Ecosystem services from woody vegetation in East African rangelands

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Ecosystem services from woody vegetation in East African rangelands

Ekosystemtjänster från vedartad vegetation i torra, östafrikanska betesområden

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Abstract

Drylands cover nearly half of the Earth's land surface and are dominated by croplands and rangelands. Dryland ecosystems worldwide are affected by land degradation. Increased population pressure, climate change and unsustainable land use threaten essential ecosystem services and adversely impact people's livelihoods and well-being. Dryland inhabitants in developing countries are highly dependent on ecosystem services from woody plants, and tree-based restoration measures are thus of utmost importance. However, effective restoration requires a better understanding of the complexity and variability of these ecosystems and the needs of the people living there, a perspective that is often lacking. Restoration interventions have mostly focused on agricultural land and farmers and less on rangelands and (agro)pastoralists. Rangelands are characterized by a naturally low tree cover, and the importance of trees in these areas has thus often been overlooked. This study aims to contribute more knowledge on the importance of woody plants to rangeland inhabitants, focusing on the contribution of different species in providing important ecosystem services, as well as how people manage woody vegetation and how this management, in turn, affects woody vegetation. Two different sites with different dominant livelihood strategies were selected for this study; Chepareria in West Pokot County, Kenya, dominated by agro-pastoralists, and Rupa in Moroto District, Uganda, dominated by pastoralists. Findings from this study show that people in these two sites possessed significant knowledge of woody plants and their benefits. People perceived several ecosystem services from woody plants, most of which were associated with native species. The most valued ecosystem services were food, firewood, fodder and improved local climate. Although most ecosystem services identified in both sites were similar, the associated species often differed. In Chepareria, the land was dominated by privately managed enclosures, while in Rupa, it was mainly open common access communal land. In both sites, people actively managed woody plants to preserve and protect them, although with more emphasis on assisted natural regeneration in Rupa. Despite this, local people perceived that the native tree cover had decreased in both sites, negatively affecting the availability of critical ecosystem services. In Chepareria, the decline was attributed to land use change and increased grazing pressure, while in Rupa, it was attributed to a shift in livelihood strategies from livestock keeping to charcoal production. Due to insufficient data, results on links between land-use, access to land, preferred species and ecosystem services, and woody species presence and abundance in the landscape were inconclusive. The many differences between the two studied sites clearly highlight that restoration requires tailored strategies with a bottom-up approach that considers the local people's knowledge, experience, needs, and aspirations.

Keywords: dryland ecosystems, rangelands, ecosystem services, woody vegetation, restoration, West Pokot, Karamoja, pastoralists, agro-pastoralists, East Africa

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Abbreviations

AFR100	African Forest Landscape Restoration Initiative
ANR	Assisted natural regeneration
ES	Ecosystem Service
FGD	Focus Group Discussion
FLR	Forest Landscape Restoration
FMNR	Farmer Managed Natural Regeneration
KII	Key Informant Interview
NGO	Non-Governmental Organization
SDG	Sustainable Development Goals
SLU	Swedish University of Agricultural Sciences

1. Introduction

Drylands – Defined as areas where the ratio of annual precipitation to mean annual potential evapotranspiration is below 0.65 (Cherlet et al. 2018) - occupy ca. 40% of Earth's land surface and host about 40% of the world's population, most of whom live in developing countries (Safriel & Adeel 2005; Cherlet et al. 2018). Rangelands and croplands account for 90% of dryland areas and are often intermixed (Safriel & Adeel 2005). Livestock-based livelihoods are prevalent in arid regions, where rainfed agriculture is not feasible, and serves as a vital source of income, fuel, draught power and quality food thus contributing to household livelihoods, food security and nutrition (FAO 2009). In Eastern Africa, drylands cover 47% of the land area (FAO 2019).

Even though ecosystem service research has developed in recent years, drylands are underrepresented in the literature, and have been considered marginal in ecosystem service assessments (Safriel et al. 2005; Reyers et al. 2009; O'Farrell et al. 2011). However, dryland inhabitants (in developing countries in particular) rely heavily on ecosystem services (ES) provided by trees and other woody vegetation. These species supply various provisioning services such as food, fodder, medicine, building materials and non-wood products, as well as supporting and regulating services like biodiversity conservation, erosion control, shade, and improved soil ferility and water infiltration (FAO 2019). Due to their relatively low abundance, high visibility in the landscape, and ability to provide shade trees also hold cultural significance in dryland communities and have historically served as meeting places for social and religious activities (Safriel & Adeel 2005).

Land degradation is estimated to affect 10-20% of drylands globally, leading to the loss of ecosystem functions and services, which in turn adversely impacts people's livelihoods and well-being (MEA 2005). Key drivers of land degradation in drylands include increasing population pressure, inappropriate cultivation and grazing practices, wasteful water use, overharvesting of wood fuel (Berrahmouni et al. 2015), and the expected increase in extreme weather events (Shukla et al. 2019) is expected to further exacerbate land degradation and decrease land productivity in these areas (IPBES 2018).

Restoring degraded lands is critical to reverse the negative trends in land degradation. Initiatives like the Bonn Challenge (Dave et al. 2019) and the UN Decade on Ecosystem Restoration 2021-2030 (UN Decade on Ecosystem restoration 2023) have placed the restoration of degraded lands on the global agenda. In Africa, several countries have made ambitious restoration pledges through regional initiatives such as the Great Green Wall for the Sahara and the Sahel initiative (GGWSSI 2008) and the African Forest Landscape Restoration Initiative (AFR100 2023). Uganda and Kenya have committed to restoring 2.5 million and 5.1 million hectares, respectively (AFR100 2023). Forest and Landscape Restoration (FLR) approaches, often focused on increasing tree cover (Besseau et al. 2018), are central to all these restoration initiatives. There has been a growing interest in dryland tree-based restoration in Africa in recent years (Pasiecznik & Reij 2020). However, the main focus has been on forests, agricultural lands, and practices like agroforestry and Farmer-Managed Natural Regeneration (FMNR). Yet, many trees in drylands are found in grasslands used as rangelands. Grasslands have the greatest number of trees outside forest, particularly in the arid and semi-arid zones (FAO 2019), but little is known about these trees and their importance for the local communities. In addition, the selection of species used in dryland restoration has often been made without considering the ecological suitability and the preferences of local stakeholders (Simons & Leakey 2004). However, the use of native tree species is associated with more successful restoration outcomes, and has been shown to enhance biodiversity, soil fertility, and groundwater availability and recharge, leading to more resilient landscapes (Pasiecznik & Reij 2020). In addition, native species often have the ability to regenerate naturally and are easier to manage. Local communities in drylands also carry a wealth of ancestral knowledge related to native species that have helped them to survive and prosper in these areas for millennia. More local species-specific information and an improved understanding of how native woody plants contribute to ES in rangelands are thus vital for more sustainable restoration outcomes.

Current literature on ES from woody vegetation in Sub-Saharan Africa has a limited focus on local management (Sinare & Gordon). However, there is a growing awareness of the vital role farmers play in supporting the natural regeneration of woody vegetation on their land (i.e., FMNR) and in promoting and protecting important species (Chomba et al. 2020), as well as how this management can contribute to explaining the ‘regreening’ trends observed across the Sahel or changes in the composition and spatial distribution of woody vegetation (Brandt et al. 2018). Nonetheless, little is known about how (agro)pastoralists manage woody vegetation in rangelands. An increasing number of studies highlight the importance of engaging local stakeholders to improve restoration outcomes (Asah et al. 2012). It is essential to acknowledge that local communities are not only spectators but

active managers of ecosystems' capacities to deliver services (Folke et al. 2005). A shift in focus away from tree planting and toward people and ecosystems is needed, because good solutions can only be effective and sustainable if they respond to the needs and aspirations of the local communities (Fleischman et al. 2020; Pritchard 2021; Fleischman et al. 2022).

1.1 Aims and objectives

The overall aim of this study has been to contribute practical knowledge on the status, importance, access, and management of woody vegetation in the rangelands of East Africa. This knowledge is key for finding better strategies for the management and restoration of these areas and for contributing to climate change mitigation and adaptation. This was accomplished through the following specific objectives:

1. Identify perceived ecosystem services from woody vegetation and explore differences in preferences among different groups within the local community. These groups are, e.g, people of different age, gender, level of education or main livelihood.

2. Identify the most important woody species contributing to different ecosystem services and explore differences in preferences among groups within the local community.

3. Identify current woody vegetation management practices, access to ecosystem services from woody vegetation and status of woody cover.

4. Explore links between land-use, access to land, preferred species and ecosystem services, and woody species presence and abundance in the landscape.

2. Methodology

2.1 Study area

The study was conducted in two different sites within the Karamoja cluster, the cross-border area between Ethiopia, Kenya, South Sudan, and Uganda. Data were collected in two of the 100 km^2 field sites established as part of the research project Drylands Transform in 2020 (Drylands Transform 2023). The first site was in Chepareria division, West Pokot County, Kenya, and the second was in Rupa sub-county, Moroto district, in the Karamoja sub-region, Uganda (Figure 1). These sites vary in dominant livelihood strategies and climate.

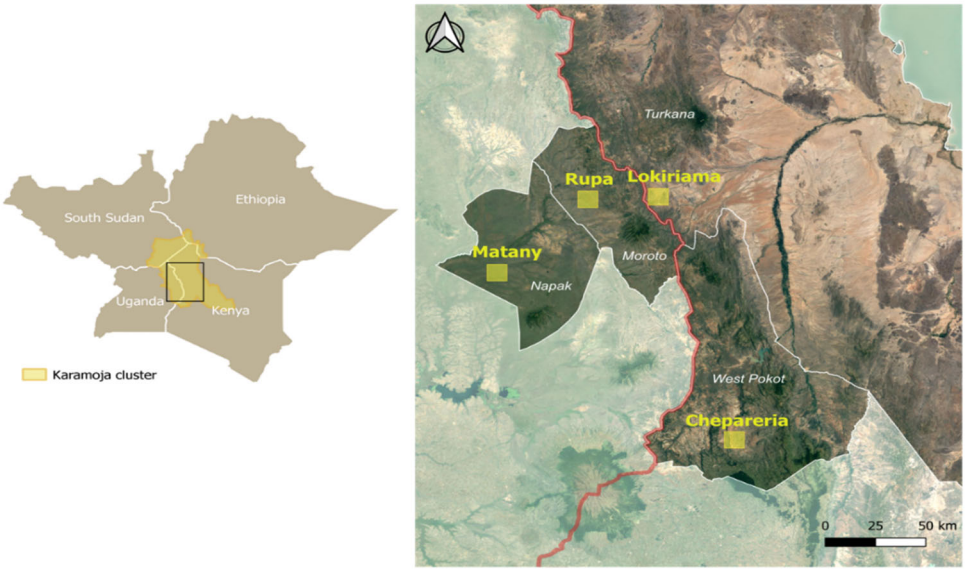

Figure 1. Map of the Karamoja cluster, with the four 10 x 10 km^2 Drylands transform field sites marked in yellow (Drylands Transform 2023).

Chepareria division is part of the semi-arid sub-Saharan region and experiences a profoundly seasonal climate. The average temperature (2004-2022) measured in Nasukuta was 21°C, and the annual maximum and minimum temperature for the same period were 27.5 and 14.5 °C, respectively (County meteorological office West Pokot 2023). The mean annual rainfall was 1120 mm. The rainfall regime is

bimodal, with a long rainy season, usually between March and May, and a short rainy season between October and December (Arukulem et al. 2015). The altitude ranges between 1200 and 1600 m above sea level (Touber 1991). The climate in Rupa sub-county is also semi-arid and characterized by a long dry season from November to March. The rainy season typically lasts from April to October, with peaks in May and July and a marked minimum in June. The mean annual rainfall in Moroto district (1980-2009) was 856 mm. The average temperature for the same period was 29.9°C, while the annual maximum and minimum temperature were 31.2°C and 16.2°C, respectively (Egeru et al. 2019). Moroto district is situated at an altitude between 1356 and 1524 m above sea level (Lowot & Alexander 2022).

