



Community Perceptions on the Transformation of a high-altitude Grassland Through Invasion by *Leucosidea sericea* at Vuvu, South Africa

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Abstract

We assessed perceptions of *Leucosidea sericea*, a woody plant that is increasing in density such that it may threaten rangelands among agro-pastoralists whose livelihoods rely on livestock (56%) and crop farming (36%) in Vuvu, Eastern Cape, South Africa. Using semi-structured questionnaires, we asked 198 respondents about the spread of the species in the last few decades, and its impact on the availability of graze for livestock. Responses indicated that *L. sericea* started spreading in the 1950s, with marked increases in 2011–2020, particularly in the mountainous areas used for grazing as well as by rivers and village residences. Respondents suggested that livestock were the main biological agent of seed dispersal, and livestock ownership had increased dramatically in recent years, with a preference for sheep (a minimum of 120 per household). Overall, respondents indicated that *L. sericea* encroachment negatively affected their community.

Keywords Agro-Pastoralism · Eastern Cape · Fire · Herbivory · Land Degradation · *Leucosidea sericea* · Livelihoods · South Africa · Vuvu · Woody plant encroachment

Introduction

In southern Africa, woody plant encroachment (also called bush encroachment) has become a serious threat to grassland health and human livelihoods over the last century (Buitenwerf et al., 2012; O'Connor et al., 2014; Russell & Ward, 2016). Bush encroachment results in an increase in the density of native woody plants at the expense of herbaceous plants in grasslands and savannas (Tedder et al., 2014; Stafford et al., 2017). In South African grasslands and savannas, the spread of woody plant cover began in the 1940s across different land-use types (Stevens et al., 2016), and increased dramatically from 1993 (Ward, 2005). As a result, bush encroachment has been described as a primary factor leading to the decline of rangeland quality and integrity (Dougill et al., 2016).¹ Food for grazing domestic and wild animals is compromised by the shift in vegetation type from dominance of herbaceous to woody plants (Sala & Maestre, 2014), which degrades rangelands due to reduced grass production (Oba et al., 2000; Lohmann et al., 2012; Beyene et al., 2014) such that grazing livestock may suffer

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¹ For example, bush encroachment increased by 19% between 1990 and 2006 in communal areas of KwaZulu-Natal in South Africa (Luvuno et al., 2018).

weight loss (Beyene et al., 2014). Bush encroachment may decrease the grazing capacity of rangelands and damage the healthy functioning of the ecosystem, affecting the delivery of ecosystem services (Luvuno et al., 2018).

One of the main problems associated with plants encroachment is understanding the mechanisms of spread or seed dispersal. In many instances, seeds are dispersed by environmental (e.g., wind) or physical (e.g., animals) agents (Soons et al., 2004; Couvreur et al., 2005). Animals may disperse seeds via ingestion (e.g., cattle (*Bos taurus*) and goats (*Capra hircus*) (Ansley et al., 2017)) or attachment to fur (February et al., 2017). Fire may also increase woody plant encroachment through enhanced seed germination (Gashaw & Michelsen, 2002). This, too, may be exacerbated in communal rangelands because annual burning may be carelessly managed and escape to cause unintended damage (Snyman, 2004; Russell & Ward 2016). However, the use of fire promotes nutritional grazing by enabling the growth of high quality grasses after burning (Angassa & Oba, 2008).

Encroaching woody plants can provide important resources for humans in terms of fuel, timber, and medicines (Goebel et al., 1990; Sehlakgwe et al., 2020). For instance, *Leucosidea sericea* is used to treat eye inflammation, skin infections, and cough (Mafole et al., 2017; Pendota et al., 2018). In addition, woody plants may also provide forage for domestic animals, e.g., *Vachellia nilotica* was reported to provide livestock feed during the dry season, likely reducing supplemental feed costs (Mekoya et al., 2008). The encroachment of legume plants is widely documented in grasslands and savannas but fewer records exist for non-legume plants (but for encroachment by *Terminalia sericea* in Namibia see, Nakanyala & Hipondoka 2020; Daniels & Throop, 2022). For example, *L. sericea*, which is a serious encroacher of high-altitude grasslands of South Africa, Zimbabwe, Swaziland (now Eswatini), and Lesotho, is noted for its medicinal properties (Goebel et al., 1990; Boon, 2010; Daemane et al., 2010). Consequently, people may ignore the spread of woody plants until it begins to interfere with the delivery of other services (e.g., grazing).

In Africa, land used for human settlements and crop and livestock farming is frequently held communally (Gxasheka et al., 2017). Livestock play a role in the livelihoods of rural communities, providing food and financial security (Sebitloane et al., 2020; Kraai et al., 2022). However, high stocking rates or animal densities in communal rangelands can result in deterioration of rangeland conditions through overgrazing leading to bush encroachment that in turn may result in the rapid decline in grass cover (Dougill et al., 2016) and promote invasion by woody plants because the low fuel of overgrazed areas cannot sustain fire. Another factor that contributes to the shrinkage of rangelands is increase in human settlements (Gxasheka et al., 2017). Nevertheless,

management of these rangelands would likely sustain conditions for optimal yield and functioning.

Bush encroachment reduces grazing capacity of communal rangelands (Russell & Ward, 2016), while in private and state-owned rangelands, there is a greater tendency to abide by formal rangeland management practices such as woody plant clearing (Luvuno et al., 2022), which may be funded by the government (e.g., the Working on Water programme in South Africa, see Hobbs 2004) or undertaken during firewood collection. In addition, livestock browsing itself prevents the spread of woody plants (Scogings et al., 2011). Goats are able to consume woody plants (Webb et al., 2011), but may be kept in lower numbers.

Landowners and users are important in determining effects of landscape and climate change in communal areas (Gyampoh et al., 2009; Inman et al., 2020; Sebitloane et al., 2020). For example, in Ethiopia, the cessation of managed fire in grasslands resulted in increased woody plant encroachment (Angassa & Oba, 2008), which in turn resulted in a shortage of grazing areas exacerbated by dry periods (Angassa & Oba, 2008). Local history and current challenges are best understood in light of local perceptions of past and ongoing developments (Russell & Ward, 2016; Gxasheka et al., 2017), which emphasises the need for elderly participation in such studies. A rural community in Taung, North-West Province of South Africa, was fully aware that stocking rates and types of livestock contributed to bush encroachment and of the trade-offs associated with animal ownership and rangeland degradation (Sebitloane et al., 2020). While owning livestock at high numbers is associated with greater social status (Beyene et al., 2014), the downside of this is the potential degradation of the rangeland as the grazing capacity is exceeded, which ultimately affects livestock productivity.

Our research addresses two questions: (i) What changes have occurred in the rangeland over the years in forage availability? and (ii) How have these changes affected the livelihoods of the community? Specifically, we determined the community's perceptions of the time periods in which *L. sericea* began to spread and identified the causes of spread including areas showing different levels of encroachment and the management strategies, uses, and impacts of the plant. We also traced the history of livestock farming and livestock densities. We expected animal numbers to increase with increasing number of residents in the communal area over time.

