforts to contribute to economic growth and food production, especially in rural areas. Given this challenging situation, the study was guided by the following objective: to assess the impact of climate-induced disasters on water availability and agricultural productivity and to analyse the coping and adaptation capacity of smallholder farmers.

2. Conceptual Framework

The Sustainable Livelihoods Framework (SLF) was used to design and formulate the study (Figure 1). The SLF defines a livelihood as comprising the skills, resources, and activities necessary to earn a living (DFID, 1999). Smallholder farmers may have different skills, resources, and off-farm coping and adaptation strategies that they combine to make a living in the face of climate change. The SLF was used in this study to analyse the adaptation strategies of smallholder farmers. Therefore, it provided a framework that helps determine critical areas requiring intervention for development and alleviation of poverty through the lens of the beneficiaries (Krantz, 2001; Serrat, 2017). The SLF consists of five integrated elements, namely the (1) vulnerability context; (2) livelihood assets; (3) policies and institutions; (4) livelihood strategies; and (5) livelihood outcomes.

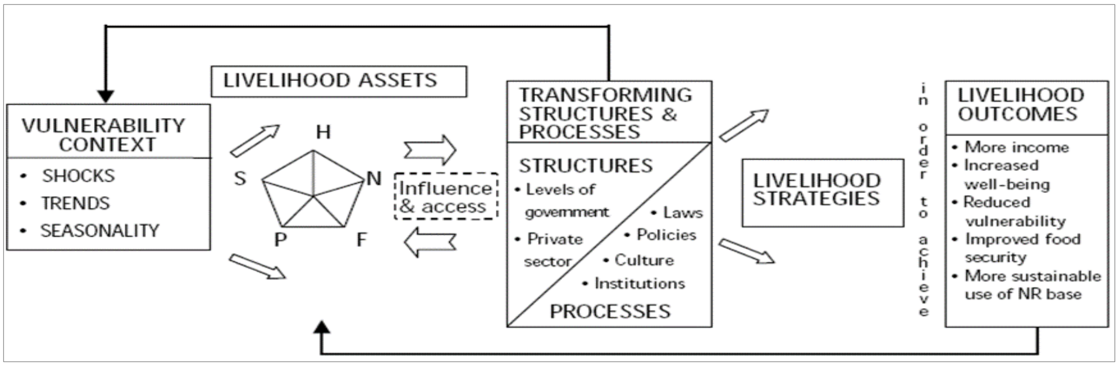

Figure 1: *Sustainable livelihoods framework (DFID, 1999)*

Sustainable livelihoods framework involves H – Human Capital, N – Natural Capital, F - Financial Capital, S - Social Capital, P – Physical Capital. The SLF suggests that people may be vulnerable to both internal and external changes and may have access to various resources governed by policies, processes, and institutions. The dynamics between these factors determine their livelihood strategies and outcomes (Jethwani & Mishra, 2012; Tham-Agyekum, 2015). Vulnerability refers to the degree of exposure to hazards. Serrat (2017) identifies two elements of vulnerability: the external, which includes seasonal changes, trends, or shocks, and the internal, which comprises the inability to cope with uncertainty. Vulnerability limits the strategies people employ to meet their needs. Generally, individuals have little or no control over external factors such as climate-related disasters (Tham-Agyekum, 2015). Therefore, communities must strengthen their adaptive capacity against future stressors.

The SLF also illustrates that different communities rely on both tangible and intangible resources to build their livelihoods. These resources are classified into five different types of livelihood capitals: human, social, natural, physical, and financial resources (Krantz, 2001; Serrat, 2017; Fanadzo et al., 2021). Human capital includes "health, education, knowledge, and skills" (Jethwani & Mishra, 2012). Social capital comprises: 1) networks and interconnections that enhance people's confidence and capabilities to work as a group for mutual benefits and to increase their access to institutions with broader objectives; 2) participation in formal social structures governed by certain rules, norms, values, and sanctions; and 3) mutual relationships and trade-offs that accelerate partnerships, reduce the costs of selling and buying, and provide security among poor individuals (UNDP, 2017).

Smallholder farmers rely on natural resources as capital assets to support their livelihoods. These resources encompass water, land, trees, as well as intangible assets such as climate and biodiversity. For smallholder farmers, natural assets are crucial for their farm productivity, including rainfall for crop irrigation and trees for climate adaptation. Physical capital includes basic infrastructure and tools that enhance productivity, both of which are essential for sustainable livelihoods. It influences access to basic services, including shelter, information, safety, affordable transportation, water, sanitation, and energy. Finally, financial capital encompasses access to savings, wages, credit, and remittances (Serrat, 2017). Financial capital plays a critical role in enabling individuals to invest in various opportunities and manage their financial affairs effectively. Nonetheless, access to these capital assets is governed by policies and institutions that are continuously changing (Krantz, 2001). These institutions can be formal or informal, directly or indirectly facilitating access to capital assets (Serrat, 2017). This, in turn, affects how people make a living.

3. Study Area

The study was conducted in the Overberg District Municipality (ODM) in the Western Cape Province, South Africa. The ODM is located in the southern part of the province (Figure 2). It covers an area of 12,241 km^2 and includes four local municipalities: Overstrand, Cape Agulhas, Swellendam, and Theewaterskloof (Western Cape Government, 2017). The towns included in the Overberg region for data collection were Bredasdorp, Napier, Elim, Caledon, Tesselaarsdal, Swellendam, Genadendal, Suurbraak, Buffeljagsrivier, and Villiersdorp. Farming is a predominant activity in these towns.

Latest statistics indicate that the total population of the ODM was 359,446 in 2022 and is expected to increase by at least 8.8% by 2027 (Western Cape Government, 2023). The unemployment rate in the ODM was lower than that of other districts and the province, at 14.9%. Agriculture in the Overberg and the entire province makes a substantial contribution to employment creation. Smallholder farmers in the Overberg are self-employed on their farms but also seek work outside of their farms to diversify their incomes.