Chepareria division is mainly inhabited by the Pokots, an ethnic group with a long tradition of livestock husbandry. The Pokots were originally nomadic people, moving seasonally with their livestock in search of pasture and water and to let the land recover from grazing (Nangulu 2009). Today, most Pokots in Chepareria have adopted an agro-pastoral lifestyle. This transition started in the late 1980s, when the non-governmental organization (NGO) Vi Agroforestry (Vi-skogen) introduced enclosures and agroforestry to restore degraded lands and increase agricultural productivity (Makokha et al. 1999). Most inhabitants in Rupa identify themselves as Metheniko, a section within the larger ethnic group Karamojong. The Karamojong people are predominantly pastoralists and still practice a semi-nomadic lifestyle. Men are seasonal nomads, moving with their livestock in search of grazing areas and water during the long and hot dry season. Men from a particular clan, or group of clans, stay together in temporary livestock camps called *Awi*. The women, children, and elders usually remain in the village, in semi-permanent settlements called *Ere*. Even though semi-nomadic livestock herding is the predominant livelihood strategy in the Karamoja sub-region, there is also a high dependency on subsistence agriculture, and government and development programs are promoting more sedentary crop-based livelihoods, which has led to cropland expansion in the region (Levine 2010). However, changes in temperature and rainfall (Chaplin 2017) have led to continued crop failures in recent years (Nakalembe et al. 2017).

2.2 Systematic field surveys of soil and land health

Systematic field surveys of soil and land health were carried out in 2021 and 2022 as part of the research project Drylands Transform following the Land Degradation Surveillance Framework (LDSF) (Vågen et al. 2023). In each of the 100 km² field sites, indicators of soil and land health were measured at the plot and sub-plot level across 160 plots (640 subplots) following a hierarchical random sampling approach

(Figure 2.). Within these subplots, all woody plants taller than 1.5 meters were identified to the species level and measured.

Figure 2. Sampling design of the LDSF survey (Vågen et al. 2023).

2.3 Identification of perceived ecosystem services from woody vegetation

Focus group discussions (FGDs) were conducted at both study sites to identify perceived ES provided by woody vegetation (objective 1). At each site, six FGDs were carried out, with three groups consisting of only women and three groups consisting of only men. Each group had five to seven participants. In Chepareria, the groups were organized by three area Chiefs from different locations, while in Rupa, a trusted community member arranged all the groups. The organizers were instructed to select participants of various ages, statuses, and preferably from different villages within or near the LDSF sites. In Rupa, all residents within the LDSF site had been forced to move due to violent conflict and were residing in villages near Moroto urban area at the time of the FGDs. During the FGDs, participants were asked to identify all the benefits they could derive from trees and other woody vegetation. The definition of woody vegetation used was trees and shrubs that can grow taller than 1.5 meters, following the criteria used in the LDSF survey. All the mentioned benefits from woody vegetation during the FGDs were listed by site and grouped into different ES categories.

2.4 Preferences for ecosystem services

Individual interviews were conducted to investigate potential differences in preferences for ES among different groups within the local communities.

Approximately 60 interviews were conducted at each site. To be able to assess differences between genders, an equal number of men and women were interviewed at each site. In Chepareria, all villages within the LDSF site were numbered, and 20 villages were randomly selected. Three interviewees were randomly chosen from each of these villages when possible. In Rupa, where no villages were found within the LDSF site, a list of nearby villages was used. From this list, 20 villages were randomly selected using the same approach as in Chepareria. A detailed description of the method used to randomly select interviewees can be found in the supplementary material (SM1). A list of all villages visited during interviews can be found in supplementary material (SM15).

A questionnaire based on the identified ES from woody vegetation obtained during the FGDs was used for all interviews. However, since the list of identified ES differed between the two sites, the two questionnaires were not identical. The interviews commenced with gathering personal information, including name, age, gender, village, place of birth, type of livestock owned (if any), and level of education. In Rupa, additional questions were asked regarding livestock loss, crop cultivation, and whether the respondent had been displaced due to insecurity. The next part of the interview focused on the list of identified ES, and respondents were asked to rank the value they assigned to each ES using a modified Likert scale (Bardo & Land 2021) ranging from 1 to 5, where 1 = Negative value/never heard of, 2 = See no value, 3 = Not sure of the value, 4 = Some value, 5 = High value/cannot manage without. The ranking had to be motivated by the respondent. Finally, the respondents were requested to list the three most important and three least important ES. A review of ethical and methodological considerations related to the interviews (both FGDs and individual interviews) can be found in the supplementary materials (SM2).

2.5 Identification of woody species contributing to different ecosystem services and species preferences

During the individual interviews, data was also collected to identify the most important woody species associated with each ES and examine preferences for different species (objective 2). Participants were asked to mention up to 5 key woody species that contributed to each ES, when relevant. Additionally, they were requested to list up to 5 undesired woody species (in general). Local species names were recorded during the interviews, standardized in terms of singular form and spelling, and compiled into a list. Local names were later translated into scientific

names with the assistance of two botanists and community members with extensive knowledge of trees and shrubs.

2.6 Management, status, and access to woody vegetation

A second round of FGDs was conducted in both sites to identify current woody vegetation management practices and explore questions of access to ES from woody vegetation and the status of tree cover (objective 3). The groups were arranged following the same approach as in the previous FGDs.
Participants were asked to discuss subjects related to management, such as planting, cutting and clearing of trees and shrubs, natural regeneration, access to woody vegetation, the status of woody cover, among others. The questions were open, and the participants were encouraged to discuss and mention other related topics. In addition to the FGDs, three key informant interviews (KII) were performed. In Chepareria, two agricultural officers at the Agriculture Office for Pokot South Sub-County and one of the field staff from the NGO World Vision (World Vision Kenya 2023) were interviewed, and in Rupa, the Chairman of Karamoja´s cultural elders association was interviewed.

Except for the KIIs, almost all individual interviews and FGDs in both sites were done in the local language with the help of local interpreters.

2.7 Complementary data collection on land use and land characteristics

In order to explore the linkages between people's preferences for woody species and corresponding ES, access to land, land-use, and species presence and abundance in the landscape (objective 4), available data on woody vegetation from the LDSF surveys from Chepareria and Rupa sites was used. The dataset was complemented with additional data on land-use and land characteristics collected during the spring of 2022 at each LDSF plot in Chepareria site. Due to insecurity, additional data collection from the LDSF plots in Rupa was not possible. In each plot, data was collected on: 1. Land-use; whether the plot was located inside a homestead (In homestead), on crop land (Crop-based), on land primarily used for grazing livestock (Livestock-based), or other land (Other); 2. Enclosure; (Inside/outside); 4. Distance to surface water (On stream or riverbank, <100 m, >100 m) 5. Distance to homesteads (Inside homestead, <100 m, >100 m). All the

160 plots from the LDSF survey were located based on their coordinates using the LocusMap application (Locus Map 2023).

2.8 Data analysis

All statistical analyses and data visualizations were conducted using R Statistical Software version 4.2.1. (R Core Team 2022).

The Jaccard similarity coefficient J (Jaccard 1908) was computed to compare the similarity between different ES and between woody species mentioned in Chepareria and Rupa sites. J is defined as the size of the intersection divided by the size of the union of two sample sets: A coefficient value of 1 indicates complete similarity, while 0 indicates complete dissimilarity.

For the LDSF data, all plots were included in the dataset. For calculations on woody species density per hectare associated with different plot characteristics, the number of woody plants per ha in each plot was calculated. One-way ANOVA was used to investigate whether woody species density significantly differed based on plot properties.

3. Results

3.1 Perceived ecosystem services from woody vegetation and preferences

3.1.1 Socio-demographic overview

Table 1 presents an overview of the socio-demographic data obtained from all individual interviews conducted in Chepareria and Rupa. Approximately half of the respondents in both sites were male, and half were female. Age distribution between respondents over 40 years and below 40 years was close to 50%. Most of the respondents in Chepareria had either primary or secondary education, while most respondents from Rupa had no formal education. Despite people in Rupa being considered primarily pastoralists, 80% cultivated crops, only 61.7% had cows and 25% of the respondents had no livestock. Furthermore, majority (76.7%) of the respondents had suffered major livestock loss.

Table 1. Respondent socio-demographic data from individual interviews in Chepareria and Rupa.

Chepareria: 62 respondents

Gender		**Age**		**Education**		**Type of livestock**	
Female:	48.4%	Age span:	19-80	No formal education:	30.6%	Cow:	93.3%
Male:	51.6%	> 40 (Old):	48.4%	Any primary:	45.2%	Goat:	93.3%
		< 40 (Young):	51.6%	More than primary:	24.2%	Donkey:	5.0%
						None:	6.7%

Rupa: 60 respondents

Gender		**Age**		**Education**		**Type of livestock**	
Female:	50%	Age span:	20-92	No formal education:	80.0%	Cow:	61.7%
Male:	50%	> 40 (Old):	53.3%	Any primary:	18.3%	Goat:	68.3%
		< 40 (Young):	46.7%	More than primary:	1.7%	Donkey:	6.7%

Camel:	3.3%
None:	25.0%

Cultivate crops		Moved because of insecurity		Major recent livestock loss due to raiding or disease	
Yes:	95%	Yes:	38.3%	Yes:	76.7%
No:	5.0%	No:	60.0%	No:	20.0%
No data:	0%	No data:	1.7%	No data:	3.3%

3.1.2 Perceived ecosystem services from woody vegetation

In total, 24 ES were identified in the two sites together (*Table 2*), and 20 and 23 were identified in Chepareria and Rupa, respectively. The number of overlapping ES was 19; Pest control was only identified in Chepareria, whereas meeting places, food preservation, tools, and protection and shelter were only identified in Rupa. Most of the identified ES (50%) were classified as provisioning. A definition of ES classes can be found in the supplementary material (SM14). During the individual interviews, two additional benefits of woody vegetation that had not been mentioned during the FGDs were identified. However, these were not added to the questionnaires.

Table 2. Ecosystem services identified by site with definitions. The number next to every ecosystem service refers to the following ecosystem classes: 1. Cultural, 2. Provisioning, 3. Regulating, 4. Supporting, 5. Other.

Ecosystem service	Chepareria	Rupa
[1]Beauty	Beauty refers to the aesthetic benefit of trees and shrubs, and their ability to beautify the landscape and the homestead. However, for many of the respondents in Rupa, the concept of beauty was difficult to separate from other benefits, and the question then had to be ignored.	
[1]Cultural	The cultural benefit of woody species has a broad definition. It can be items made from specific woody plants used during rituals, ceremonies, or other traditional practices. It can be fruits or seeds eaten during specific ceremonies. It can also be the tree itself, for example, if it grows in a shrine or if it is used as the site for performing specific rituals. Some trees are also said to host the ghosts of ancestors.	
[1]Meeting places		Trees are used for community meetings and ceremonies, for privacy during courtship and private conversations, as a playground for children, as a place to take guests etc.
[1]Protection/shelter		Due to insecurity, it can be necessary to be able to hide from potential enemies when away from the village. Many times, the ability to hide among the trees in the bush can save someone's life. Trees can also protect people from wild animals.