Methods

Study Area

The communal area of Vuvu (30° 36' 29.16" S; 28° 14' 38.04" E) is located about 20 km north west of Mount Fletcher in the Eastern Cape Province of South Africa (Fig. 1) in the southern Drakensberg Mountains, which is an important water catchment for the Umzimvubu and Tsitsa Rivers (van der Waal & Rowntree, 2017). The area, characterized by a distinctive topography with steep slopes and deep valleys forming intermittent streams that drain into the major river systems (Rowntree et al., 2012), is part of the Maputaland-Pondoland-Albany biodiversity hotspot (Mucina & Rutherford, 2006). The vegetation is described as high-altitude grassland, which includes Lesotho highland

basalt grassland, east Griqualand grassland, and southern Drakensberg grassland (Mucina & Rutherford, 2006). Grass species prevalent include *Aristida junciformis*, *Sporobolus africanus*, *Eragrostis curvula*, *Themeda triandra*, *Hyparrhenia hirta*, and *Heteropogon contortus* (Mucina & Rutherford, 2006). Woody plants include *L. sericea*, *Buddleja salviifolia*, *Diospyros lycioides*, *Eucalyptus* spp. and *Acacia mearnsii*. The soils are deep and consist mainly of sandy-loam and clay-loam soils, which occur on the uplands of the mountains and are suitable for cultivation (van der Waal & Rowntree, 2017). Mean annual rainfall is approximately 580 mm (Fig. 2), and ranges from 620–816 mm (Mucina & Rutherford, 2006). The region receives predominantly summer rainfall (October to February), and experiences annual low temperatures (14.7°C) for the most part, with increases (25°C) in the summer period (Mucina & Rutherford, 2006).

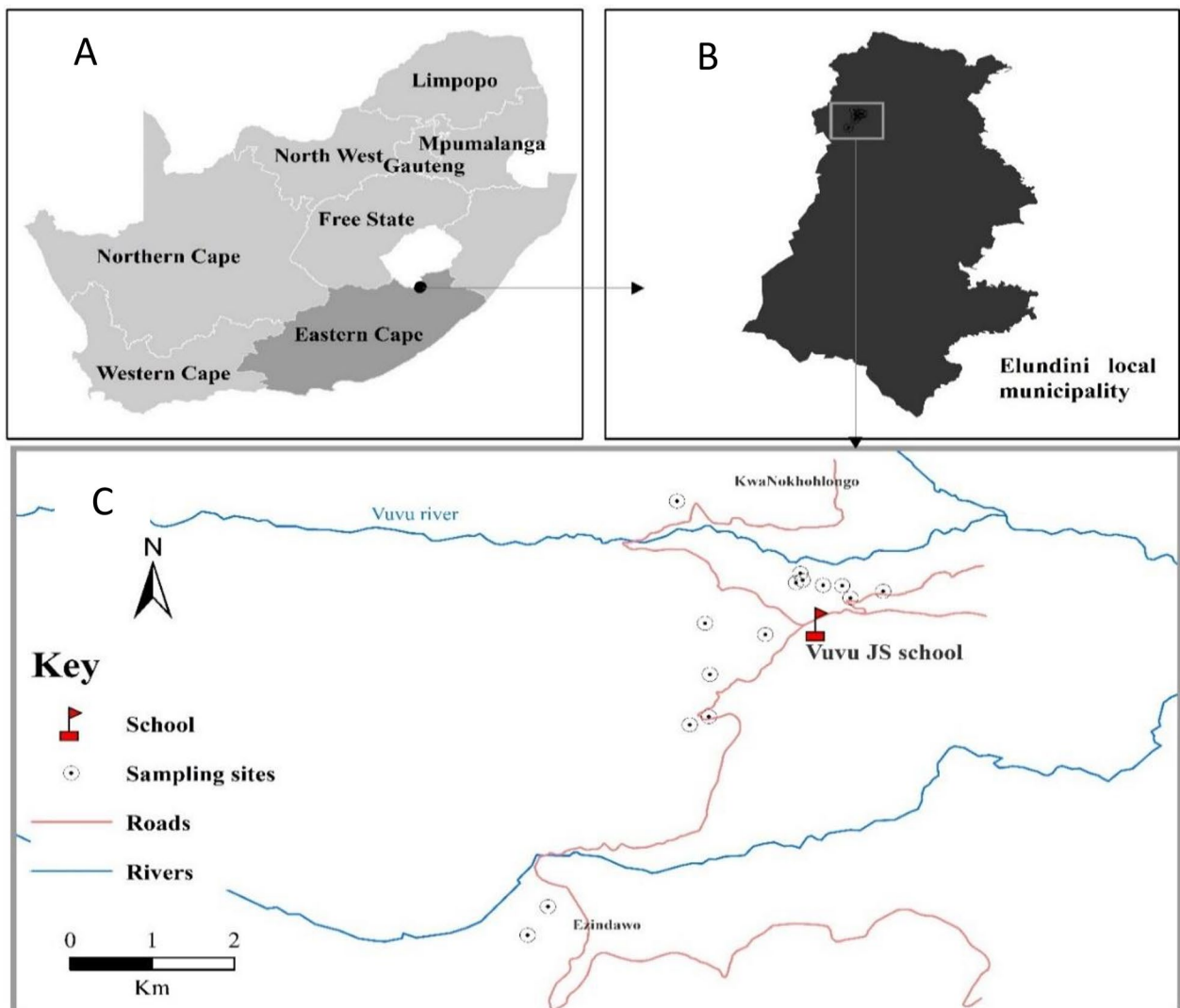
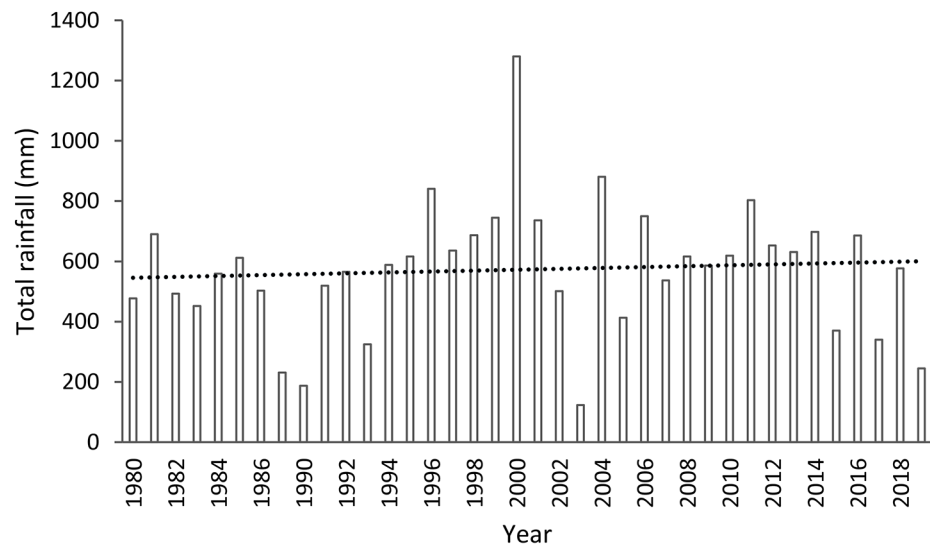


Fig. 1 Map of (A) South Africa, (B) Vuvu communal area and (C) households centered at Vuvu Junior Secondary School

Fig. 2 The total annual rainfall pattern of the Vuvu communal area in South Africa over 39 years. (Source: South African Weather Service)



The area is prone to frost for approximately 150 days during the winter period (Mucina & Rutherford, 2006; Elundini Local Municipality, 2017).

Subsistence farming is the main economic activity of the community and has been practiced for over 200 years (van der Waal & Rowntree, 2017). As a result, livelihoods mostly depended on livestock and crop farming until social grants were introduced in the late 1990s (Sinyolo et al., 2016). The introduction of social grants may have led to a decreased reliance on land-based livelihoods (Chitiga et al., 2014; Sinyolo et al., 2016), which resulted in the cessation of crop farming and abandonment of agricultural fields (Blair et al., 2018), and grazing livestock became the main land use (van der Waal, et al., 2015).