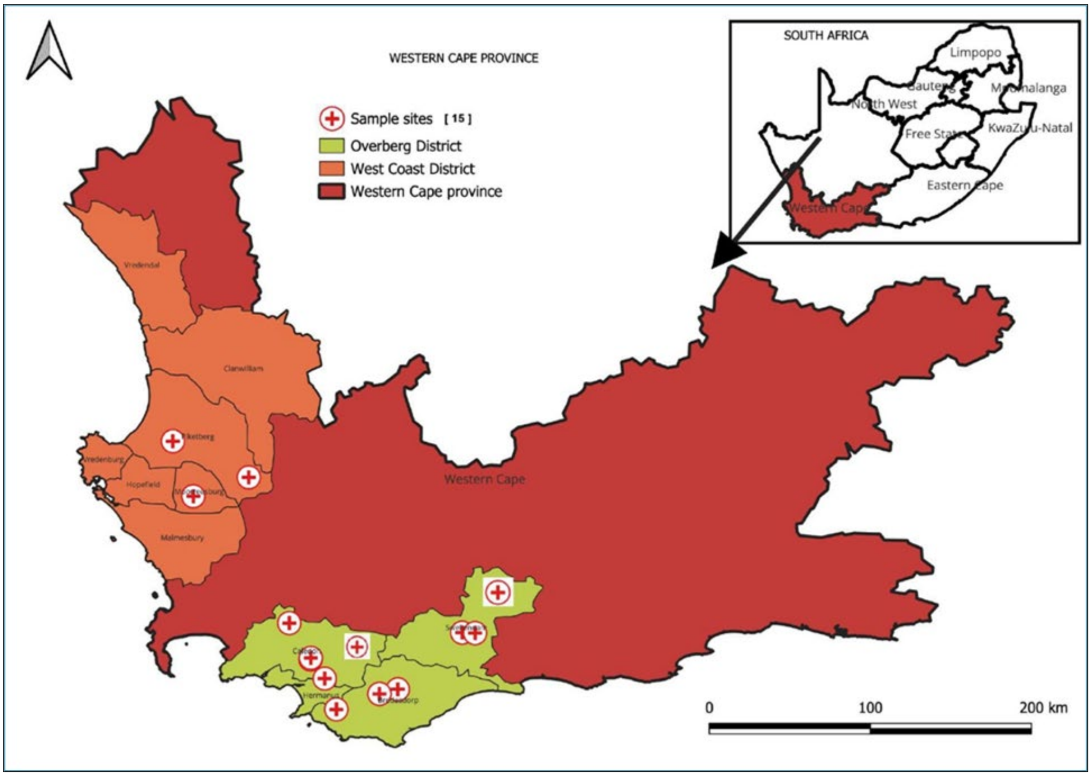

Figure 2: *Map of the study sites in Overberg District (shaded green). Source: (Ncube et al., 2025)*

The climate in the Overberg region is Mediterranean, characterised by warm, dry summers and cold, wet winters. The regional climate forecast estimates an average temperature increase of 3°C by 2060 in the study area (Western Cape Government, 2017). Rainfall patterns are also uncertain; it is expected to decline in the winter months while increasing in the summer. This means that climate change is likely to cause a shift in planting seasons, as rain-dependent farmers would expect to receive more rain in the winter months, but it is instead shifting to the summer. This emphasises the need to make climate information available to smallholders, enabling them to adapt effectively to climate change. The following hazards related to climate change have been identified in the Overberg region related to climate change: drought, floods, storms, erratic rainfall, and changes in seasonal patterns (Western Cape Government, 2017). The identified risks include infrastructure damage, food and water insecurity, health crises, impacts on natural resources, and reduced investments. The water resources in Overberg include rivers, dams, springs, and boreholes.

4. Methods

This study employed a concurrent mixed-methods design, integrating qualitative and quantitative approaches simultaneously in one or more stages of the investigation (Mohammadi et al., 2020; Levanon et al., 2021). Both qualitative and quantitative data were treated with equal importance and were employed in both stages of data gathering and analysis. The motivation for adopting a mixed-methods approach was that a single research approach (qualitative or quantitative) could not adequately address the research problem. The target population for the study consisted of smallholder farmers and key informants from important water and agriculture-related local institutions in the ODM. To identify smallholder farmers, we used the Department of Agriculture, Forestry, and Fisheries' (2015) characterisation of them as individuals who produce for their households and sell surplus to generate income, with aspirations to grow into commercial farming.

In this study, both smallholder farmers and key informants were purposively selected. Purposive sampling was employed, using a list of smallholder farmers with contact information obtained from the Western Cape Department of Agriculture. Initial contacts were made with smallholder farmers to arrange site visits and interviews through agricultural advisors. However, the lists obtained from the Western Cape Department of Agriculture did not yield a sufficient number of participants to meet the required sample size for the study, particularly for statistical analysis. This may be due to some smallholder farmers not receiving support from the Department, resulting in their absence from the database. To increase the sample size, additional smallholder farmers were recruited through the initial contacts, who were also farmers, using snowball sampling. It should be noted that this non-probability sampling method is subjective, introducing a risk of bias through referrals to colleagues and acquaintances.

To mitigate potential bias and ensure the validity and reliability of the study findings, we employed method and data triangulation by concurrently using surveys of smallholder farmers (n = 100), focus group discussions (FGDs) (n = 37), and key informant semi-structured interviews (n = 13). The key informants were from the Swellendam Municipality, the Western Cape Department of Agriculture, the Breede-Olifants Catchment Management Agency, and the World Wide Fund for Nature, all of which work with smallholder farmers. This allowed for the cross-verification of information from multiple sources and techniques (Figure 3). Moreover, using mixed methods ensured that qualitative data provided context and depth to the quantitative statistical analysis, thereby strengthening the trustworthiness of the findings.