[2]Building material	Building material refers to the benefit of woody species in providing materials for all sorts of construction work, especially house construction.
[2]Charcoal	This refers to charcoal production as a source of income. In Chepareria, it was more common to use dead wood for charcoal production, while in Rupa most interviewees used to cut live trees.
[2]Fences	This ecosystem service includes the benefit of woody plants for the production of fences. Fences can be made with live trees ("Live fences"), or from poles or dead branches ("Dead fences"). Fences are important for protecting crops from thieves and animals, and for protecting the home from wild animals and strangers. Fencing is also important for demarcation.
[2]Fibers	This ecosystem service includes the many uses of fibres from local trees and shrubs. Fibres can be used to make ropes, brooms, threads, baskets, and scrubs.
[2]Firewood	Firewood refers to the use of wood for making fire for cooking and roasting, and as a source of heat and light.
[2]Fodder	This ecosystem service includes leaves, pods, fruits and other parts of woody plants that is used as livestock feed.
[2]Food	This refers to the importance of trees and shrubs as source of food and nutrition. Fruits, seeds, nuts, and leaves are an important part of the diet of many families, especially during the dry season and other times of food shortage. Trees and shrubs are important for food security and constitute an important backup when crop harvest fails. It is also an important source of food for the herders when they are away with the animals.
[2]Food preservation	Food preservation means two different things; preserving agent, or food that can be preserved and stored. As a preserving agent woody species were usually not valued very highly by the respondents, but they were highly valued as a source of fruits and seeds that can be stored and consumed later.
[2]Handcraft material	This includes the benefit of woody species in providing material to make items such as furniture, walking sticks, cooking implements, beehives, food containers, feeding troughs for animals etc.
[2]Hygiene	This is the benefit of woody plants for hygiene products. All respondents in both sites used twigs from specific trees as toothbrushes. Bark from specific trees also creates a foam when you rub it, which some people use as soap.
[2]Medicine	This ecosystem service includes trees and shrubs with medicinal properties, and the importance of access to traditional medicine for people's health and wellbeing.
[2]Tools	Tools essential for gardening, like yokes for the ox plough, traditional hammers, hoe handles, bats for threshing etc., are usually handmade from local trees.
[3]Erosion	This refers to the role of woody plants in controlling soil erosion. It includes both live trees and shrubs, as well as dead logs and branches that can be used to block or reduce water flow.

[3]Local climate	This ecosystem service includes the benefit of trees in providing protection from sun and wind and attracting rainfall.	
[3]Pest control	Some woody species are said to repel pests, for example, snakes.	
[3]Soil fertility	This refers to the benefit of some woody plants that improve soil fertility, thereby benefitting crops and other vegetation. Most respondents only used animal dung as fertilizer and did not think that trees had any benefit, except by providing shade and preventing drought and erosion. However, some were trained in agroforestry methods, and they actively managed trees on their farms and produced compost.	
[3]Water retention	Water retention in Chepareria mainly refers to large trees close to seasonal streams and rivers that trap water in their root system. This water can be excavated for human and animal consumption during the dry season.	Water retention is a more general term in Rupa, referring to the ability of trees and shrubs to retain moisture in the ground and prevent evaporation from land and surface water.
[4]Honey	This ecosystem service is defined as the importance of access to honey as a resource, and the role of trees in supporting bees for honey production. Trees provide nectar and pollen for the bees, and trees with hollow trunks can also serve as natural hives for the bee colonies.	
[4]Wildlife	This ecosystem service refers to the value of trees and shrubs for providing a habitat for wild animals. Wildlife is valued for bush meat, hides used in traditional ceremonies (only in Rupa), for aesthetic reasons, and for the benefit of future generations. Wild animals, like some birds, can warn you of danger. This ecosystem service refers to trees as a group, and the respondents were not asked to mention specific species.	
[5]Support economy	This refers to the benefit of woody species by providing products, or material for making products, that can be sold to generate an income for the household. Here the respondents were asked to mention products, and not specific species. Common products mentioned were firewood, charcoal, kitchen implements, furniture, building material, fruits, honey, fodder, gum arabic etc.	
Additional benefits mentioned during individual interviews	In Chepareria specific species that produce good smoke used when extracting honey were mentioned. In figure 7. these species are found as other specific products.	A benefit mentioned in Rupa, that is not species specific, is that trees are important for orientation, by creating more variation in a homogenous landscape.

3.1.3 Preferences for ecosystem services from woody vegetation

In both sites, most of the identified ES were highly valued. The median Likert score was 5 for 16 out of 20 ES identified in Chepareria, while in Rupa, it was 5 for 21 of the 24 identified ES (*Figure 3*). Two ES stood out when comparing the ES scores in both sites: Charcoal and Soil fertility. The median Likert score for charcoal was 5 in Rupa but only 1 in Chepareria. Soil fertility, on the other hand, was ranked very low in both sites compared to other ES (median Likert score was 1). Motivations for the given Likert score can be found in the supplementary material (SM4)

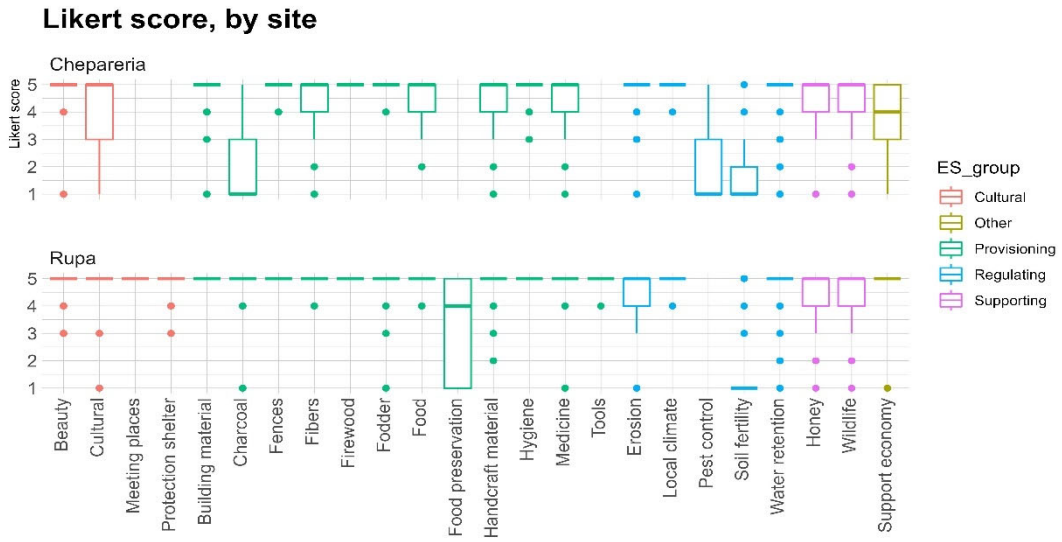

Figure 3. Boxplots (Q1, median, Q3) showing the ranking (Likert score) of each ecosystem service by site.

The distribution of the three most valued ES varied across and within sites (*Figure 4*). Of 24 identified ES, 21 were mentioned as the most valued at least once on one of the sites. In Chepareria, fodder, firewood, and food comprised over half (53%) of the responses. In Rupa, food and local climate accounted for nearly half (49%) of the responses, followed by medicine (10%).

Food was the most frequent answer in both sites together. Woody vegetation played a crucial role in supporting food security, serving as an important buffer during the dry season and when crop harvests failed by providing fruits, seeds, nuts, and vegetables. Leaves from trees were considered an essential vegetable during the dry season in Chepareria. In Rupa, gathering large quantities of fruits from the "bush" and preserving them for later use was common. Wild foods from trees were also considered important sources of vitamins and key to enhancing dietary diversity.
Leaves and pods from woody species were also vital in sustaining livestock during the dry season. In Chepareria, livestock were fed tree leaves daily, while in Rupa, herders took their animals to areas with abundant trees during the dry season to browse. Firewood was essential for cooking and heating, but its availability was limited, particularly in Chepareria, where people relied more on resources from their own land. In Rupa, where most land was communal, firewood was relatively easier to access, though women had to walk long distances to gather sufficient amounts. Local climate was the most valued ES in Rupa, primarily because trees provide shade. The small and dark houses in Rupa made people spend less time indoors during the daytime. In the shade under the trees, people had their social life,

the children played, people worked or just relaxed etc. Shade was also important for the animals. Using medicine from woody species, mainly bark and roots, was common in both sites, often serving as first aid. Access to public health clinics was limited and modern medicine was expensive. Most villages had local herbalists that could be consulted, and traditional remedies were often perceived as more effective. In Rupa, traditional medicine was the only accessible form of treatment available from the *Awi* (livestock camps).

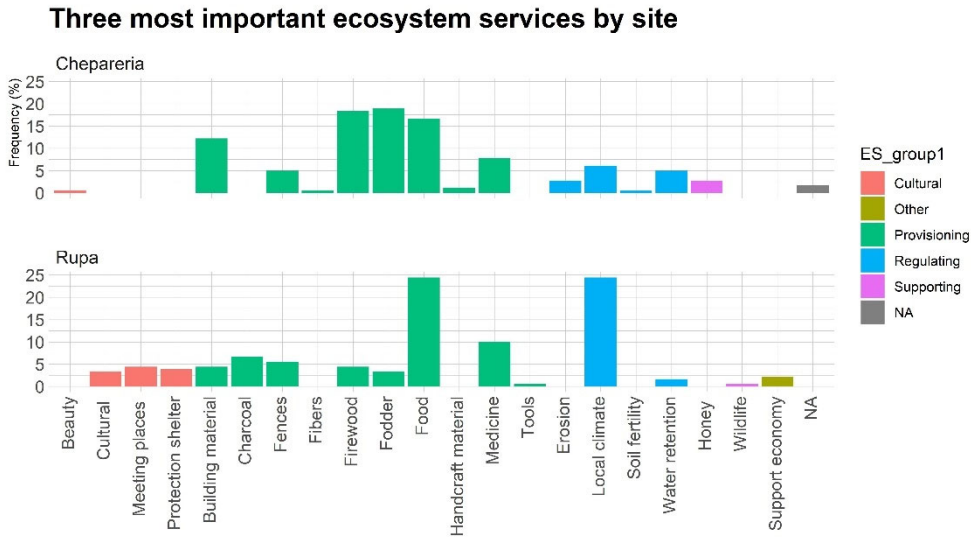

Figure 4. Frequency of responses corresponding to the three most important ecosystem services by site.

The distribution of the three least valued ES also showed variation, both between and within sites (*Figure 5*). In Rupa, many respondents refused to answer this question because they deemed all ES as important, thereby the high proportion of NAs. Many respondents also mentioned just one or two ES that they valued less than others. In both sites, Soil fertility was considered the least important ES. In Chepareria, the second least important ES was Charcoal, followed by Pest control, while in Rupa, the second least important ES was Food preservation, followed by Honey. Food, Firewood, and Local climate were never mentioned among the least important ES in either site.

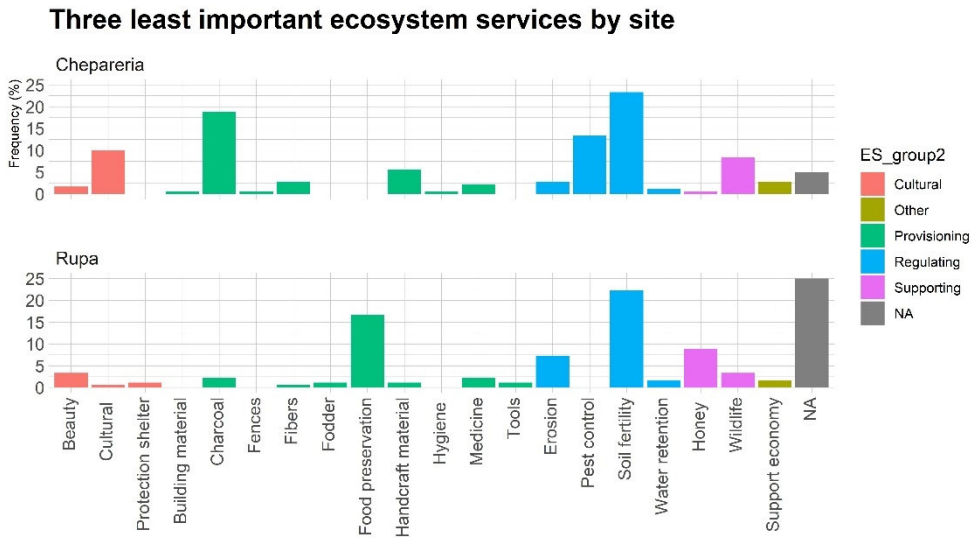

Figure 5. Frequency of responses corresponding to the three least important ecosystem services by site.