Ethical Considerations

One's positionality may influence the research process from formulating the research questions through research methods to reporting study findings (Holmes, 2020). Researchers' sense of belonging to a particular group, such as in terms of nationality, race, ethnicity, religion, gender or social class, may result in bias in their perceptions of the worldview. Additionally, respondents' perceptions of the researcher may be similarly affected. Before the interview began, the researcher (main author) explained what the research entailed and the purpose of the study, and noted that she grew up in a communal area located in a neighbouring district where the same language (isiXhosa) is spoken, and was already known in the area from an earlier research project undertaken in the same area. However, she is educated and relatively well-travelled, and has lived in the cities, all of which could engender in respondents a

viewpoint that she was different to them, which could make them wonder, "Why did she choose our area?", "What are her intentions?". Some respondents may have hoped that the researcher would find a way to remove the plant out of the area, or could harness resources for this to happen, while others may have hoped for job creation. Respondents were, however, informed that the study was being conducted solely for academic purposes. However, empathy was expressed on the problems affecting the respondents, while maintaining a neutral position as much as possible.

Prior to data collection, the project was approved by the University of KwaZulu-Natal's Human Research Ethics Committee (HSSREC/00000915/2019). In addition, permission was sought and secured from the local traditional authorities as gatekeepers for the Vuvu communal area. Participation by respondents was voluntary and confidential, and participants were informed that they could stop participating at any time during the interview, should they feel the need to do so. The participants consented that participation was not associated with incentives and that the data collected would be published.

Data Collection

In August 2018, we visited the study site prior to the development of the questionnaire survey. We requested from the traditional leader of the area permission to visit and meet with the community about our interest in rangeland utilisation. We had an informal discussion with members of the community in isiXhosa, the local language. Three (NGN, MK, NRM) of the four research team members present speak and understand the language, while a summary interpretation into English was provided for ZT. The meeting

culminated in the development of a questionnaire survey written in English.

We used a questionnaire survey in January and February 2020 to determine *L. sericea* encroachment on a high-altitude grassland. Vuvu consists of approximately 300 households, and we interviewed a total of 198 randomly selected individuals, representing 66% of households. The interviews were conducted in isiXhosa by the lead author (NGN) and two well-trained local fieldworkers, all of whom are bilingual in English and isiXhosa. The responses were recorded in handwritten English. NGN processed (into Excel and coding) and analysed the responses. The study had a wide representation of respondents in terms of gender, age groups, and education levels. We interviewed one person per household, and the interviewee could be any member of the household, which allowed us to obtain a broad view of people's perceptions of *L. sericea*.

Structured questionnaires were administered to the respondents, who represented households through face to face interviews where the interviewer and respondent interacted with each other to reduce the omission of difficult questions and word misinterpretation or misunderstanding by respondents (Bless et al., 2000). The interviews also allow for the inclusion of people who can neither read nor write (Teddlie & Tashakkori, 2012). We asked closed-ended (questions requiring yes or no as answers) and open-ended questions, which allowed the respondents to freely express perceptions in their own words (Onwuegbuzie & Collins, 2007).

We divided the questionnaire into three sections: personal information of the respondents, their perceptions of the changes in the natural environment, and the history of their livestock ownership. Personal information questions were designed to gather data on age, education levels, the period of residence in the study area, position of the respondent in the household (for example, female or male headed) and their main source of livelihood. To determine the respondents' perceptions of change in the natural environment and understanding of the woody encroaching plant, we asked: (1) When did *L. sericea* begin to spread? (2) What could be the causes of the spread? (3) What could be the consequences of the spread? (4) What are the negative or positive impacts of the plant in the area? (5) What can be done to control the spread of *L. sericea*? (6) When is the flowering and seed production season? We also asked the respondents about their types and numbers of livestock and the specific years in which they were acquired.

Statistical Analysis

Descriptive statistics (frequencies and percentages) were run of household demographic profiles using SPSS (IBM

SPSS v 25). In preliminary analysis, we explored whether there were gender differences in the respondents' understanding of *L. sericea* spread using independent samples *t*-tests and chi-square tests. We found no effect of gender ($P > 0.05$ in all cases).

The data were organised under specific responses related to the causes of *L. sericea*, history of *L. sericea* spread, uses of *L. sericea*, and the impact of *L. sericea* in the area. Open-ended questions were analysed using thematic analysis. Thematic analysis is a "method for identifying, analysing and reporting patterns within qualitative data" (Guest et al., 2020). Transcribing all interviews and reducing the data into themes through a coding and representing data process were used to prepare the data for analysis. The coding process was guided in the first stage by the study's main research question, and some codes and themes were identified from the interview questions. Themes relevant to the objectives were identified in order to explain, compare, or describe various phenomena. Themes emerged across the entire subset of interviews and were identified in order to create a framework for drawing contrasts and comparisons between different respondents (Gomm, 2008).

Also, we displayed other data graphically to show relationships between variables (Guest et al., 2020). The data were analysed to determine trends and to bring coherence of ideas in answering the research questions. We also reported the type of domestic herbivores kept by respondents and their numbers over the years and the date of inception of livestock ownership using percentages. We then used mean values to present herd sizes of the different animals owned by residents.

Results

The Demographic Profile of the Vuvu Community

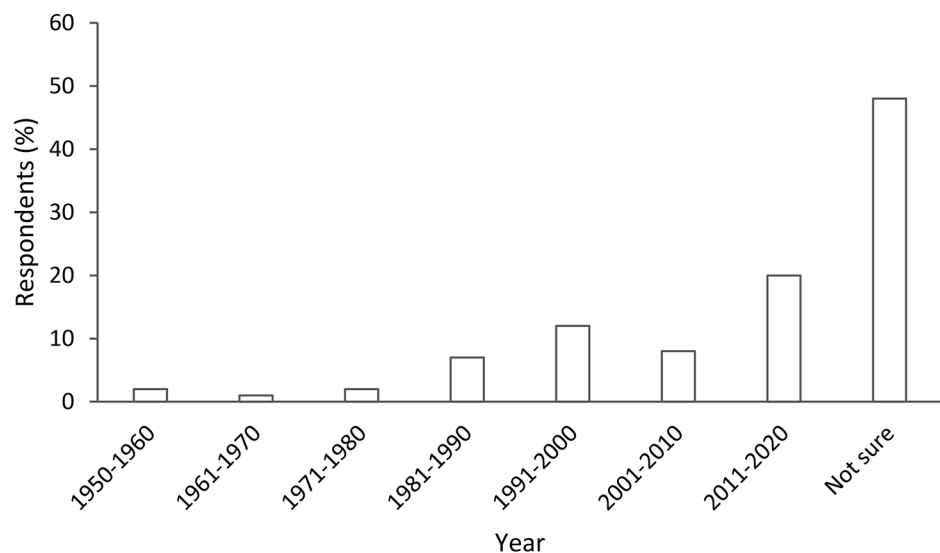
We interviewed more females than males (Table 1), as most of the households were female headed. Most respondents were older than 61 years, were born and raised in the area, and had lived in Vuvu for more than 30 years. The respondents had a relatively poor educational background, as none had a tertiary qualification, while 10% never attended school (Table 1). Main livelihood activities included livestock and crop farming, and few respondents depended on temporary jobs such as the national government's expanded public works programmes (EPWP), which are aimed at reducing poverty and income inequality by providing unemployed people with temporary work.