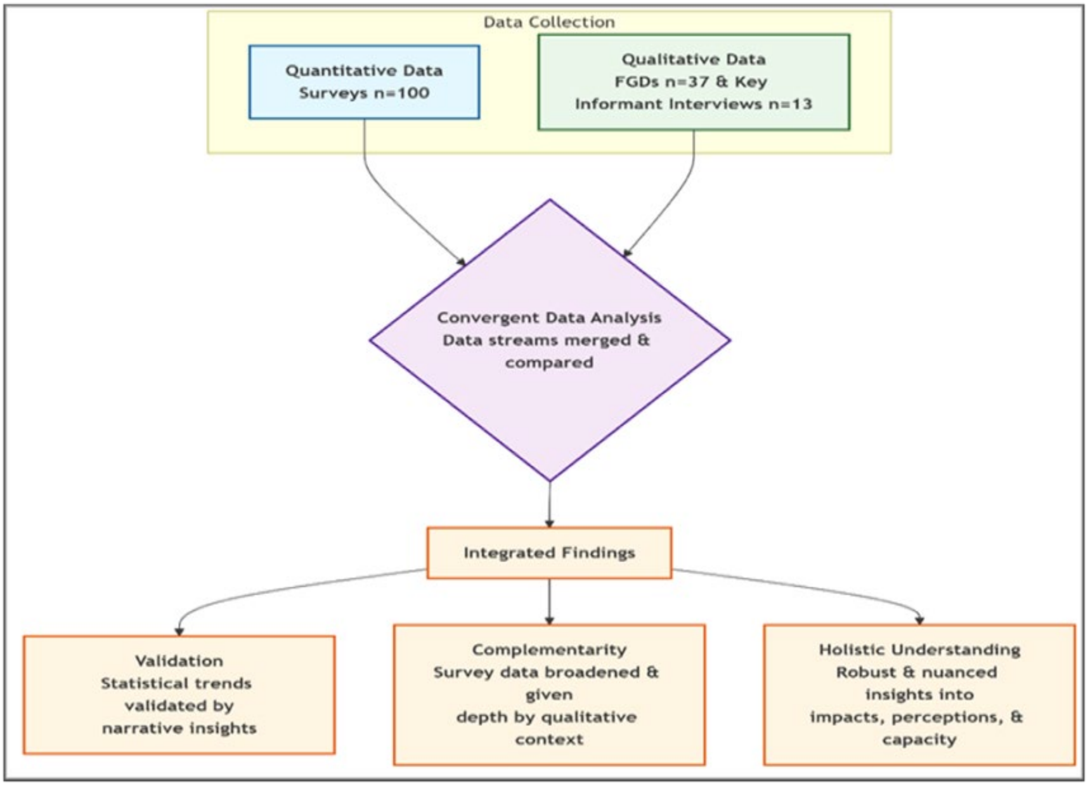

Figure 3: *Data triangulation map for the study*

The study adhered to ethical guidelines by obtaining informed consent from participants and ensuring anonymity and confidentiality through the use of pseudonyms for direct quotes. Ethical approval was obtained from the Institutional Ethics Committee. Data were collected in person from smallholder farmers at their homes. Each participant signed a consent form, acknowledging that they had given permission for audio recording and that their participation was voluntary. Data on smallholder farmers' perceptions of climate change and its impact on water availability and access were gathered through face-to-face interviews using a questionnaire that included both closed-ended and open-ended questions. Focus group discussions were then conducted to follow up on issues and expand the scope of data collection for in-depth analysis. Semi-structured interviews were carried out with local organisations working directly with smallholder farmers and institutions responsible for managing water resources. These interviews took place both online and in private spaces at participants' offices. Quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS) to produce descriptive statistics (graphs and frequency tables) on the characteristics of smallholder farmers and their coping and adaptation strategies. Qualitative data were analysed using ATLAS.ti software as a tool for thematic coding of the qualitative data.

5. Presentation of Results

5.1 Characteristics of the smallholder farmers

Table 1 presents the demographic characteristics of the smallholder farmers. Middle-aged farmers predominated, with a smaller representation of youth (10%). There were more male farmers (76%) than female farmers (24%). The level of education was generally low, with only a few having attained tertiary qualifications (8%). Most farmers worked on land that was less than a hectare (48%) and lacked secure tenure, as most land was leased from the government. Finally, the majority of farmers operated individually (72%) and did not have access to credit (84%).

Table 1: *Smallholder farmer characteristics*

Characteristics	Sub-characteristics	% (n=100)
Age	18-35	10
	36-50	34
	51-65	37
	66+	19
Gender	Male	76
	Female	24
Education	Primary	22
	Some secondary	32
	Matric	30
	Post-secondary	8
	No formal education	1
	Not sure	1
Land sizes (hectares)	Less than 1	48
	1-10	22
	11+	27
	Not sure	3
Land Tenure	Allocated	39
	Inherited	18
	Bought	6
	Borrowed	18
	Rented	12
	Other	7
Types of farming	Mixed	26
	Crops	33
	Livestock	41
Farming methods	Group	28
	Individual	72
Credit access	Yes	16
	No	84

5.2 Climate change perceptions

5.2.1 Temperature and rainfall changes

Figure 4 presents participants' perceptions of temperature and rainfall changes for the last 20 years. Regarding temperature changes, 68% of the participants reported an increase, 15% reported a decline, and 13% reported no change. Regarding rainfall, 51% of participants reported an increase, 29% noted a decrease, and 16% observed no change. Finally, only 4% of the participants were unaware of any changes in temperature and rainfall.