The ranking of ES did not display any substantial variation based on gender or age. Because of the predominating low education level, especially in Rupa, the effect of education was inconclusive. Figures of ranking and Likert score according to gender, age, and level of education can be found in the supplementary material (SM5 & SM6)

3.2 Woody species contributing to different ecosystem services

A total of 133 and 156 distinct woody species were mentioned in Chepareria and Rupa, respectively, and the large majority of these were native. The complete species list can be found in the supplementary material (SM7). Of these species, 105 and 89 were identified with scientific names in Chepareria and Rupa, respectively. However, only 56 and 57 species in Chepareria and Rupa, respectively, were mentioned more than five times, and of these, only seven species were not identified with scientific names. Only 38 of the identified species were mentioned in both sites.

The most important species associated with different ES varied between the two sites, as did the total number of species mentioned for each ES (*Figure 7, Table 3*).

Table 3. Overview of the number of species associated with different ecosystem services in both sites, the overlap, and the resulting Jaccard similarity index. Only species mentioned more than five times in each site are included. Six unidentified species from Rupa are excluded.

Jaccard similarity index	**Nr. of sp. in common**	**ES**	**Tot. Chep**	**Tot. Rupa**
-	-	Support economy	-	-
0.21	6	Food	18	16
-	-	Food preservation	-	17
0.22	7	Beauty	29	10
0.17	6	Cultural	16	25
0.32	11	Firewood	21	24
0.19	9	Building material	32	31
0.33	8	Charcoal	16	16
0.22	10	Handcraft material	26	30
0.33	14	Fodder	31	26
0.15	5	Hygiene	20	18
0.16	8	Medicine	27	31
-	-	Meeting places	-	6
0.20	7	Erosion	24	18
-	-	Pest control	5	-
-	-	Protection/shelter	-	0
0.1	1	Soil fertility	2	9
-	-	Tools	-	25
0.13	3	Water retention	14	4
0.27	13	Honey	34	27
0.27	11	Fences	26	26
0.35	8	Fibers	17	14
0.21	8	Local climate	31	16
-	-	Wildlife	0	0
0.25	**21**	**Total**	**55**	**50**

The species mentioned during the interviews exhibited varying levels of multifunctionality (*Figure 6*). Some species were associated with multiple ES, indicating high multifunctionality, while others were more associated with specific ES. In Chepareria, the five most multifunctional species were *Balanites aegyptiaca*, *Zantoxhylum chalybaeum*, *Grewia bicolor*, *Terminalia brownie*, and *Albizia amara*. In Rupa, the five most multifunctional species were *Balanites aegyptiaca*, *Acacia tortilis*, *Ziziphus mauritania*, *Acacia senegal*, and *Acacia nilotica*. *Balanites aegyptiaca* was the most frequently mentioned woody species in both sites and was associated with a wide range of services, including shade, windbreak, firewood, charcoal, soap production, toothbrush, medicine, food, erosion control, fencing material, handcraft material, construction, beauty and cultural practices etc. A list of all species and number of associated ecosystem services can be found in the supplementary materials (SM8).

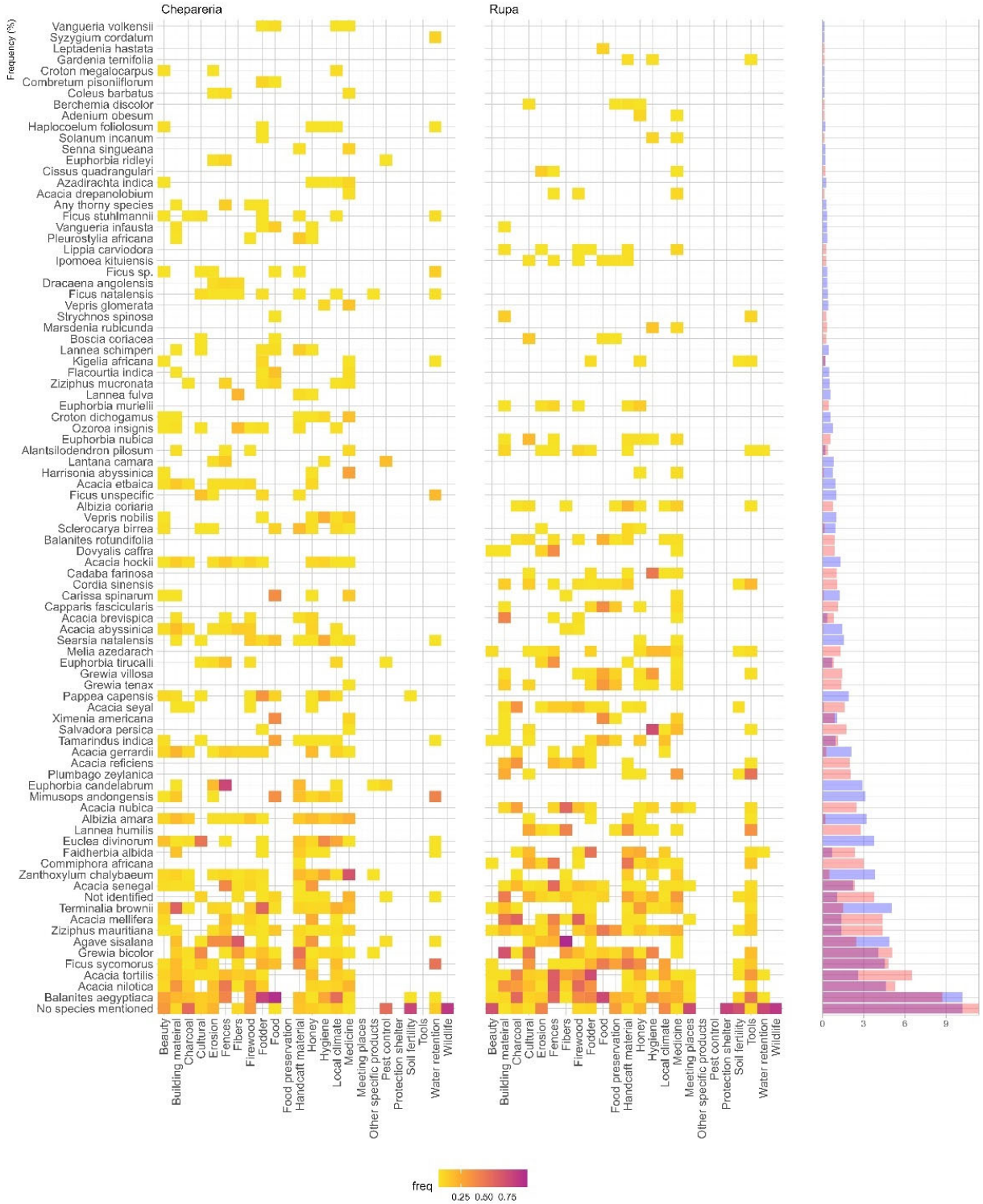
Chepareria
Rupa
Frequency (%)
Vangueria volkensii
Syzygium cordatum
Leptadenia hastata
Gardenia ternifolia
Croton megalocarpus
Combretum pisoniiflorum
Coleus barbatus
Berchemia discolor
Adenium obesum
Haplocoelum foliolosum
Solanum incanum
Senna singueana
Euphorbia ridleyi
Cissus quadrangulari
Azadirachta indica
Acacia drepanolobium
Any thorny species
Ficus stuhlmannii
Vangueria infausta
Pleurostylia africana
Lippia carviodora
Ipomoea kituiensis
Ficus sp.
Dracaena angolensis
Ficus natalensis
Vepris glomerata
Strychnos spinosa
Marsdenia rubicunda
Boscia coriacea
Lannea schimperi
Kigelia africana
Flacourtia indica
Ziziphus mucronata
Lannea fulva
Euphorbia muriellii
Croton dichogamus
Ozoroa insignis
Euphorbia nubica
Alantsilodendron pilosum
Lantana camara
Harrisonia abyssinica
Acacia etbaica
Ficus unspecific
Albizia coriaria
Vepris nobilis
Sclerocarya birrea
Balanites rotundifolia
Dovyalis caffra
Acacia hockii
Cadaba farinosa
Cordia sinensis
Carissa spinarum
Capparis fascicularis
Acacia brevispica
Acacia abyssinica
Searsia natalensis
Melia azedarach
Euphorbia tirucalli
Grewia villosa
Grewia tenax
Pappea capensis
Acacia seyal
Ximenia americana
Salvadora persica
Tamarindus indica
Acacia gerrardii
Acacia reficiens
Plumbago zeylanica
Euphorbia candelabrum
Mimusops andongensis
Acacia nubica
Albizia amara
Lannea humilis
Euclea divinorum
Faidherbia albida
Commiphora africana
Zanthoxylum chalybaeum
Acacia senegal
Not identified
Terminalia brownii
Acacia mellifera
Ziziphus mauritiana
Agave sisalana
Grewia bicolor
Ficus sycomorus
Acacia tortilis
Acacia nilotica
Balanites aegyptiaca
No species mentioned
Beauty
Building material
Charcoal
Cultural
Erosion
Fences
Fibers
Firewood
Fodder
Food
Food preservation
Handcraft material
Honey
Hygiene
Local climate
Medicine
Meeting places
Other specific products
Pest control
Protection shelter
Soil fertility
Tools
Water retention
Wildlife
freq
0.25 0.50 0.75
0
3
6
9

Figure 6. Heat map of woody species and associated ecosystem services, according to frequency. Species mentioned less than five times during the interviews have been excluded. The histogram side panel shows the total frequency (%) of species mentioned during interviews: Blue = Chepareria, red = Rupa, purple = overlap.

Different ES could be more, or less associated with specific species (*Figure 7*). Food was closely associated with *Balanites aegyptiaca* in both sites. This was a common fruit tree, and the young leaves were a common vegetable, especially in Chepareria, where it was often consumed daily during the dry season. The seeds could be boiled and eaten as a snack or used to extract oil. *Ximenia americana*, *Carissa spinarum*, and *Mimusops adongensis* were the most important fruit trees in Chepareria. In Rupa the most important fruit trees were *Ziziphus mauritania*, *Ficus sycomorus*, *Capparis fascicularis* and *Ximenia Americana*. Fodder was strongly associated with *Balanites aegyptiaca*, *Terminalia brownii* and *Papea capensis* in Chepareria, and with *Acacia tortilis*, *Faidherbia albida* and *Balanites aegyptiaca* in Rupa.
Fibers were strongly associated with *Agave sisalana* in both sites, and with *Acacia nubica* in Rupa. Both species were used to make ropes. Building material was strongly associated with *Terminali brownii* in Chepareria, and *Grewia bicolor* in Rupa. In Rupa, *Salvadora persica* was the most common species used as toothbrush, and strongly associated with hygiene. In Chepareria *Euphorbia candelabrum* was commonly used as a live fence around croplands and homesteads. In Rupa, it was more common to use dead branches from thorny species as fence, and therefore *Acacia nilotica* was more important. A list of the most frequently mentioned species associated with each ecosystem service can be found in the supplementary material (SM9).

Figure 7. Fruits from Balanites aegyptiaca, Ximenia americana and Searsia natalensis. Photo: Aida Bargues Tobella.

Provision of certain ES was not species-specific but depended on woody vegetation more generally, and often the interviewees chose not to mention any specific species at all for these ES. For example, local climate was less closely associated with any particular species in Rupa, but strongly associated with *Balanites*

aegyptiaca in Chepareria. Firewood was less associated with any particular species in Chepareria, but strongly associated with *Acacia mellifera* and *Acacia nilotica* in Rupa. Water retention was less associated with specific species in Rupa, but in Chepareria most respondents associated this ES with *Ficus sycomorus* and *Mimusops adongensis*. Wildlife, beauty, meeting places, protection and shelter and soil fertility were not strongly associated with specific species in either site. A list of the times no species was mentioned for each ecosystem service can be found in supplementary material (SM9).

The variation in species mentioned and associated ES did not vary substantially depending on age, gender, or level of education. More details can be found in the supplementary material (SM11 & SM12).