Table 1 The demographic profiles of respondents from the community of Vuvu, Mt Fletcher, South Africa

Item	Category	Frequency	%
Gender	Males	93	47
	Females	105	53
Position in household	Male headed	93	46
	Female headed	105	54
Age (years)	< 30	20	10
	31–40	34	17
	41–50	35	18
	51–60	29	15
	> 61	80	40
Period of residence in the area (years)	< 10	9	5
	11–20	18	9
	21–30	26	13
	> 31	145	73
Education level	None (cannot read or write)	20	10
	None (but can read or write)	29	15
	Finished primary school	125	63
	Finished high school	24	12
Livelihood activities	Livestock farming	167	56
	Crop farming	109	36
	Temporary jobs	22	7
	Self-employed	2	1

Years of Perceived *Leucosidea sericea* Spread

Leucosidea sericea was observed as a potential problem by some respondents from the 1960s to 1980s (Fig. 3). However, some (21%) of the respondents believed the spread occurred between the years 2011 to 2020. Most (48%) of the respondents could not account as to the time the spread of *L. sericea* started.

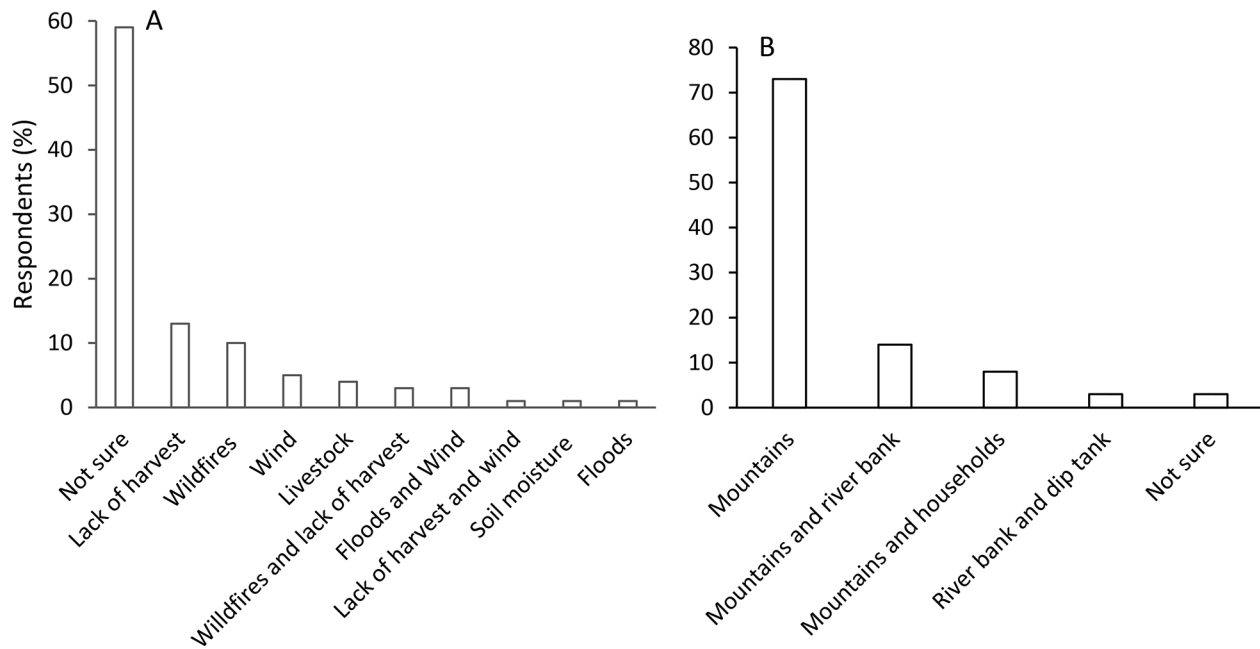
Fig. 3 The perceptions of the community of Vuvu on the commencement of *L. sericea* spread

Perceptions on Causes of *Leucosidea sericea* Spread

Based on open-ended questionnaire responses, we compiled a list of perceived causes of *L. sericea* encroachment (Fig. 4A). Overall, 13% of the respondents stated that a decrease in collecting and using it for fuel is the cause of its spread. Some (10%) believed that uncontrolled annual frequent wildfires were to blame for its spread in the area. In addition, 5% of the respondents believed that excessive wind contributed to the establishment of the plant. However, some respondents (4%) thought livestock contribute to the spread of the plant through faecal material, which acts as a fertilizer, facilitating the spread of *L. sericea*. Respondent H6 described the relationship of soil moisture and the growth of *L. sericea*: “The increased soil moisture availability allows woody plant seeds to germinate and grow into thick bushes.”

Dominant Areas and Uses of *Leucosidea sericea*

According to 68% of the respondents, the most dominant areas of *L. sericea* spread are the mountains where their livestock graze. Others (24%) thought the plant was dominant in both mountains and rivers, while the remaining 8% thought it was spreading beyond the mountains to fields near houses. Mountains were commonly identified by respondents in all areas of *L. sericea* dominance (Fig. 4B). Most (53%) respondents did not believe *L. sericea* was useful in the area, while others (44%) said it was mostly used for fuel.



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Fig. 4 Community perceptions on the (A) causes and (B) dominant areas of *Leucosidea sericea* spread in the Vuvu communal area in South Africa

Table 2 Perceived impact of *Leucosidea sericea* in the Vuvu (n = 198) communal area in South Africa. The percentage was based on the frequency each item was mentioned in thematically coded open questions

Negative impact	Respondents %
Poor livestock production	15
Poor quality of sheep wool	10
Reduction of grass growth	9
Reduction of land for crop farming	7
Absorbs too much water	4
Reduction in grazing areas	3
Livestock death	2
Positive impact	
Shade on rainy and sunny days	3
Feed for livestock in the dry season	7
Neutral	45

Perceptions on the Impact of *Leucosidea sericea* Spread

Respondents identified more negative than positive impacts of *L. sericea* (Table 2), and believed that the spread of *L. sericea* was detrimental to their livelihood and general well-being, was primarily associated with low livestock production caused by a decrease in grass biomass for grazing. Other notable effects of *L. sericea* included a reduction in crop farming areas, poor quality of sheep (*Ovis aries*) wool, death of livestock, and the plant absorbing an excessive amount of water leading to reduction in stream flow. Respondent H39 described this: “The plant grows rapidly in

bush clumps, competing with grasses, resulting in a reduction in grazing areas and grass growth. This, in turn, has an impact on livestock, which is our livelihood.” Death of livestock was also reported as a negative effect of the spread of *L. sericea*. A positive effect identified by the respondents is that *L. sericea* could contribute forage for livestock during the dry season. In addition, livestock could use *L. sericea* for shade on hot days as well as shelter from wind and rain. However, most respondents did not recognise any positive effects of *L. sericea*.

Perceptions of Respondents on *Leucosidea sericea* Seed Dispersal and Deposition

Respondents indicated that seeds of *L. sericea* can be dispersed and deposited through various mechanisms, but wind and livestock were identified as the main drivers (Table 3), along with various other biotic and abiotic factors (Fig. 5).

Suggested Action Needed to Manage the Spread of *Leucosidea sericea*

Respondents mentioned various actions needed to control the spread of *L. sericea*, for instance, respondent H12: “The plant needs to be removed from the area, also uncontrolled frequent wildfires need to be stopped. We need government intervention to help us with resources that will help

Table 3 Drivers of *Leucosidea sericea* seed dispersal and deposition as perceived by the Vuvu community in South Africa. The percentage was based on the frequency each item was mentioned in thematically coded open-ended questions

Drivers	Respondents %
Wind	24
Livestock	10
Uncontrolled wildfires	8
Floods	6
Wind and floods	5
Wind and birds	3
Harvesting of <i>L. sericea</i>	1
Not sure	43

to control the spread of *L. sericea*. This will help us to have improved grazing areas and livelihood.” Specifically, 53% of the respondents suggested the removal of the plant from the area by physical cutting, while 12% suggested the reduction in frequency of random wildfires (Fig. 6). Another 5% thought that government intervention would help them to manage the spread of the plant.