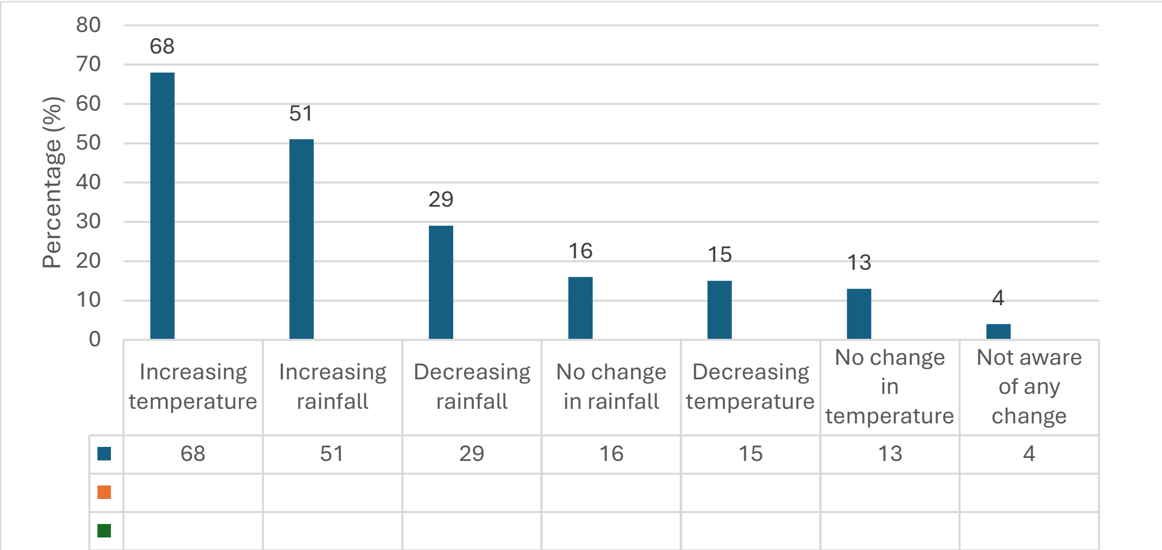

Figure 4: *Smallholder farmers' perceptions of temperature and rainfall changes (n=100)*

During the focus group discussions (FGD) in Elim, participants reported that they had started experiencing hotter days in winter, unlike in previous years. This finding was consistent with the quantitative responses of most participants regarding temperature changes. The views of some participants were as follows:

> "*We see the change in heat and warmth because all of a sudden, we get warmer days in winter than before.*" (FGDP1)
>
> "*I think 2014/15, we recorded the warmest days in June.*" (FGDP3)
>
> "*Nowadays, it becomes hotter throughout the seasons.*" (FGDP2)

During another FGD in Bredasdorp, the participants revealed that rainfall was increasing and its pattern was changing. One participant indicated that they used to farm throughout the year, but this had now changed due to inconsistent rainfall:

> "*Our rainfall was above 600 millimetres now, and that's a lot of rain.*" (FGDP1)
>
> "*There is a change; we used to get rainfall throughout the year.*" (FGDP2)

The views of smallholder farmers on changes in climate conditions can provide valuable data to inform future adaptation strategies. This suggests that farmers are aware of long-term variations in climate conditions, which may help them adapt their farming practices and enhance productivity.

5.2.2 Climate-related disasters

Table 2 shows climate disasters experienced by smallholder farmers over the past 20 years. Floods (33%) and drought (29%) were more widely experienced than storms (15%), forest fires (12%) and heatwaves (11%).

Table 2: *Climate-related disasters experienced by smallholder farmers (n=100)*

Climate change-related disasters	Frequency	Percentage (%)
Floods	57	33.1
Drought	50	29.1
Storms	25	14.5
Forest Fires	21	12.2
Heatwaves	18	10.5
Other	1	0.6
Total	172	100

Given the prominence of responses to droughts and floods, the following section provides a detailed analysis of the impacts of these disasters on water availability and smallholder farming productivity.

5.3 Drought and flood impacts

According to the SLF, the impacts of droughts and floods represent the vulnerability context in the erosion of natural capital, such as water and soil. Table 3 illustrates the impacts of droughts on water availability and farm productivity, as reported by the farmers.

Table 3: *Impact of climate disasters on smallholder farm productivity (n =100)*

Disaster	Impact Category	Specific Impact	Farmers Reporting (%)
Drought	Water and feed shortage	Agricultural water shortage	36
	Production loss	Low crop yield	19
	Livestock impacts	Lack of grazing	9
		Livestock mortality	6
	Water quality	Reduced water quality	2
Floods	Production loss	Loss of crops	24
	Livestock impacts	Livestock mortality	17
	Infrastructure damage	Damage to water infrastructure	9
		Destroyed animal housing	7
		Damage to road infrastructure	3
	Environmental damage	Water pollution	4
		Land degradation	4

The effects of drought and floods on productivity create external shocks that deplete financial, physical, and human capital assets. This, in turn, influences the livelihood strategies and outcomes for smallholder farmers.

5.3.1 Drought impacts

The effects of drought reported by the participants included a shortage of agricultural water (36%) and a reduction in crop yields (19%). The lack of water for irrigation during drought conditions led to a decrease in crop yields. For example, participant CalOD11 said:

> "*Drought affects our yield because we run out of water for irrigation.*"

This finding was explored further during an FGD in Elim. One participant expressed that, despite having abundant water resources, they were affected by drought:

> "*We are very privileged to live in a very water-rich area, but yes, there were times in the past 10 years when we were facing challenges during the drought period, when by the time there was talk about day zero (FGDP1).*"

However, the impacts of drought on water resources were not uniform. In other towns, such as Genadendal, farmers indicated during a focus group discussion that they had never experienced water shortages for agriculture because they had sufficient water in the mountains and the rivers were constantly flowing. The participants expressed that:

> *"We never really have a drought problem, not here, but we were close to it. In 2018 and 2019, we were close to having a drought; things were tough here, but it was not bad, and we survived."* (FGDP1)

Some participants attributed the abundance of water in their area to both a natural resource and a divine blessing linked to devotion and moral standing. This was demonstrated by one participant who, while acknowledging the severity of the regional "Day Zero" crisis, dissociated their community from it:

> *"They did not have water in Cape Town because they do not go to church often. We go to church a lot, and we do not have a problem with water. I believe in God."* (FGDP1)

This narrative represents an important finding on the modelling of risk perception. It validates how beliefs can serve as cognitive buffers, framing environmental solidity as a moral product rather than a haphazard physical process. This cultural framing impacts awareness and adaptive behaviour, potentially leading to a lower sense of urgency in implementing current water conservation measures.