In Chepareria, only 65% of the individual interviewees chose to mention any unwanted woody species, while the rest left this question blank. *Acokanthera scimperi* and *Pleurostylia Africana* predominated among the mentioned unwanted species. In Rupa, 73% of the respondents chose to mention any unwanted species, with *Calotropis procera* and *Capparis tomentosa* being the most prominent. The complete list of unwanted species can be found in the supplementary material (SM10).

3.3 Management and access to woody vegetation

Management practices and access to woody vegetation differed between the two sites. In Chepareria, most lands were privately managed and enclosed, and people relied mainly on resources from the trees and shrubs on their own land. However, people could gather food (fruits, leaves and seeds) and medicine from trees on private land, except when these were growing within someone's homestead or were planted for a specific purpose. Buying or exchanging products from woody plants from neighbours or local markets was also common. In Rupa, in contrast, most lands were communal with common access, and enclosures were rare, facilitating access to resources from woody vegetation. However, many species grew far from the villages, and people often had to walk considerable distances to find specific species.

In Chepareria, livestock was often left to graze freely inside enclosures used for pastures, which reduced the need for herding compared to Rupa. However, this created a need to enclose smaller areas within these enclosures where livestock grazing and browsing were undesirable, like homesteads and croplands. Another major difference in land management practices between the two sites was that fire

was used extensively to improve pastures and control ticks in Rupa, but not in Chepareria.

3.3.1 Tree cutting

FGDs and individual interviews revealed a strong resistance to cutting mature trees. Instead, people preferred to cut only branches when harvesting wood for different purposes. Cutting the entire trunk of a tree was often associated with taboos, and cleansing rituals were often performed if important trees were felled accidentally. Clearing land for cultivation and establishing new homesteads were the main reasons for cutting trees in Chepareria, while charcoal production was the main reason in Rupa. Thinning of trees on croplands and pastures to enhance crop and grass production was common in both sites. Firewood was mostly collected from dead wood, with minimal cutting of live branches in both sites.

In Rupa, cutting branches for fodder was uncommon since animals were taken to places where they could browse directly on reachable branches, whereas in Chepareria, tree branches were cut daily as fodder for livestock during the dry season. After the leaves were consumed, the branches served as materials for dead fences and subsequently as firewood.

Trees could be protected from cutting for various reasons. In both sites, native food trees and medicinal trees belonged to the community and were considered taboo to cut. In Rupa, trees growing in shrines were always protected. Trees could be protected for spiritual reasons even in Chepareria; traditional rituals were often performed under large trees close to the river, and these trees should never be cut. Old trees were associated with bad spirits, and people feared cutting them. In Rupa, old settlements where the ancestors used to live were associated with ghosts, and thereby protected. In both sites, trees located near rivers and streams were protected for water retention and to prevent erosion.

In Chepareria, charcoal production was stigmatized and associated with poverty, resulting in few people wanting to be associated with it. Those who admitted to burning charcoal claimed to only use dead wood or trees that had to be cleared for other reasons. In Rupa, in contrast, charcoal production was practiced extensively. The importance of charcoal production as a source of income had increased considerably in recent years, resulting in a more careless attitude towards tree felling. Major livestock losses due to raids and an increase in tick-borne diseases had created a need for alternative livelihoods, with charcoal production becoming the primary source of income for many pastoralists. The chairman of the Karamoja cultural elders' Association, Jackson (2022), estimated a loss of around 80% of the stock since 2018. He further claimed that people tended to care more about trees

when they had more livestock that relied on them for fodder during the dry season. The absence of livestock had resulted in desperation, causing extensive tree-cutting without regard for sustainability or natural regeneration. Before the conflicts escalated, people did not usually cut whole trees for charcoal production and clearing a whole bushland area was rare. There used to be a careful selection of trees to be cut according to Jackson (2022).

3.3.2 Tree planting

Tree planting was not a common practice in either site and was usually only performed by people with training.

In Rupa, woodlots had been established in several villages through Third Northern Uganda Social Action Fund (Limlim 2020), a program funded by the World Bank. Villagers received training on tree planting and management, along with seedlings to take home. However, the focus was primarily on exotic tree species (e.g., mango, guava, passion fruit, orange, avocado, eucalyptus, and neem), that required intensive care and access to water, and many of the seedlings died from drought and termites. After the program ended, people faced difficulties obtaining new seedlings, but more people began collecting wild seedlings instead. Relocating wild seedlings had been a traditional practice for a long time but was not very common. Tree seedlings were usually planted in homesteads or croplands as part of the fence, where they could be protected from browsing animals and direct sunlight. Relocated seedlings were watered, shaped, and pruned, and were often planted during the wet season. Trees were planted for various reasons in Rupa, including shade, windbreaks, fruits, medicine, fencing, demarcation, and for attracting rain. However, the most common reason to plant trees was to prevent and reduce soil erosion in areas such as croplands, footpaths, rivers, and streams.

Tree planting was more common in Chepareria, and most people planted *Euphorbia candelabrum* as a live fence around their homesteads and croplands. *Agave sisalana* was also commonly planted as a live fence around pastures, along streams and rivers, and in other erosion-prone places. Many people reported receiving training in tree planting from different NGOs, or at school. However, as in Rupa, the main focus of these trainings was on exotic species such as eucalyptus, cypress, grevillea, neem, mango, orange, and papaya. The primary reasons mentioned for not planting trees were the high cost of seedlings and a lack of knowledge of proper management. Many people had tried to plant exotic fruit trees but failed since these species were often sensitive to drought and browsing animals. However, compared to Rupa, more people in Chepareria collected and relocated wild seedlings. Local trees were easier to manage than exotic species. Seedlings were typically planted in areas inaccessible to livestock but close to homesteads, usually during the rainy

season. Seedlings were often relocated to the fence around the cropland or compound. Common reasons for planting trees were for food, medicine, shade, beauty, building material, handcraft materials and firewood. Suitable fodder species could be planted in pastures if they could be protected from browsing animals. Other reasons for planting trees were to attract rain and to replace dead trees. Individuals with training could establish woodlots, but these required fencing to protect the seedlings, especially from goats. However, limited access to suitable fencing materials posed challenges for establishing large woodlots.

3.3.3 Protection of trees and support of natural regeneration

Assisted natural regeneration (ANR) of woody vegetation was common in Rupa, where it was practiced extensively in the community grazing lands to secure fodder production, shelter for humans and animals, and other essential ES. Livestock movement was carefully managed with rotational grazing coordinated by clan leaders to prevent overgrazing, which also facilitated the regeneration of woody vegetation. In addition, areas throughout the community grazing lands where tree cover had decreased were closed off and entirely or partly restricted from grazing for more extended periods specifically to promote the natural regeneration of trees. Trees around these exclosures' boundaries were marked to signal that livestock was restricted. ANR was less common outside the community grazing lands, near the villages. However, many villages had fenced-off areas for calves and sick animals, which remained in the village while the rest of the herd was taken to the community grazing lands. These areas served as a backup for pasture during the dry season. Trees within these areas were not cut except for thinning and pruning. When cropland became infertile, it was usually left to fallow. After some years, unwanted trees and shrubs were cleared, and new crops were planted. Valuable trees were left to regenerate and were usually pruned to reduce shade. Land could also be protected by the government for different reasons e.g., land around important water reservoirs. These areas were fenced, and cattle grazing and cutting trees was prohibited. Some people fenced and protected individual seedlings near their homestead or cropland, but this was uncommon.

Even in Chepareria, land was commonly fenced off to regenerate pastures, typically for periods ranging from six months to two years. However, since most land was managed privately, many people did not have enough land to restrict it from grazing for more extended periods. The result was that natural regeneration of trees was often insufficient. Valuable trees could sometimes be fenced individually, but this practice was uncommon. In 2022, the NGO World Vision (World Vision Kenya 2023) started training people in FMNR in Chepareria, initially limited to Pserum location. Several model farms were established, serving as training hubs and inspiration for others. Even small-scale farmers were targeted. Good fencing

material to restrict animal grazing was often a limiting factor for practicing FMNR, but according to Ondere (2022), staff at World Vision in Chepareria, even closing off a small piece of land for shorter time periods could change people's mindset and encourage them to do more at a later stage.

3.3.4 Unwanted trees and shrubs

Certain species were considered undesirable when they were found in the wrong place. Species with many sharp thorns, species that attracted snakes, or that were poisonous were often cleared near the homestead, while species that were poisonous to livestock or that reduced grass growth were cleared from rangelands, and species that could compete with crops were cleared from croplands. However, most of these species also provided valuable ES and were desirable if found elsewhere.

3.3.5 Perceptions of tree cover change over time

According to Lomatum (2022) and Stanselus (2022) from Chepareria ward agricultural office, the tree cover in Chepareria division had increased in many areas due to tree planting efforts in recent years. However, the trees planted were mainly exotic species like cypress and eucalyptus for timber, and the consensus from FGDs and KIIs was that the native tree cover was declining. This decline was attributed to population growth - which had led to more land clearing for settlements and cultivation - and overgrazing - which hindered the natural regeneration of woody vegetation. In the past, when people in Chepareria were seasonal nomads, controlled livestock migration and sustainable pasture management were overseen by elders and clan leaders. Nowadays, individual land managers are responsible for ensuring sustainable land management. In Chepkopegh location, where communal land is still common, trees were being overharvested for timber, charcoal, and medicine (*Figure 8*), and according to Lomatum (2022) and Stanselus (2022), privately managed land today tended to be managed more sustainably. Despite this, when asked if the woody vegetation was enough to provide essential ES, the most common answer during the FGDs was no. Since most lands were privately managed and enclosed, people mainly depended on the resources available on their own land, which were often insufficient. Reductions in tree cover had caused problems with erosion in many places, and fruit trees, medicinal plants, and firewood were often in short supply, leading to overharvesting. Obtaining enough fodder during the dry season was often challenging, resulting in the need to rent pastures or buy fodder from neighbours. Many people also migrated with their animals to Uganda. Buying wood for building, fencing and handcrafting was common since these resources were often insufficient.

Figure 8. Trees where the bark has been harvested for medicine

The perception that the number of native trees was decreasing was also prevalent during the interviews in Rupa. Until a few years ago, there used to be many trees inside and close to the villages, but now most of these trees had been cut. When asked whether the most important species for providing different ES were enough, the most common answer was that they were enough, but that most of them were not found close to the villages anymore and that people had to walk long distances to find them. The woody species cover in the community grazing lands was still mostly intact since these areas were located far from the villages. Due to the major livestock loss in Rupa, the grazing pressure was low compared to before. Even though this might positively affect the natural regeneration of trees, this benefit was masked by the increased cutting of trees for charcoal, leading to a net loss of tree cover in Rupa.

3.4 Woody species' presence and abundance in the landscape

3.4.1 Comparison between species data from the LDSF survey and individual interviews

The species presence data from the LDSF survey showed only a partial correlation with the species identified as important in the individual interviews (*Figure 9-10*).

In Chepareria, 122 distinct woody species were identified from the interviews and LDSF survey combined. Of these, 39 were found in both datasets (32% overlap). In Rupa, 109 species were identified from the interviews and LDSF survey combined, and only 24 of these were found in both datasets (22% overlap). Several frequently mentioned species from the interviews were absent in the LDSF data, and several species that were relatively common in the LDSF data had not been mentioned during the interviews.