Flowering, Seed Production, Uses of Seeds and Flowers

The majority (73%) of respondents believed that *L. sericea* flowered in spring, while others thought it flowered in winter (Fig. 7A). Most respondents indicated that the flowers were not useful, while few (11%) indicated that *L. sericea* flowers can be used for medicinal purposes (Fig. 7B). There

was a lot of uncertainty regarding the season of seed production, but most (44%) thought it occurred in spring (Fig. 7C). Similar to flowers, most respondents (93%) were uncertain about the importance of the seeds, while others thought they were not useful (Fig. 7D).

Perceptions on *Leucosidea sericea* as Feed for Livestock

About half of respondents reported observing livestock feeding on *L. sericea*. Goats and sheep were the main browsers, but respondents also indicated cattle, horses (*Equus caballus*), and donkeys (*Equus asinus*) (Fig. 8). These animals seemed to prefer feeding on the plant in the dry season. 35% stated that observations of livestock feeding on *L. sericea* were rare and did not regard the plant as an alternative feed for livestock.

History of Livestock Ownership

Patterns of types and ownership of livestock have changed considerably over the years in Vuvu. Between 1960 and 1970, few people owned livestock, mainly cattle, sheep, and donkeys (Fig. 9). Cattle and sheep ownership increased considerably from 1971 to 2000. During the years 2001 to 2010, sheep had overtaken cattle as the main livestock but goats, donkeys, and horses also increased (Fig. 9). Many respondents (60%) did not remember the history of inception of their livestock ownership.

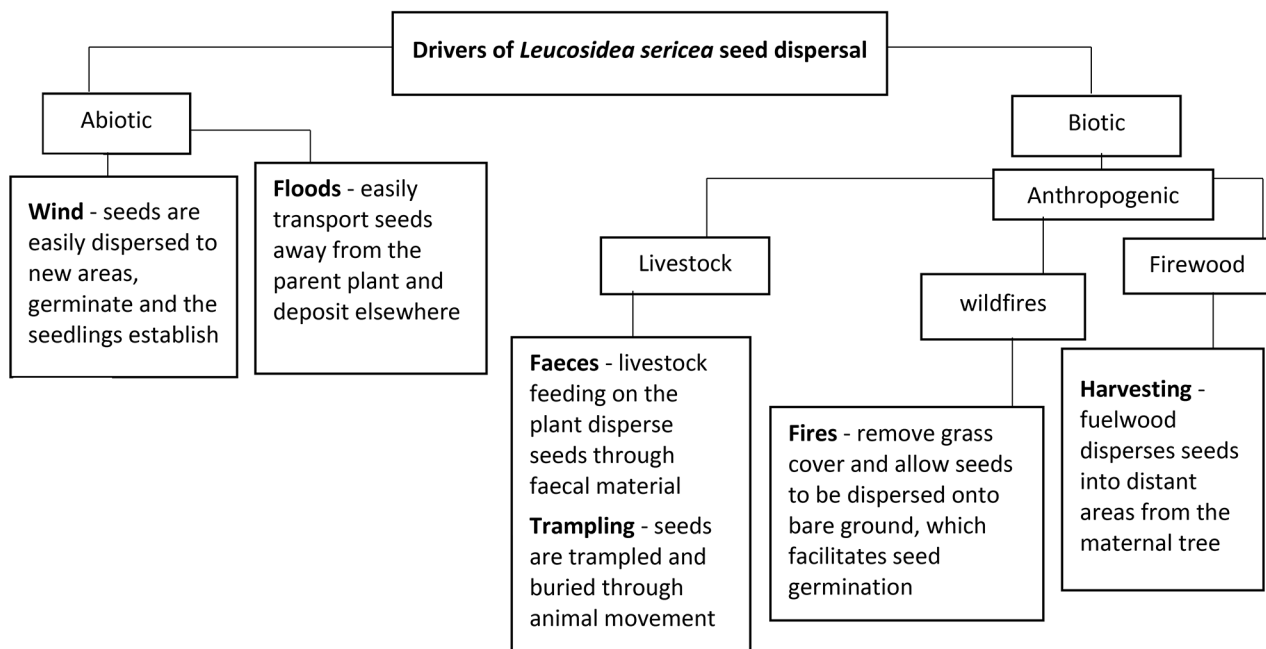


Fig. 5 Thematic analysis of the drivers of seed dispersal and deposition of *Leucosidea sericea* in the Vuvu communal area in South Africa

Fig. 6 Perceptions by the respondents of the actions needed to control the spread of *Leucosidea sericea* in the Vuvu communal area, Mt Fletcher, South Africa

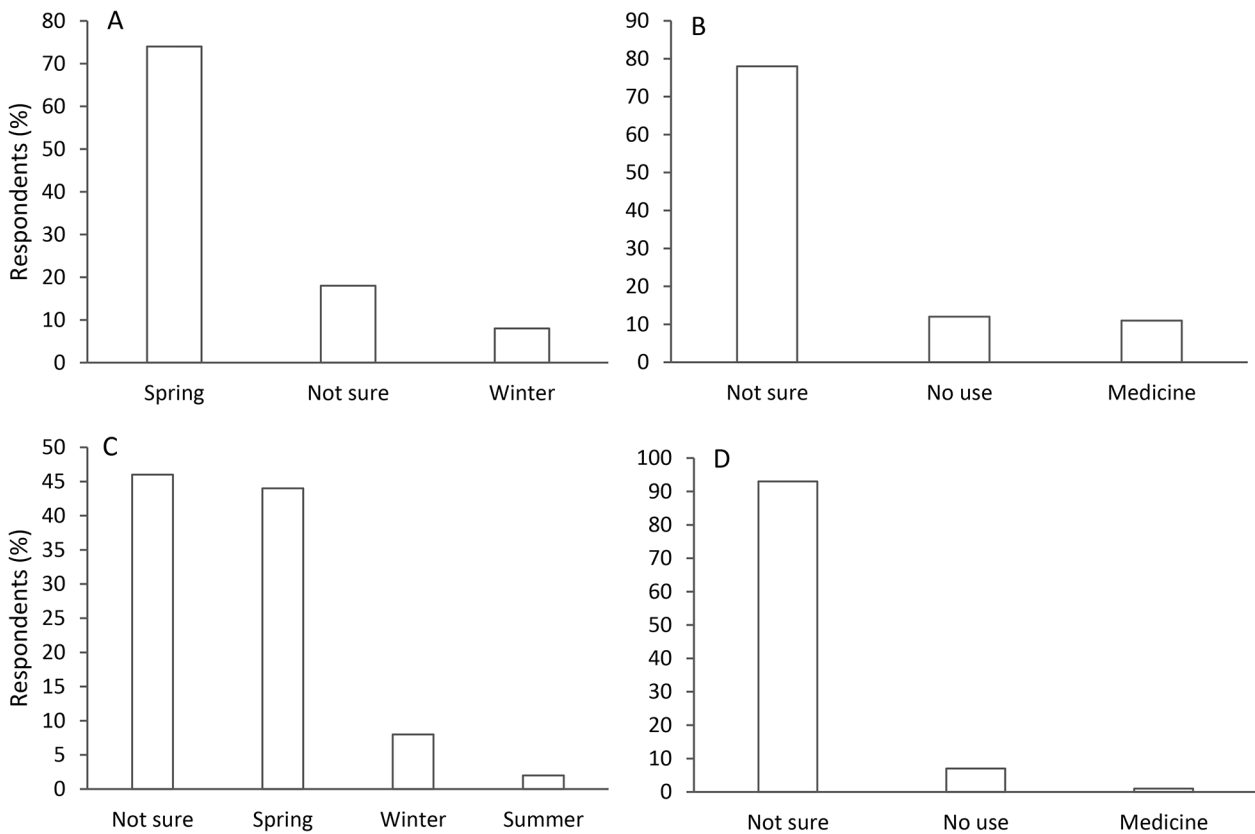
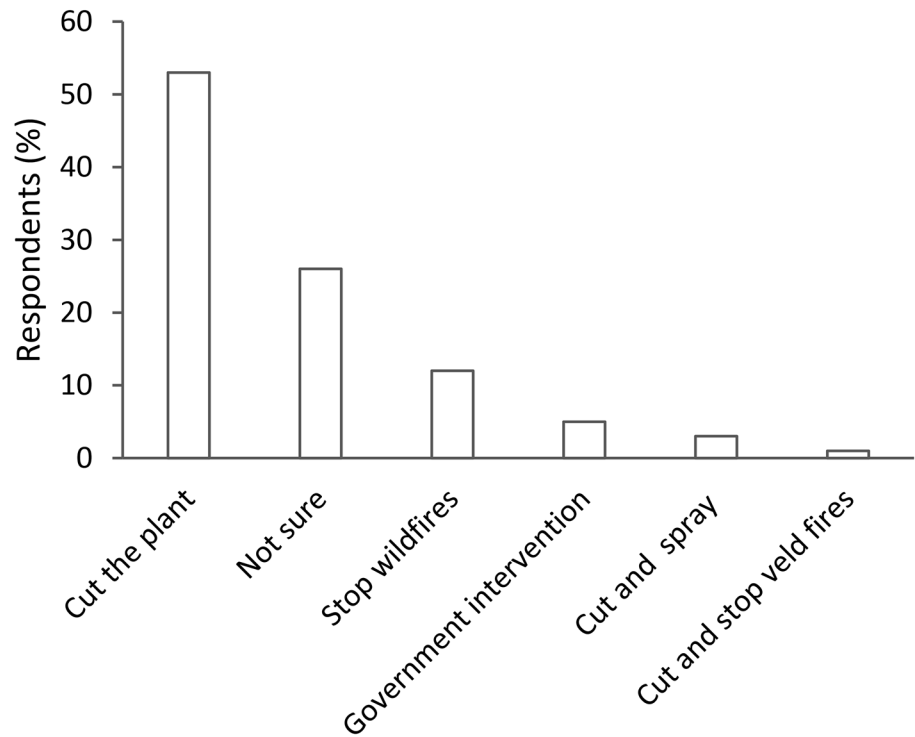