The findings from the key informant interviews confirmed the farmers' perceptions of drought. The key informants indicated that smallholder farmers experienced water scarcity primarily due to repeated droughts. They argued that the water sources upon which smallholder farmers relied diminished during these droughts. Figure 5 illustrates the views of key informants on the impacts of drought. The narratives in the relationship diagram indicate that drought resulted in a reduction in water availability across multiple sources. It shows that the major dams were depleted and water was restricted, forcing farmers to rely on boreholes, which subsequently dried up, compelling them to transport water for their livestock.

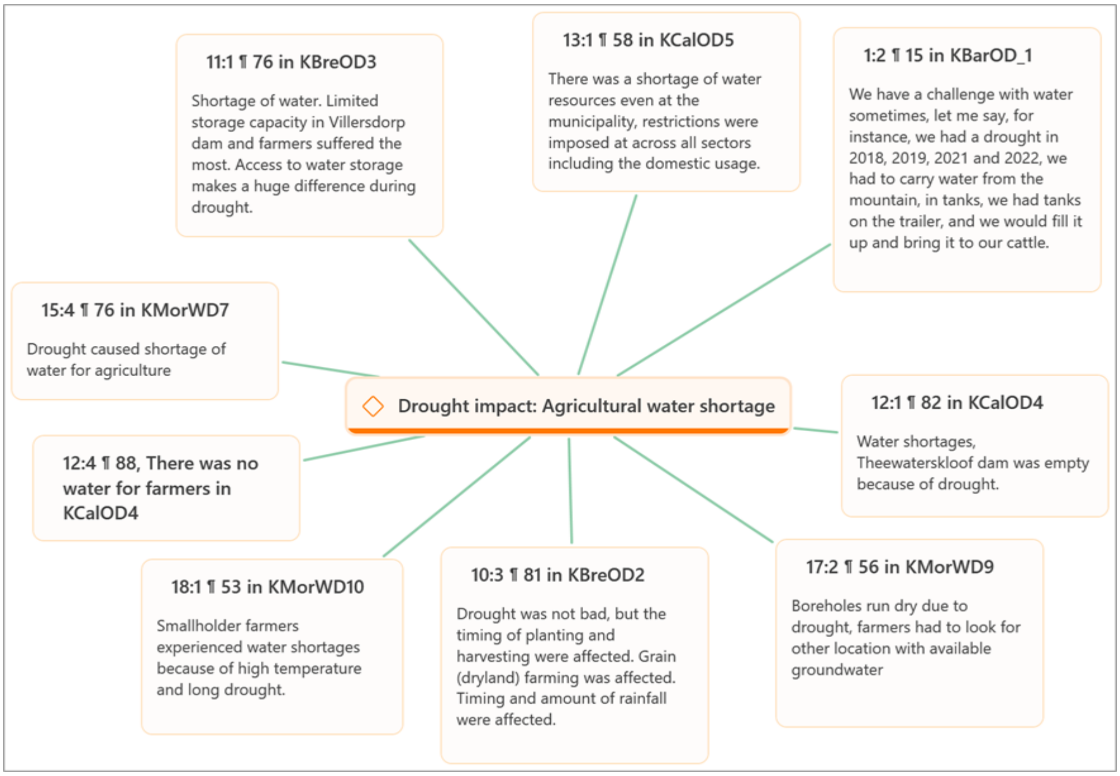

Figure 5: *Impact of drought on agricultural water availability*

Another effect of drought on the productivity of smallholder farming was the death of livestock, often associated with a lack of feed due to the dry conditions. This is evident in a statement by participant BredOD49, who said:

> "*During the drought, it was dry, and there was a lack of feed for animals.*"

Thus, drought affected the productivity of smallholder farms, posing a risk to their livelihood.

5.3.2 Flood impacts

Table 3 shows the impact of floods on water and farm productivity, which included a loss of crops (24%), livestock mortality (17%), and damage to water infrastructure (9%). Other impacts included the destruction of animal housing (7%), water pollution (4%), land degradation (4%), and damage to road infrastructure (3%). The participants experienced a series of floods that washed away their crops, as evidenced by their statements:

> "*We lost some crops because of the floods.*" (BredOD29)
>
> "*Floods destroyed our crops.*" (BarOD26)

Critical infrastructure, such as roads, was severely damaged by floods, posing a challenge for farmers trying to access markets. During fieldwork, the effects of the floods were still evident on several roads used by farmers to reach the markets. Some roads were flooded, and several bridges were broken. Participant BredOD48 said:

> "*The flood damaged the road, and we could not cross the river to go and sell our products because it was flooded.*"

Poor access to adequate infrastructure, such as proper roads, restricted smallholder farmers from participating in formal markets. The frequent occurrence of floods likely aggravated these structural barriers. Participants also reported losing livestock during floods. Farmer GenOD31 revealed that he lost 19 pigs. Similarly, during a focus group discussion in Bredasdorp, one farmer recounted losing 14 pregnant ewes that were due to give birth. The participant said:

> "*Last year, when it rained for almost a week, we lost quite a few of our ewes. We lost 14 ewes due to the river flooding during heavy rain.*" *(BredFGP5)*

Although the participants-built structures to house their livestock, particularly pig farmers, floods damaged these structures, resulting in substantial losses. Essential topsoil was washed away by the flooding. Key informants explained that they had experienced consecutive floods over the past four years in the Overberg region. These floods typically occur between January and March, and again in October and December. The floods affected water availability and access by damaging critical water infrastructure. Water pipes and irrigation systems were washed away during these events. Figure 5 illustrates the views of key informants on the impacts of the floods. The narratives in the relationship diagram interestingly indicate that floods result in water loss due to the destruction of infrastructure.