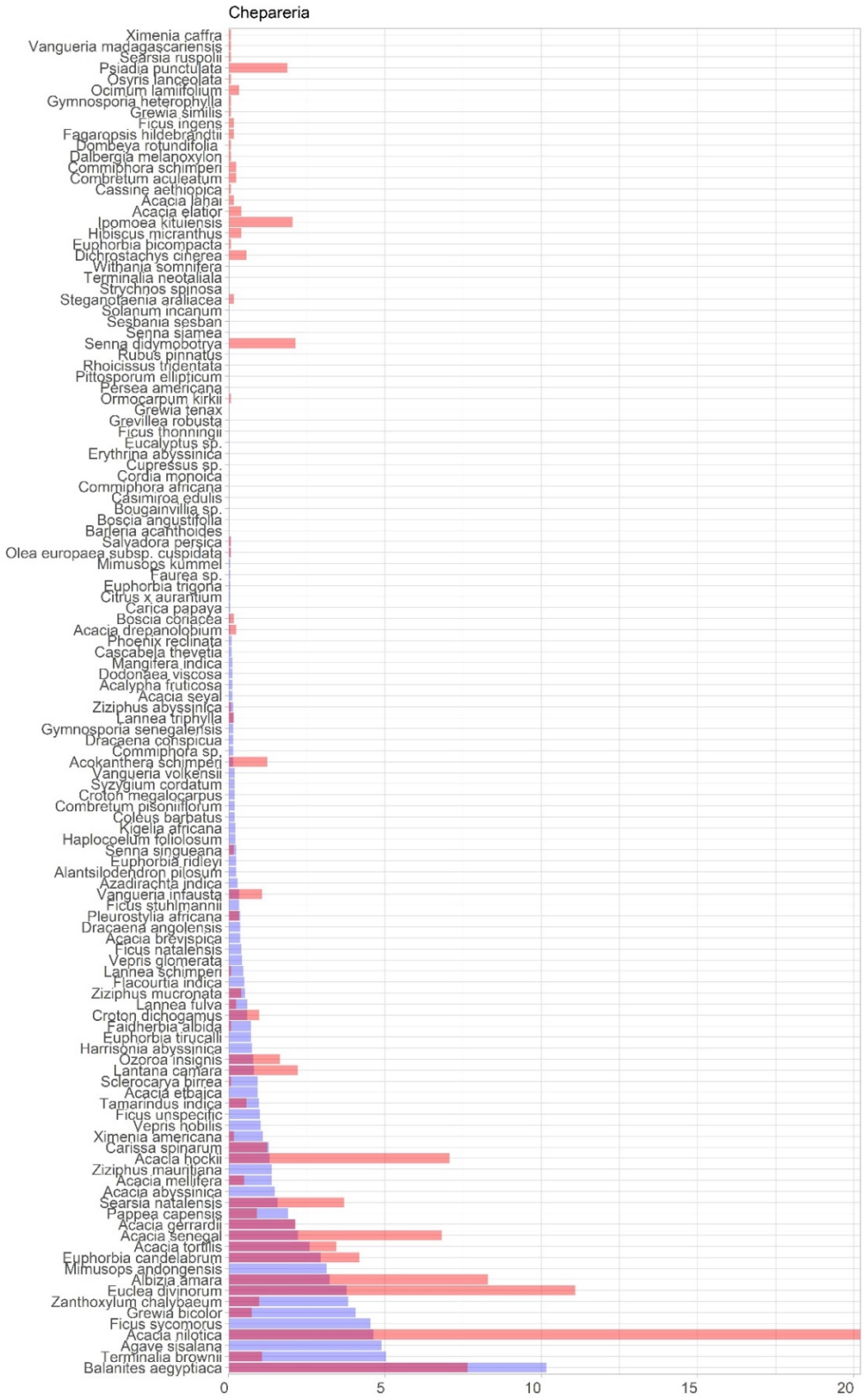

Figure 9. Species frequency data (%) from interviews (blue), combined with species frequency data from the LDSF survey (red) for Chepareria site, Kenya.

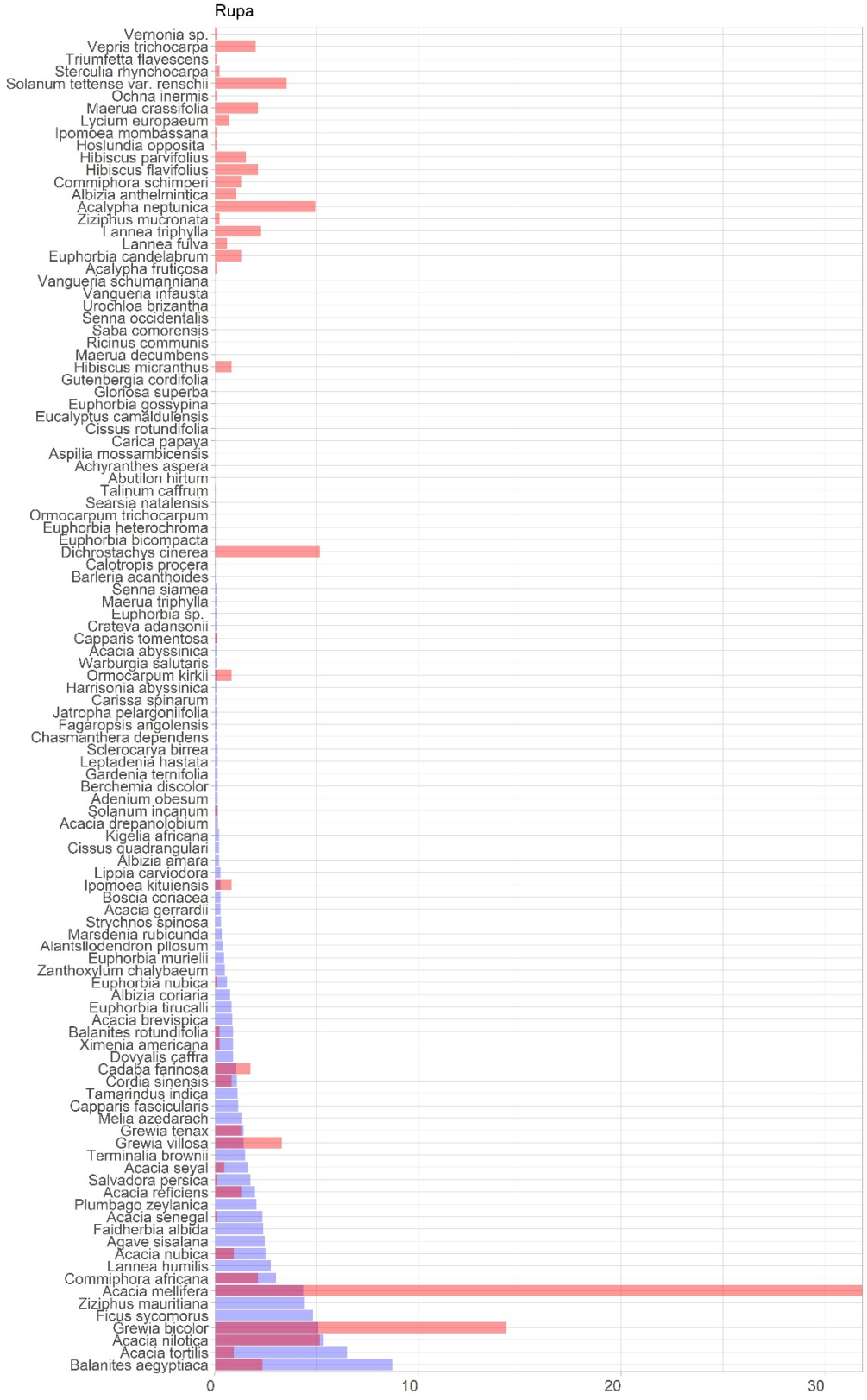

Figure 10. Species frequency data (%) from interviews (blue), combined with species frequency data from the LDSF survey (red) for Rupa site, Uganda.

3.4.2 LDSF plot characteristics, Chepareria

When all LDSF plots in Chepareria were grouped according to different plot characteristics, the counts displayed considerable variation (*Figure 11*). Most plots were inside livestock-based enclosures (land used mostly as pasture), far from surface water and homesteads.

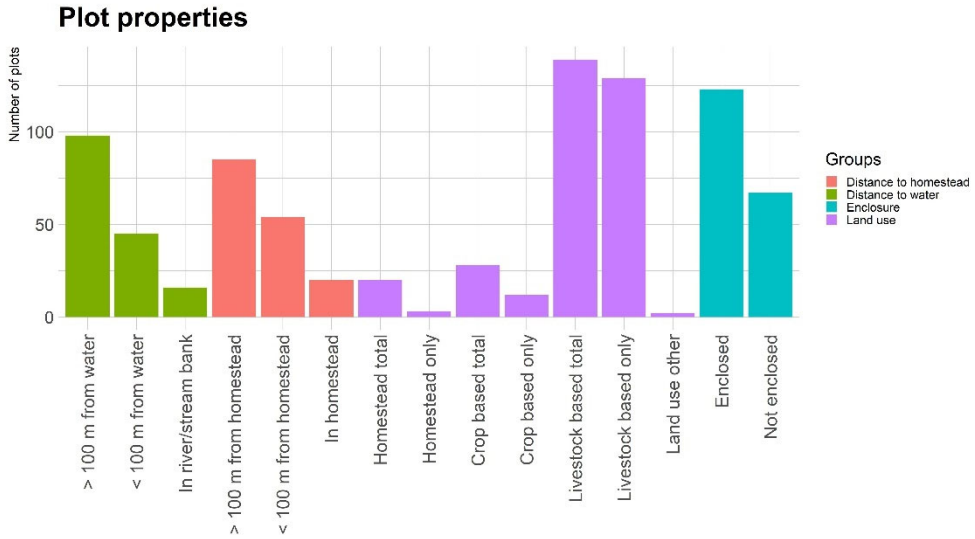

Figure 11. Number of LDSF plots by plot properties in Chepareria site. The total of plots is 160. The following land-use characteristics: In homestead total, Crop based total, and Livestock based total, involve counts of plots that have a mix of different land uses.

3.4.3 Species presence according to plot characteristics in Chepareria

In total, 86 woody species were identified during the LDSF survey in Chepareria. More species were identified in plots inside enclosures compared to plots that were not enclosed, and the most common species found inside enclosures were mentioned more times during the individual interviews and were associated with more ES compared to plots that were not enclosed (*Table 4*). *Balanites aegyptiaca*, the most frequently mentioned species during the individual interviews, was almost twice as frequent in enclosed plots compared to other plots. None of the species unique to enclosed and non-enclosed plots were among the most frequently mentioned or multifunctional species mentioned during interviews. Figures with species distribution and frequency based on different plot properties can be found in the supplementary material (SM13)

Table 4. Total number of unique species associated with different plot properties, the 5 most frequent specie, and unique key species mentioned more than 10 times during the individual interviews. For each species Tot. count is the number of times the species was mentioned during individual interviews in Chepareria, and Nr. ES is the number of associated ecosystem services.