Fig. 7 *Leucosidea sericea* (A) season of flowering, (B) uses of flowers, (C) season of seed production and (D) use of seeds based on community perceptions in the Vuvu communal area, Mt Fletcher, South Africa

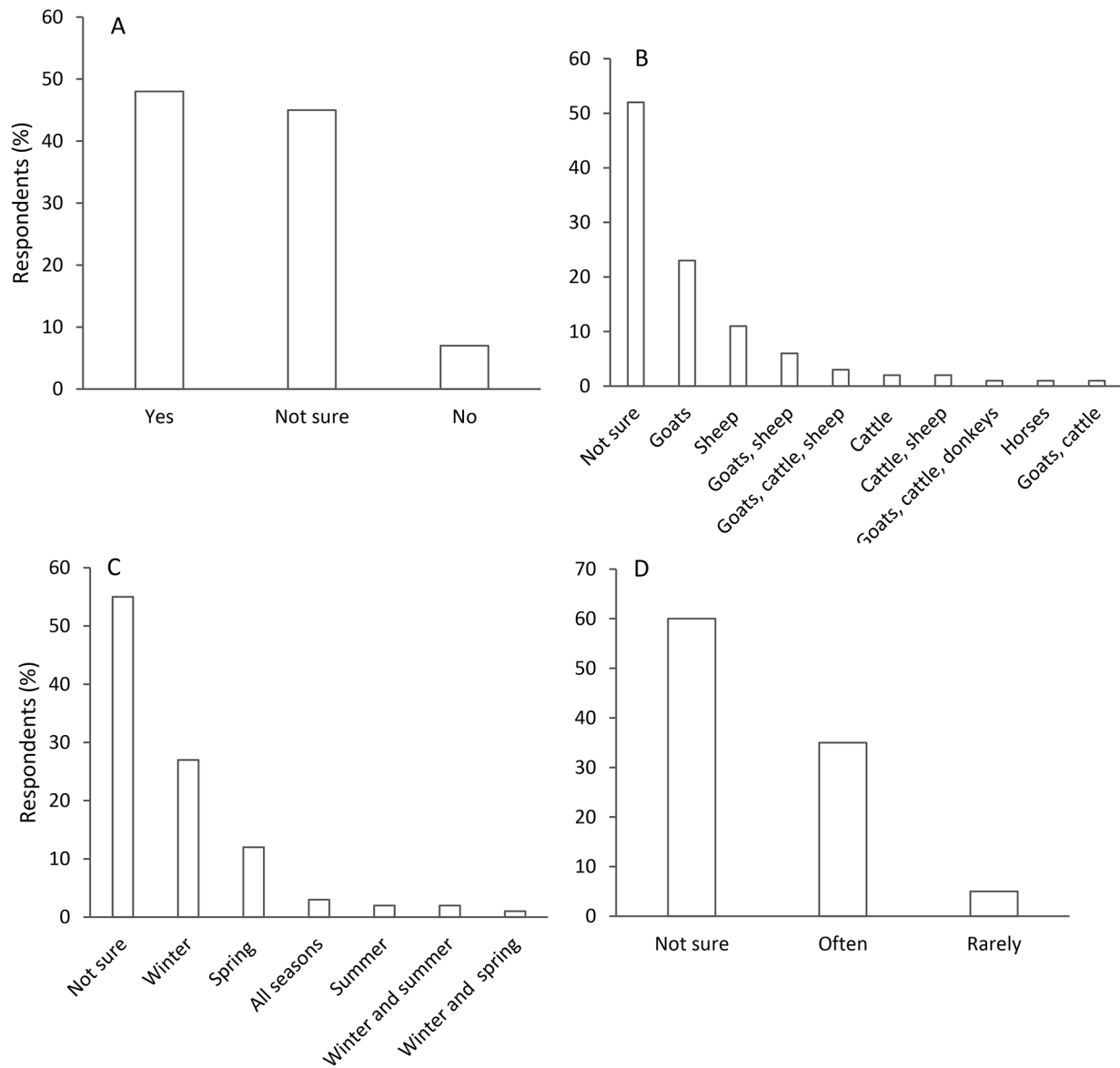


Fig. 8 The perceptions of the Vuvu community as to (A) whether livestock feed on *L. sericea* (B) the type of domestic animals that use *L. sericea* as food (C) the season of preference of *L. sericea* food for livestock, (D) the reliance of livestock on *L. sericea* as food

Herd Sizes of Livestock

Respondents kept various livestock but mainly sheep, goats, and cattle (Figs. 9 and 10). Most people own sheep (62%) and cattle (56%). Sheep herds ranged from 120 to 320 animals, while the largest herd of cattle did not exceed 50 animals (Fig. 10). Other respondents owned goats, and the largest herd size comprised up to 100 animals. Donkeys and horses were the least herded animals both in terms of number of respondents owning them (28% and 29%, respectively) and in terms of herd sizes.