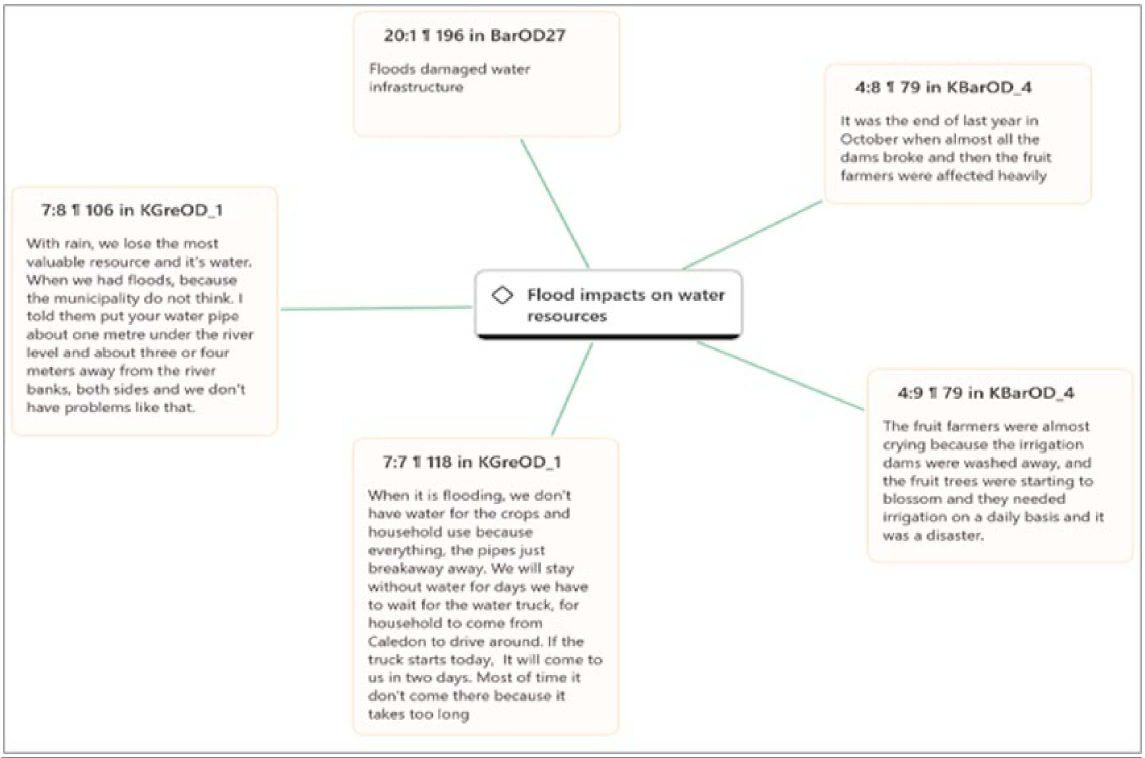

Figure 5: *Impact of floods on agricultural water availability*

5.4 Coping and adaptation

Most farmers (57%) did not implement any strategies to cope with the effects of extreme weather events (Figure 6). Among the remaining 43%, coping strategies included transporting water (16%) to their farms, government drought relief (11%), relocating livestock (4%) to higher ground to survive flooding, purchasing feed during dry periods, reducing irrigation, and selling livestock.

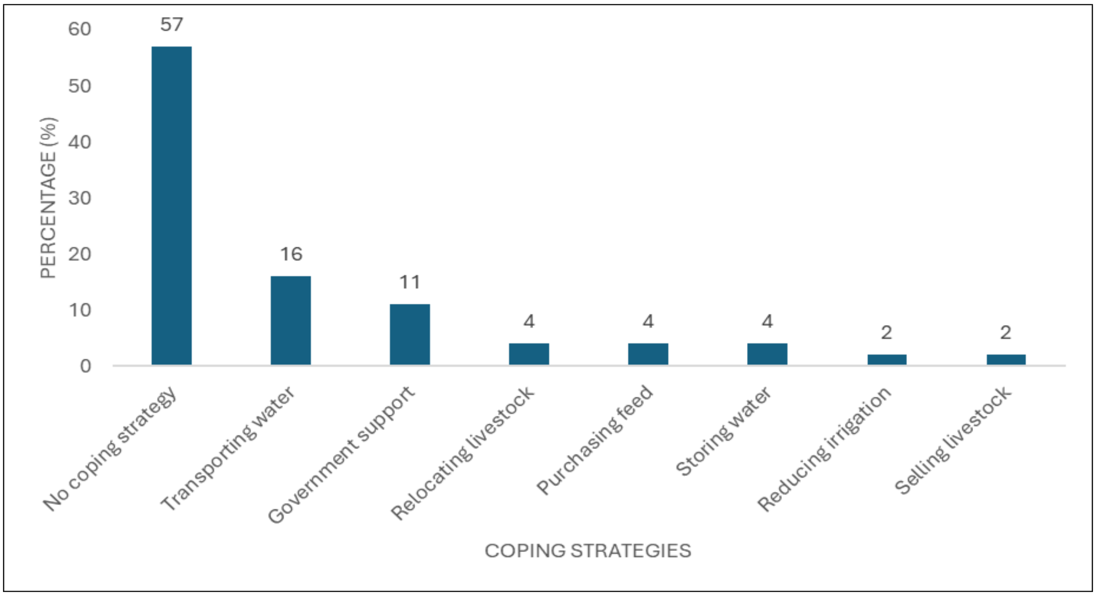

Figure 6: *Distribution of coping strategies adopted by smallholder farmers (N=100)*