Sp. tot.	Uniqe sp.	Top 5.	Tot. count	Nr. ES	Unique key sp.	Tot. count	Nr. ES
Not enclosed							
55	6	*Acacia nilotica*	148	12	*Croton dichogamus*	19	6
		Acalypha neptunica	0	0			
		Senna didymobotrya	1	1			
		Euclea dicinorum	121	12			
		Acacia mellifera	44	7			
Enclosed							
80	31	*Acacia mellifera*	44	7	*Sclerocarya birrea*	30	8
		Acacia nilotica	148	12	*Lannea schimperi*	15	6
		Grewia bicolor	130	14	*Faidherbia albida*	23	6
		Euclea divinorum	121	12			
		Balanites aegyptiaca	325	16			
Crop-based							
40	4	*Acacia mellifera*	44	7	*Faidherbia albida*	23	6
		Grewia bicolor	130	14			
		Balanites aegyptiaca	325	16			
		Euphorbia candelabrum	94	7			
		Acacia tortilis	83	12			
Livestock-based							
80	32	*Acacia mellifera*	44	7	*Sclerocarya birrea*	30	8
		Acacia nilotica	148	12	*Lannea schimperi*	15	6
		Grewia bicolor	130	14	*Pleurostylia africana*	12	4
		Euclea divinorum	121	12	*Lannea fulva*	19	3
		Balanites aegyptiaca	325	16	*Zanthoxylum chalybeum*	122	14
					Croton dichogamus	19	6
Homestead							
35	3	*Acacia nilotica*	148	12			
		Acacia mellifera	44	7			
		Grewia bicolor	130	14			
		Albizia amara	103	13			
		Acalypha neptunica	0	0			
< 100 m from homestead							
52	7	*Acacia mellifera*	44	7	*Faidherbia albida*	23	6
		Grewia bicolor	130	14			
		Balanites aegyptiaca	325	16			

		Acacia nilotica	148	12			
		Acacia Senegal	71	9			
> 100 m from homestead							
75	29	*Acacia nilotica*	148	12	*Croton dichogamus*	19	6
		Acacia mellifera	44	7	*Lannea schimperi*	15	6
		Euclea divinorum	121	12	*Pappea capensis*	61	10
		Balanites aegyptiaca	325	16	*Pleurostylia africana*	12	4
		Albizia amara	103	13	*Sclerocarya birrea*	30	8
On river/stream bank							
37	5	*Acalypha neptunica*	0	0	*Croton dichogamus*	19	6
		Croton dichogamus	19	6			
		Euclea divinorum	121	12			
		Albizia amara	103	13			
		Acacia mellifera	44	7			
< 100 m from water							
54	8	*Euclea divinorum*	121	12	*Lannea schimperi*	15	6
		Acacia nilotica	148	12	*Pleurostylia africana*	12	4
		Acacia mellifera	44	7			
		Acacia hockii	42	12			
		Albizia amara	103	13			
> 100 m from stream/river							
73	24	*Acacia nilotica*	148	12	*Sclerocarya birrea*	30	8
		Acacia mellifera	44	7	*Faidherbia albida*	23	6
		Grewia bicolor	130	14			
		Balanites aegyptiaca	325	16			
		Acacia senegal	71	9			

In total, 80 species were found in livestock-based plots, 40 species in crop-based plots and 35 species in plots located inside a homestead (Table 4). More unique species were also associated with livestock-based plots, and among these species, there is *Zanthoxylum chalybeum*, one of the most frequently mentioned and multifunctional species. However, the number of plots associated with each separate land-use was not equal – 133 livestock-based plots, 22 crop-basd plots and 18 homestead – and thus, these results should be interpreted with caution.

Among the five most common species in livestock-based plots, only *Balanites aegyptiaca* and *Grewia bicolor* were among the five most important fodder species mentioned during interviews. *Balanites aegyptiaca* also had a higher frequency of occurence in crop-based plots, and *Grewia bicolor* was more common in both crop-based plots and inside homesteads. Except for *Euclea divinorum*, which was not found in crop-based plots, the most abundant species per land use were relatively similar (*Table 4*). Among the five most common species associated with the three

different land-uses, all but *Acalypha neptunica* were relatively frequently mentioned during interviews.

Due to the uneven distribution in the number of plots by distance to streams and rivers and distance to homesteads, no clear pattern could be determined. More species in total, and more species mentioned as important during individual interviews were identified in plots far from homesteads and far from surface water, but whether this was an effect of management or a result of the higher number of plots in these locations was not possible to determine. However, the two most multifunctional species, also among the most frequently mentioned during interviews - *Balanites aegyptiaca* and *Grewia bicolor* - were more common in plots close to a homestead compared to more distant plots.

3.4.4 Woody species density according to different plot properties in Chepareria

Woody species density varied depending on plot properties (*Figure 12*). A slightly higher density of woody plants was observed in plots less than 100 m from a stream or river compared to plots closer to or on a stream or riverbank. A higher density of woody plants was also observed in plots more than 100 meters from a homestead compared to plots closer to or inside homesteads. Enclosed plots also displayed a slightly higher density of woody plants than non-enclosed plots, and livestock-based plots had a slightly higher density of woody vegetation than crop-based and plots located inside homesteads. However, none of these differences were significant ($p > 0.05$).

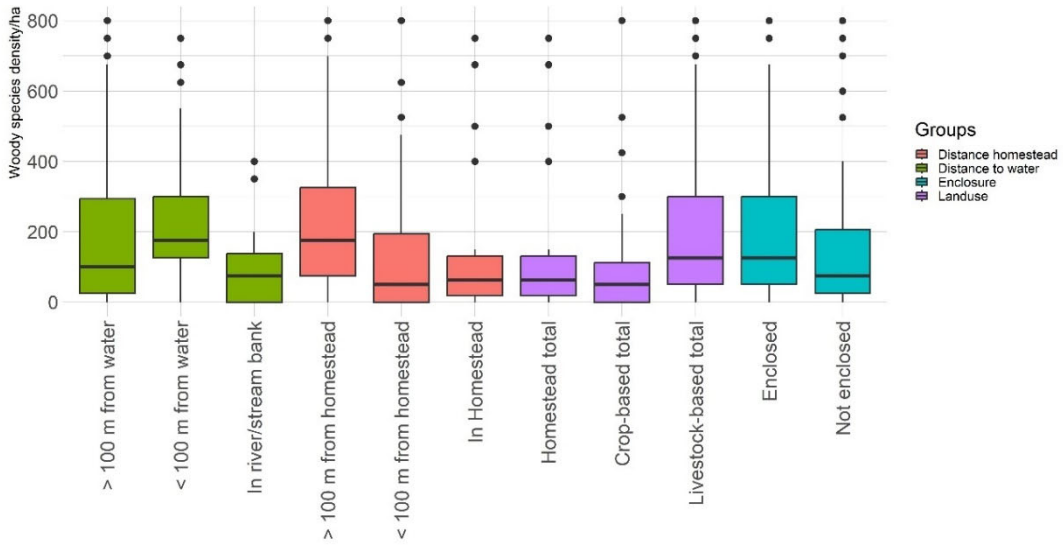

Figure 12. Woody species density per hectare (ha) for different plot types in Chepareria. The following land-use properties: Homestead total, Crop-based total, and Livestock-based total, involve plots that can have a mix of different land use, and data is repeated for each land use.

4. Discussion

4.1 Ecosystem services from woody vegetation

Results from this study reveal that local communities in Chepareria and Rupa perceived various ES from woody vegetation, including provisioning, supporting, regulating, and cultural services. Woody vegetation played an important part in Pokot and Karamojong culture and was essential in supporting people's livelihoods. A participant in the focus group discussions in Rupa captured the significance of trees by stating that "the entire life of a Karamojong is animals and trees".

Although most perceived ES were the same in both sites, two cultural services - Meeting places and Protection and shelter - were only mentioned in Rupa. This illustrates key differences between the sites. In Chepareria, the houses were relatively large and the distance between homesteads could be up to several hundred meters. In contrast, houses in Rupa were small and usually located only a few meters from the nearest neighbour, which gave little room for visitors or private conversations. Visitors were usually attended outside the house, under the shade of a tree, and private conversations were held under trees outside the village gate. Schools and other buildings were used for community meetings and gatherings in Chepareria, while large trees outside the village gate were more commonly used for this purpose in Rupa. Due to the violent conflicts in Rupa, trees could be important for personal security, and many interviewees reported that being able to hide among the trees in the “bush” had saved their lives.

Most perceived ES in both sites were provisioning services. In Chepareria, Food, Firewood and Fodder were identified as the most important ES, while in Rupa, it was Food and Local climate. Food, Firewood and Local climate were never mentioned among the least important ES in any site, reinforcing their significance. Other studies have also found that rural communities prioritize provisioning services over other services, particularly in developing countries, where these services are vital for subsistence and livelihoods (Fagerholm et al. 2012; Muhamad et al. 2014). Results from this study align with previous findings showing that woody vegetation provides vital provisioning services like food, firewood,

medicine, and shelter, and also function as safety nets during emergencies, both in economic and environmental terms (Shyamsundar et al. 2020; Razafindratsima et al. 2021). Soil fertility was the least valued ES, and most respondents did not believe that woody vegetation had any effect on soil fertility, except for water retention and erosion control.

Restoration initiatives have traditionally focused more on regulating and supporting services, like biodiversity conservation and carbon sequestration, while provisioning ES were neglected. However, results from this study highlight that enhancing the supply of provisioning services, particularly food and energy, in developing countries is critical. The importance of woody vegetation for food and nutrition has received increased attention in recent years (Ickowitz et al. 2021), and an increasing number of FLR projects promote planting of fruit trees on farms, including native species (Akinnifesi et al. 2007). However, the importance of wild indigenous trees is often overlooked. Also, that trees can provide vegetables, and not just fruits, remains largely ignored. This study demonstrates that wild indigenous trees are critical food sources for the local communities, highlighting the importance of promoting them. Similarly, the aspect of energy security and sustainable management of wood fuels is often neglected in FLR initiatives (Harvey & Guariguata 2021). This is surprising considering that over 90% of Sub-Saharan Africa's population relies on wood fuel for cooking and heating (Iiyama et al. 2014), and that wood fuel often constitutes a central component of local livelihoods and economies, and that fuelwood harvesting is a major driver of deforestation (Specht et al. 2015). In Chepareria, where most land was privately managed, firewood resources were often insufficient to meet household energy needs. In Rupa, where most land was communal, women and children often spent several hours daily searching for firewood. Enhancing and promoting sustainable fuelwood supply is thus critical to address energy insecurity and promoting gender equality (Njenga et al. 2021).

That local climate was among the highest-valued ES in Rupa is not surprising. Trees often provide the only protection from the sun, enhancing people's comfort and well-being. In recent years, however, the tree cover near the villages has been greatly reduced, leaving people more exposed to the sun than before.

Despite Rupa being a pastoralist community, fodder was not as frequently mentioned among the most valued ES compared to Chepareria. One explanation could be that the interviews in Rupa were conducted after the onset of the rainy season when fodder was plentiful. In Chepareria, in contrast, most individual interviews were conducted during the dry season, when most families were cutting branches from trees on a daily basis to feed their livestock. Fodder was also a more limited resource in Chepareria, where people depended mostly on the resources

from their own land. In Rupa, the herders could migrate with the livestock in search of pastures. Additionally, the massive livestock loss in Rupa had forced people to find alternative livelihoods.

The way people valued ES from woody vegetation was independent of gender, age and level of education. However, the limited number of respondents with formal education, particularly in Rupa, makes it difficult to draw sound conclusions regarding education. These findings contrast with other studies showing that socioeconomic factors influence people's perceptions and value of ES (Muhamad et al. 2014). One possible explanation for the homogenous response is that the respondents answered not only from an individual perspective but rather from a family and community perspective. For example, respondents in Rupa who did not own livestock still ranked fodder five, and women assigned a high value to handcraft materials despite handcraft being a traditionally male activity.

4.2 Species associated with ecosystem services from woody vegetation

Local communities in Chepareria and Rupa hold considerable knowledge of numerous woody species and their importance in supplying various ES. While some species were strongly linked to specific ES, others served multiple functions. Although similar ES were identified in both sites, the associated species often differed, emphasizing the importance of adapting tree-based restoration interventions to local contexts through species selection.

The majority of woody species mentioned during the individual interviews were native. Still, local tree planting projects and trainings mainly seemed focused on exotic species, whereas native trees were usually not promoted. Although exotic trees may provide many benefits, they often require more intense management and care. Moreover, when trees need to be brought up in nurseries, the focus can only be on a few species, but to cover several critical ES requires diversity of species. Native species often regenerate naturally and are better adapted to local conditions, making them more resilient to climatic and environmental changes. This makes ANR a more suitable strategy for effective large-scale tree-based rangeland restoration than tree planting. It enhances species diversity and thus the supply of multiple ES. ANR is also more cost-effective and easier to scale up compared to tree planting (Pasiecznik & Reij 2020).
Yet, tree planting can be an important complement. Promoting native species in dryland restoration has been shown to yield positive outcomes (Pasiecznik & Reij 2020), as demonstrated in individual case studies in East Africa, where indigenous

trees and local knowledge of agro-pastoralist communities have been successfully employed (Barrow & Mlenge 2003). In West Africa, farmer-managed natural regeneration (FMNR) has been widely implemented, resulting in significant increases in tree cover across vast agricultural lands. This is often considered Africa's most significant restorative transformation (Reij et al. 2020). According to Toudou et al. (2020), the only way to win the battle against land degradation is to mobilize millions of land users to invest their scarce resources in protecting regenerating native trees.