Discussion

Respondents indicated that bush encroachment commenced as early as the 1950s in Vuvu. Although many were not sure, accounts for the perceived spread increased in the years 2011 to the present. Likewise, many could not identify the factors contributing to the spread of *L. sericea* but identified lack of *L. sericea* harvest for fuel, wildfires, wind, and livestock (vectors of seed dispersal) as leading causes of its spread, with wind and livestock as the primary vectors of *L. sericea* seed dispersal. This explanation may likely be supported by the dramatic increase in livestock ownership and numbers from 1991 to the present. The mountainous

Fig. 9 Livestock owned by residents of Vuvu from the years 1960 to 2020

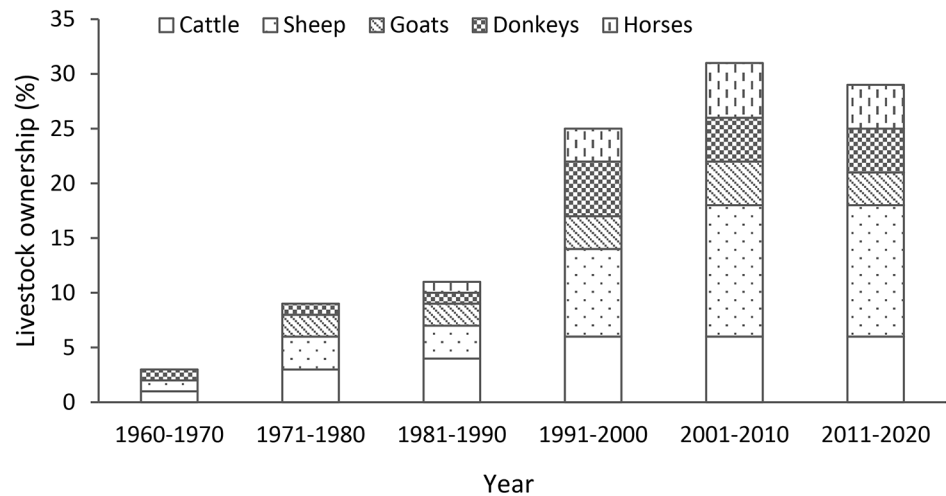
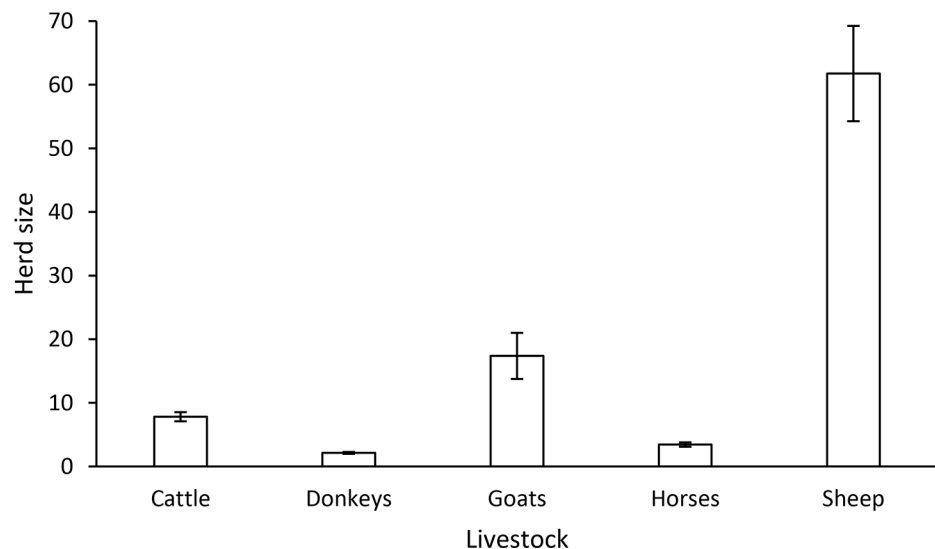


Fig. 10 Herd size (mean \pm SE) of livestock owned by respondents at Vuvu from 1960 to 2020



areas were perceived to have the highest levels of *L. sericea* encroachment compared to riverbanks, dip tanks, and households, which were also affected. Yet most respondents reported that they have no use for the woody plant except for those who use it for fuel. Its negative impacts do not match its usefulness (e.g., potential feed and shelter). Specifically, *L. sericea* decreases the quality of life in Vuvu by reducing the quality of the rangelands that are pivotal to the production of livestock. Ultimately, the community suggested cutting of *L. sericea* as a management tool to deal with the problem, followed by the cessation of wildfires and government intervention.

Prior knowledge, either acquired from a formal education system or traditional ecological knowledge system, may be an important contributor to the way respondents view, manage, and accept new interventions in the management of their rangeland resources (Moyo et al., 2008). The level

of education was low at Vuvu, where most respondents had attended only primary school. While people's perceptions about environmental problems such as land degradation and woody plant encroachment may be linked to their education levels (Luvuno et al., 2022), which may hamper the spread of information about regulations and rangeland management (Moyo et al., 2008), our respondents' understanding of *L. sericea* was mainly based on traditional ecological knowledge through historical observation and experience. Other respondents have only lived in Vuvu for less than a decade, while others were too young to know the history of the area, so had limited experience of this history of *L. sericea* encroachment. The low levels of education may explain why people were unsure about bush encroachment on multiple occasions. However, we are uncertain of the extent to which their perceptions were driven by a combined lack of formal education and traditional ecological knowledge.

As expected, livestock numbers increased as human settlement expanded in the area. Livestock farming was preferred over crop farming in Vuvu, yet both are important for livelihoods (Kom et al., 2022). It is customary for communal societies to own as many animals as possible, irrespective of the condition of the animals or availability of grazing areas (Shackleton & Gambiza, 2008). Respondents were aware of the role of livestock in the spread of *L. sericea* in the area. This is supported by Tokozwayo et al. (2018) who found pastoralists reported that continuous grazing caused a loss of perennial grass species, resulting in a shift from a grass-dominated to a bush-dominated ecosystem in the Eastern Cape, South Africa.

Sheep are the preferred animal to keep in Vuvu, which could be attributed to the shorter generation time and early maturing of sheep compared to cattle, which in turn lead to the realisation of a steady income at short intervals (Mapiliyao et al., 2012). In addition, sheep are prized for their wool (Beyene et al., 2014), which is shorn annually for income (Mvinjelwa et al., 2014). Goats are owned in low numbers, and were the only animals whose browsing may contribute in curbing bush encroachment (Webb et al., 2011). However, the use of *L. sericea* by goats may only be relevant in the dry season, which may not be sufficient to result in browser controlled woody plant establishment. If goat browsing killed or suppressed the growth of young plants, then goats would be effective at controlling this encroaching plant, as reported for dik-dik (*Madoqua kirkii*) (Augustine & McNaughton, 2004). Thus, the low stocking rates of goats might have allowed *L. sericea* to proliferate in Vuvu. Goats and sheep were reported to feed on *L. sericea* in the dry season (winter), which may coincide with the maturity of the seeds. Thus, the increased animal densities may exacerbate the effect of seed dissemination in winter, which may influence shrub recruitment positively (Roques et al., 2001; Shackleton & Gambiza, 2008).