Concerning adaptation, a notable finding is that 37% had not implemented any strategy. Among the 63% of smallholder farmers who had adaptation strategies, the most common methods included building shelters for livestock (12%) and digging flood channels (12%), which were direct physical responses to the most immediate and devastating threats (Figure 7). The construction of shelters was a straightforward adaptation to the destructive flood events that devastated livelihoods, while the digging of flood channels signified an effort to manage the damaging hydrological power that collapses infrastructure. These were protective, "hard" adaptations. They indicate a prioritisation of loss avoidance and asset protection, reflecting a reactive approach to the most visibly destructive climate impacts, such as floods, rather than a pre-emptive enhancement of agricultural techniques against slower-onset stressors like drought.

Another significant result is the low adoption frequency of strategies that directly address the primary challenge of water scarcity. For example, rainwater harvesting (4%), using greywater (6%), and purchasing tanks (4%) were employed by a minority of smallholder farmers, despite water scarcity remaining a dominant issue. The results suggested that smallholder farmers were preparing for an immediate, devastating risk, such as flood-induced livestock deaths, rather than long-term, efficiency-related issues, such as water optimisation. This indicates a likely adaptation priority, where inadequate resources are allocated to avoid total loss rather than enhancing long-term agricultural productivity. The negligible use of mulching (2%) additionally highlights a variance in the assumption of knowledge-intensive, soft adaptations, likely due to obstacles to information access, labour, or a lack of perceived immediate benefits.

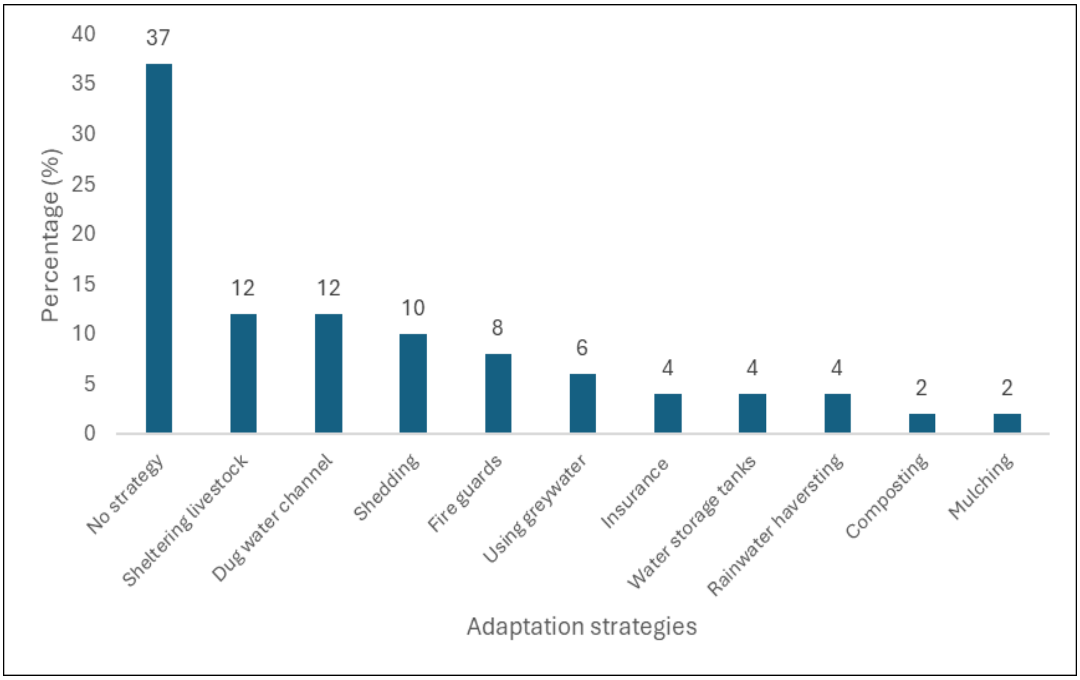

Figure 7: *Distribution of adaptation strategies adopted by smallholder farmers (N=100)*

In the context of climate vulnerability, the fact that only 4% of participants had taken out insurance signifies a dire market and institutional situation. Insurance is key in contemporary risk management, but it remains unavailable to most smallholder farmers, likely due to expense or the absence of customised products. This compels farmers to rely on self-insurance through physical methods or, as previously observed, government relief, thereby incurring a high financial risk that endangers their economic sustainability.

Overall, smallholder farmers demonstrated significant vulnerability to climate-related disasters. The lack of an adaptation strategy among 63% of farmers shows a widespread low adaptive capacity in smallholder farming. This was likely worsened by deficits in financial, human, physical, and social assets. Very few farmers (16%) utilised credit facilities. Physical and natural capital dominated the adaptation strategies. Farmers focused on localised hands-on activities, such as digging water channels and building structures to protect livestock during flooding. However, high-impact sustainable strategies such as rainwater harvesting, composting, mulching, and greywater reuse were underutilised. Moreover, only a few farmers utilised social and financial resources to mitigate the impacts of floods and drought.

6. Discussion

The study findings reveal a high level of socioeconomic marginality, defined under the SLF as a lack of livelihood assets, which limits the adaptive capacity of smallholder farmers. Access to credit is crucial for adaptation strategies; however, few farmers have this access. This aligns with the literature, which shows that smallholder farmers are often excluded from financial systems (Mutengwa et al., 2023). Other studies have also demonstrated that insecure land tenure prevents farmers from investing in long-term adaptation, perpetuating the cycle of vulnerability (Ruwanza et al., 2022). The significantly positive relationship between higher education and improved adaptations highlights the importance of human resources in climate information and evaluating options. However, this critical resource is often overlooked in smallholder farming communities (Ncube, 2018).