The majority of the participants in our study were over 60 years old. Elderly people have long-term information concerning perceived changes in the environment, influenced by their observations and experiences (Russell & Ward, 2016; Gxasheka et al., 2017). Most of the participants (73%) had lived in the area for over 31 years, and the longer period of stay in the area contributes to a better insight of understanding the impact of *L. sericea*. As a result, the respondents were able to recognise environmental changes that took place in their area and attributed it to factors such as wildfires, livestock, paucity in firewood harvest, etc. Respondents perceived the spread of *L. sericea* began between the 1950s and 1960s in Vuvu. The spread of woody plants appears to have commenced in the 1900s in South Africa (Russell & Ward, 2016). In Magersfontein, South Africa, Ward et al. (2014) reported that most of the woody

plant encroachment occurred between the years 1937 and 2008, and was particularly clear on the hill slope (mountainous), which was mostly encroached by *Acacia tortilis* and *Tarchonanthus camphoratus*. Similarly, our respondents observed the abundance of *L. sericea* spread to be conspicuous predominantly on the hill slope.

The perceived causes of *L. sericea* spread encompass reduced harvesting of firewood, frequent wildfires, increased livestock, wind, and increased amounts of soil moisture. The spread of *L. sericea* is attributed to the cessation of its use as firewood, which is consistent with Russell and Ward (2016), who reported that increased access to electricity, modern building materials, and use of wire for fencing decreased wood harvesting. Previously, women would travel long distances to collect firewood. Luvuno et al. (2022) mentioned that in the Hluhluwe area in northern KwaZulu-Natal, South Africa, only two households out of 30 relied on firewood as the primary source of energy, which clearly indicated a decline in fuelwood collection. In South Africa, as the economy within the community becomes increasingly cash-based, community members became less dependent on natural resources, such as fuel wood, timber and cultivation of crops (Shackleton & Le Maitre, 2015). Therefore, modernisation could be an indirect cause for an increase in woody plant cover (Russell & Ward, 2016).

Anthropogenic fires are a common phenomenon in the grasslands of Vuvu and they too are thought to result in the spread of *L. sericea*. Respondents perceived that fire frequency has changed from infrequent in the past to uncontrolled fires in recent times, and that *L. sericea* is thriving under these conditions. Similar findings were observed in Mursi, Ethiopia, where fires are set randomly, by individual preference rather than communal decision-making, and it has become impossible to maintain a fire regime (Gil-Romera et al., 2011). Tokozwayo et al. (2018) reported that respondents believed that the timing of the fire was the main cause of *Acacia karroo* spread in the Sheshegu communal area of the Eastern Cape in South Africa. Uncontrolled wildfires in communal areas may weaken the competitiveness of grasses against woody plants (Devine et al., 2017). Yet, a combination of frequent fires and low grazing pressure appeared to maintain low shrub cover so that these fires may benefit fire-tolerant grasses and suppress the recruitment of woody plants (Roques et al., 2001). Thus, uncontrolled, random fires and overgrazing may be detrimental to the state of grasslands.

Respondents speculated that available moisture from the soil may facilitate the spread of *L. sericea*, which could explain its spread along the riverbanks. Belayneh and Tessema (2017) reported that soil moisture allows the seedlings of woody plant species to stay alive and establish into bush coppices in African savannas. The spread may also be

explained by the size of the seed bank. In addition, respondents thought that *L. sericea* might have persistent soil seed banks, i.e., seeds remain viable in the soil or on the surface for many years. The respondents suggested that the methods of *L. sericea* harvesting may cause seeds to be dispersed into new habitats, potentially resulting in the establishment of *L. sericea* plants in new sites. Similarly, harvesting *Euryops floribundus* without a proper strategy allowed more seeds of this plant to survive and become an encroacher in Macubeni communal area in the Eastern Cape, South Africa (Shackleton & Gambiza, 2008).

The negative impacts of *L. sericea* outweighed its benefits in the study area. One of the pertinent impacts of *L. sericea* is that it confines livestock movement and reduces grazing areas. The grazing capacity of large areas of southern Africa is reported to have declined due to bush encroachment (Smit, 2004). Respondents indicated that encroachment of *L. sericea* to grazing lands may lead to low forage yields, which in turn affects livestock production. Progressive growth in bush encroachment is related to loss of palatable vegetation which causes low forage yields (O'Connor and Crow, 1999; Angassa 2005), especially in communal rangelands (Wigley et al., 2010). The key benefits of *L. sericea* recognised by the respondents are its provision of fodder, shade, and fuelwood. Similarly, in Namibia and elsewhere in South Africa, bush encroachment may be perceived as beneficial because woody plants provide browse and serve as a source of firewood and timber for construction (Katjiua and Ward, 2007; Wigley et al., 2010; Inman et al., 2020).

Community perceptions coincide with research elsewhere about the degrading state of rangelands due to bush encroachment (Blair et al., 2018; Tokozwayo et al., 2018; Luvuno et al., 2022). As a result, some communal areas in the Eastern Cape have embarked on eradicating problem plants through manual removal (Shackleton & Gambiza, 2008). The community of Vuvu also suggested woody plant clearing as a way to deal with *L. sericea* spread. Manual removal is envisioned to improve grasses in rangelands. Other communities do not have the resources to undertake clearing and sought government interventions (Shackleton et al., 2015). Overall, the desire to control woody encroachers is strong across various communities in South Africa because the costs of the encroacher plants are greater than their benefits to the rangelands and people.

Conclusion

Bush encroachment is one of the most widespread forms of rangeland degradation in southern Africa. Unfortunately, the causes are only beginning to be understood. Our respondents believed that *L. sericea* encroachment is causing more

harm than good, and several negative consequences were mentioned. Land users at Vuvu communal area are knowledgeable about the encroachment of *L. sericea* in their rangelands, particularly the older respondents who have lived in the area for many decades.

Rangelands contribute to the economy of southern Africa in a variety of ways, including the provision of agricultural commodities with market value such as wool, meat, milk, and so on. These rangelands are the primary forage sources for grazing animals, which influence livestock production. The accounts of the residents of Vuvu about bush encroachment are similar to those from other communal areas in many parts of southern Africa. Ultimately, the residents echoed the financial implications of bush encroachment to their livelihoods, which will continue if uncontrolled. Given that understanding, the perspectives of land users can aid in the development and implementation of policies or programs that are compatible with the biophysical, social, and economic needs of people who rely on socio-ecological systems. Although many interventions are carried out to improve livelihoods in many parts of sub-Saharan Africa and elsewhere in the developing world, they frequently fail, partly due to the lack of understanding of land users' perceptions and needs (see Cousins 2017; Bassett, 2020). This knowledge is essential for management strategies that aim to prevent or control the spread of woody plants into grasslands. Our findings indicate that most landowners would welcome government assistance programs to combat *L. sericea* encroachment. To address *L. sericea* encroachment, controlling plant spread through physical, chemical, and biological methods must understand and align with land users' perceptions, values, and needs. Our findings suggest that these perceptions, values, and needs may differ significantly across land users, which has implications for the design of policies that will be supported by a diverse range of local land users. This suggests that in the future, planners and policymakers should consider community knowledge when designing programs to control problem plants in communal areas. In order to establish a sound community-based rangeland development and monitoring strategy, we recommend larger studies of community perceptions in conjunction with scientific analysis. Understanding the connections between institutional issues (i.e., policy and legislation) and biotic and abiotic determinants will aid in the development of effective rangeland management programs and initiatives to restore degraded land.

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Data Availability To protect the respondents' identities, data will be available upon request in a pseudonymised form.

Declarations

Conflict of interest The authors declare no conflicts of interest.

Ethics approval and consent to participate The project was approved by the University of KwaZulu-Natal's Human Research Ethics Committee (HSSREC/00000915/2019).

Informed Consent Permission was sought and secured from the local traditional authorities as gatekeepers for the Vuvu communal area. Participation by respondents was voluntary and confidential, and participants were informed that they could stop participating at any time during the interview, should they feel the need to do so. The participants consented that participation was not associated with incentives and that the data collected would be published.

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