The central finding of the prevalent drought aligns with other studies that recorded the severe 2015-2018 drought in the Western Cape Province of South Africa (Botai et al., 2017; Fanadzo et al., 2021; Pili & Ncube, 2022). Nonetheless, the current research further explores the unequal manifestation of water scarcity. The contrast between communities experiencing water stress and those that are not, such as Genadendal, due to their proximity to mountain catchments, exemplifies the role of localised hydrogeology and demonstrates the irregular spatial dispersion of impacts. These challenges standardised macro vulnerability assessments and argued for local, catchment-specific adaptation strategies. However, the evolving narrative from traditionally resilient areas, indicating that they were "close to having a drought," suggests a distressing trend. It implies that the territorial trajectory of drought is expanding, potentially eroding formerly dependable hydrological areas (McLaughlin et al., 2017) and pushing previously protected systems to their environmental limits.

The high proportion of farmers lacking coping and adaptation strategies is a shocking finding. This reveals an overwhelming coping and adaptation ceiling, as found in other studies across South Africa (Mbuli et al., 2021; Omerkhil et al., 2020; Ncube, 2018; Pili & Ncube, 2022). The overlapping vulnerabilities of low financial assets, unreliable land tenure, limited access to credit, and an information gap create this ceiling. The coping and adaptation strategies employed by smallholder farmers are generally reflexive, distress-driven, and frequently ill-suited in the long run. For example, transporting water in bakkies is costly, and carrying water in buckets for livestock is also a labour-intensive makeshift measure that reduces smallholder farmers' agricultural production. This aligns with some coping mechanisms identified in other studies. For instance, Bahta and Myeki (2022) in the Northern Cape and Thinda et al. (2020) in KwaZulu-Natal, along with Ncube (2018) and Fanadzo et al. (2021) in the Western Cape, have also detailed the distress sale of livestock. The current findings contextualise this as a coping strategy, resulting in a similar reactive logic: when faced with an immediate and devastating loss, such as livestock death caused by drought, the only seemingly viable strategy is to liquidate the asset. Similarly, the (over)dependence on government relief found in this study and by Maluleke et al. (2020) can be viewed as an externalisation of this reactive attitude, where smallholder farmers rely on last-ditch, post-disaster relief instead of investing in self-sufficient, long-lasting resilience methods.

Lastly, the aspect of cultural and spiritual risk assessment is an important finding that is generally missing from previous studies. Scholars such as Popoola et al. (2018) and Rankoana (2022) have recorded views on physical changes, such as rainfall scarcity, but did not interrogate the perceptive and cultural paradigms used to explain these changes. The current finding on water availability, attributed to divine involvement, presents a contrasting viewpoint to the solely scientific risk simulations that often highlight policy interventions. This implies an information deficit, suggesting that disseminating weather data to smallholder farmers alone will not be sufficient to enable them to adapt. The findings contrast with the implied assertion in some adaptation literature that perceptions rely on empirical observation (Popoola et al., 2018; Rankoana, 2022), revealing an alternative perspective where deeply held worldviews can primarily shape the understanding of disasters such as drought and the recognised need for outside interventions. This means that communication must also involve local worldviews, rather than seeking to overturn them.

6. Conclusions and Recommendations

The study assessed the impact of drought and flooding on water availability and farm productivity, as well as the coping and adaptive capacity of smallholder farmers. Using the Sustainable Livelihoods Framework (SLF), we found that secure land tenure, a high level of education, and access to credit significantly contribute to the adaptive capacity of smallholder farmers. The participants' perception of climate change was linked to their risk assessment and response strategies to external shocks. Droughts and floods emerged as the major climate-induced disasters in the study area. While droughts led to the drying up of water sources, floods destroyed water infrastructure, resulting in water stress. The farmers had a low coping and adaptation capacity due to weak institutional support and inadequate training, leading to a lack of knowledge about strategies they could implement to respond to climate-induced disasters.

We recommend providing continuous training to smallholder farmers to build their adaptive capacity. There is a need to accelerate institutional support for building dams and boreholes to improve agricultural water availability and productivity. The focus should shift from providing relief to developing climate-resilient smallholder farming systems through capacity building. Water productivity in smallholder agriculture can also be enhanced by prioritising water conservation. Examples include drip irrigation, which efficiently improves productivity and builds resilience to climate change and drought. The government should invest in creating and maintaining small irrigation schemes in smallholder farming to enhance adaptation to climate change and drought. The government should also consider establishing a climate adaptation fund with a strong focus on smallholder farmers to help them acquire the latest technology and resources for climate adaptation.

The study contributes to a growing body of literature that links the impacts of drought and flooding to the erosion of livelihood assets within the SLF, thereby revealing the vulnerabilities faced by smallholder farmers. It was also concluded that the adaptive capacity of smallholder farmers is linked to capital, as evidenced by their limited financial access and insecure land tenure. There is, therefore, a need for targeted credit and land access interventions that build capacity and resilience in smallholder farming systems.

7. Declaration

Author Contributions: Conceptualisation (P.H.M., E.S., & B.N); Literature review (P.H.M., E.S., & B.N.); methodology (B.N.); validation (E.S. & B.N.); formal analysis (P.H.M., E.S., & B.N.); investigation (P.H.M., E.S., & B.N.); data curation (P.H.M., E.S., & B.N.); drafting and preparation (P.H.M., E.S., & B.N.); review and editing (E.S. & B.N.); supervision (B.N. & E.S.); project administration (B.N.); funding acquisition (B.N.). All authors have read and approved the published version of the article.

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Conflict of interest: The authors declare no conflict of interest.

Data availability: The data presented in this study will be available from the corresponding author upon request after 31 March 2027. The data are not publicly available as they are part of a larger project that must be completed and synthesised before all the data can be released to the public.

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