4.3 Management of woody vegetation

There has been a growing interest in understanding the role of farmers in promoting the natural regeneration of woody vegetation on their farms (Chomba et al. 2020). These FMNR practices have been observed to lead to increased tree cover and changes in tree cover composition (Brandt et al. 2018). However, how woody vegetation is managed by (agro)pastoralists in rangelands, especially on communal land have been largely overlooked. Pastoralists are often associated with land degradation and decreased tree cover (Homewood & Rodgers 1988), and thus their potential role in promoting woody vegetation in rangelands has been overlooked. This study provides evidence that (agro)pastoralists in Rupa and Chepareria actively manage woody vegetation by promoting and protecting important species, clearing unwanted species, and practicing controlled grazing to facilitate natural regeneration (although with less focus on trees in Chepareria). In line with other studies, these results highlight the importance of understanding, recognizing, and valuing the role of local communities as stewards of local ecosystems (Folke et al. 2005).

4.3.1 Changes in tree cover in Chepareria and Rupa

Even though data on tree cover change since the establishment of enclosures in the 1980s is missing from Chepareria, results from KIIs and FGDs indicates a decreasing native tree cover. While enclosures appear to have positively impacted soil health (Svanlund 2014) and vegetation cover in Chepareria division (Nyberg et al. 2015), this does not necessarily translate into a positive impact on woody vegetation. Grazing was usually only restricted from enclosures used for livestock parts of the year, and reports about overgrazing, suggests a negative impact of short resting times on natural regeneration of trees and shrubs. Successful regeneration requires plants to reach a size that allows them to withstand trampling and browsing from livestock, especially goats. However, when animals are restricted only for parts of the year, regenerating woody plants will not easily reach this size. Landowners with enough land can reduce grazing pressure by rotating pastures and

entirely or partially restricting grazing from certain areas over several seasons, facilitating improved pastures and the natural regeneration of woody vegetation. However, small landowners cannot afford to lose access to land for extended periods, resulting in more intensive grazing pressure and less regeneration of woody vegetation. Insufficient tree regeneration may result in a delayed negative impact, as older trees die off without enough young trees to replace them. The establishment of enclosures has shifted the risk of land degradation from communal rangelands to privately managed allotments. However, if grazing intensity and management of rangeland enclosures are not well regulated, there is a significant risk of increased land degradation over time (Wairore et al. 2015). A consequence of decreased native tree cover is that rural people in Chepareria, who depend more on resources from their own land, report that important ES from woody vegetation are insufficient to meet their needs, especially for people with smaller land holdings. The expected increase in population in the region (County Government of West Pokot 2018), will increase pressure on already limited resources. More subdivided land and smaller lots can be expected in the future, and these landowners should be explicitly targeted for restoration interventions.

The high level of insecurity in Rupa has severely impacted local communities in recent years, leading to livestock loss and restricted access to safe land. This, in combination with recurrent crop failures (Nakalembe et al. 2017) and a low level of education has resulted in limited alternative livelihood options. Consequently, many people have turned to charcoal production as an alternative source of income. However, this practice has resulted in overharvesting of trees. Live trees, preferably large, are cut without concern for natural regeneration, and people have to walk increasing distances to find trees. The importance of trees for dry season fodder used to make people take better care of the trees, but with most livestock gone, people are less concerned about the sustainable management of tree cover. Pastoralists have often been blamed for overstocking of livestock, causing problems like overgrazing and land degradation (Homewood & Rodgers 1988). However, less livestock seems to have led to more land degradation in this case. This is in line with the findings by Krätli and Shareika (2010), highlighting that pastoralism creates an important buffer against uncertainties, and Levine (2010) showing that pastoralism and a semi- nomadic lifestyle improves food security by creating a buffer against crop failures (Levine 2010).
Banning charcoal production is not a feasible solution, but there are ways to make it more sustainable. Trees for charcoal production can be grown in agroforestry systems to reduce pressure on other woody vegetation. This has been a successful approach in Ethiopia, where farmed charcoal retained more value for the producers (Kim et al, 2022). Sustainability can also be enhanced by improving charcoal production techniques with more efficient kilns, which improves charcoal quality

and reduces energy loss (Adam 2009). Alternative sources of income which do not involve reducing tree cover should also be explored. Even though ANR of trees is a common in the community grazing lands, this practice is rare in other areas. Encouraging natural tree regeneration outside community grazing lands is essential for bringing valuable resources closer to villages. However, to succeed with sustainable rangeland restoration in Rupa, it is key to address the challenges of insecurity and ensure that people's basic needs are covered. This is in line with the theory of the pyramid of human needs by Abraham Maslow (1943), stating that until a person's lower-level needs are fulfilled, higher-level needs will remain irrelevant.

4.4 Woody species' presence and abundance in the landscape

Comparison of species data from the field surveys (LDSF) and preferred species from the individual interviews resulted in a relatively small overlap, suggesting that management does not have a significant impact on the presence of preferred species in the landscape. However, there are several possible explanations for this. First, species distribution may not be uniform due to spatial variations in growing conditions or management practices. Certain species may be more abundant near water bodies, or in enclosed croplands or homesteads where they are protected from livestock. In Chepareria, most LDSF plots were located inside livestock-based enclosures distant from water and homesteads, potentially leading to species being overlooked. In Rupa, the LDSF site was located several kilometres from the nearest villages. Additionally, the semi-nomadic lifestyle in Rupa allows people to access species that may be less common in nearby areas, making them difficult to capture in the LDSF survey's sampling design. Therefore, a more targeted sampling might be a better alternative. Furthermore, the LDSF survey only sampled plants that were 1.5 meters tall or taller, excluding smaller woody plants present in the landscape. For instance, *Agave sisalana*, a common species used for live fences in Chepareria, takes years to grow above 1.5 meters. Consequently, *Agave sisalana* is not found in the LDSF data, despite its prevalence in the landscape. A third explanation could be related to species identification. Identification of species was conducted retrospectively based on local names mentioned during interviews. Several species could not be identified (although none of these were frequently mentioned), and a few species with a similar appearance could share the same local name. This might be the case for *Ximenia americana* and *Ximenia caffra*.

Results on woody species presence and density related to plot properties in Chepareria were inconclusive due to the uneven distribution of plots. However,

some interesting trends were detected. The diversity and density of woody vegetation was higher (although statistically insignificant), inside enclosures compared to outside enclosures. Enclosed plots also had a higher frequency of species mentioned as important during interviews. This suggests a more active management inside enclosures to promote woody vegetation and preferred species. *Balanites aegyptiaca* and *Grewia bicolor* (the two most multifunctional species), were more common in plots located less than 100 meters from a homestead, compared to more distant plots. However, plots near homesteads had lower diversity and density of woody vegetation, and fewer species mentioned as important during interviews were unique to these plots, suggesting a higher pressure on woody vegetation in these locations. However, these results could also be related to the higher number of plots located more than 100 meters from a homestead. Another interesting trend was the relatively low abundancy of preferred fodder species in livestock-based plots, suggesting that these species might be overharvested or that regeneration of these trees are not promoted well enough. The trends observed in this study are in disagreement with findings from a macro-scale assessment in the Sahel, where farmland management (including grazing) positively affected woody cover, with tree density decreasing with increasing distance from settlements (Brandt et al. 2018). However, obtaining more comprehensive woody vegetation data might reveal similar patterns in Chepareria. Trees near streams and rivers were usually protected. Consequently, more species diversity, distinct plant communities, and a higher density of woody plants could be expected. However, although woody species density was slightly higher in plots located less than 100 meters from rivers and streams, the limited number of plots, especially on stream or riverbanks, means that results should be interpreted with caution. Considering that people plant or relocate seedlings mainly to homesteads or croplands, and that unwanted species are often cleared from these places, one would expect to find a different species composition in these plots, compared to livestock-based plots. However, due to limited data on species presence in these two plot types, no definite conclusions could be drawn regarding the impact of management.

4.5 Conclusion

The results of this study show that woody vegetation provides many benefits to agro(pastoralist) communities in the Karamoja cluster, and that trees and other woody species are critical to support people's livelihoods and well-being. The local communities possess significant and detailed knowledge of different woody plants and their benefits. Most of the species identified as important for different ES were native species, and restoration efforts should preferably be based on the natural regeneration of these species to secure that no vital ES are lost and that the

restoration efforts respond to the needs and aspirations of the local communities. Tree planting can be a good supplement, but the local people should decide what trees they want since they know their needs best.

This study also provides evidence that the local communities in both sites actively manage woody vegetation, e.g., by promoting and protecting beneficial tree species and tree cover in general and clearing unwanted vegetation. Managing and promoting the natural regeneration of woody vegetation was practiced in both sites, although with less focus on trees in Chepareria.

Due to insufficient data, results on links between land-use, access to land, preferred species and ecosystem services, and woody species presence and abundance in the landscape were inconclusive. However, in Chepareria, there were indications that management affects woody species density and species distribution inside enclosures. However, this needs to be further investigated.

Findings from this study highlight the need to understand the role of trees and other woody vegetation in supporting rural livelihoods for successful long-term restoration outcomes that respond to the needs of local people. As also stated by Barrow and Mlenge (2003), it is crucial to ensure that restoration efforts are integrated into current institutional structures and accompanying rules, regulations and sanction systems that are well understood by local communities. This is particularly important in Rupa, where desperation and an overarching focus on covering basic needs have changed how people regard and manage trees. It is vital to involve local leaders and authorities to find strategies to make restoration possible.

Due to the many differences regarding climate, security, lifestyle and traditions, access to land, dominating land management strategies, as well as the knowledge and experience connected to woody species, dryland restoration based on woody vegetation in Chepareria and Rupa requires tailored strategies based on a bottom-up approach where the different needs, knowledge and capacity of the local population are recognized.

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Popular science summary in Swedish

Torra områden täcker nära hälften av jordens landyta. Markanvändningen domineras av jordbruk och bete, ofta i kombination. Torra ekosystem världen över påverkas i dag av markförstöring. Befolkningsökning, klimatförändringar och ohållbar markanvändning hotar viktiga ekosystemtjänster och har en negativ påverkan på människors livskvalitet och försörjningsmöjligheter. Majoriteten av befolkningen i torra områden i östra Afrika är beroende av ekosystemtjänster från vedartade växter och restaureringsåtgärder med fokus på dessa är av yttersta vikt. Effektiva restaureringsåtgärder kräver dock en bättre förståelse för komplexiteten och variabiliteten i dessa ekosystem samt för behoven hos människorna som lever här, ett perspektiv som ofta saknas. Restaureringsåtgärder har ofta fokuserat mer på jordbruksmark och bönder och mindre på betesmark och boskapsskötare. Betesmarker i torrområden har ofta låg täckningsgrad av träd, och betydelsen av träd i dessa områden har därför ofta ignorerats. Syftet med den här studien har varit att bidra med mer kunskap om betydelsen av vedartade växter i torrområden som domineras av betesmark, med fokus på hur olika arter bidrar till viktiga ekosystemtjänster samt betydelsen av förvaltning och skötsel av vedartade växter. Två olika platser med olika levnadsätt valdes ut för den här studien, Chepareria i West Pokot, Kenya, som domineras av agropastoralister och Rupa i Moroto district, Uganda, som domineras av pastoralister. Studien har visat att befolkningarna i de två områdena besatt betydande kunskaper om vedartade växter och att dessa hade en avgörande betydelse för livsgrundlaget och kulturen för båda samhällena. Ett stort antal högt värderade ekosystemtjänster identifierades på båda platserna, och de flesta av dessa var förknippade med inhemska arter. De viktigaste ekosystemtjänsterna var mat, ved, foder och ett förbättrat lokalklimat. Trots att de flesta av ekosystemtjänsterna som identifierades på båda platserna överensstämde, var arterna som förknippades med dessa ofta olika. I Chepareria förvaltades det mesta av marken privat med hjälp av inhägnader, medan det mesta av marken i Rupa var allmänning. På båda platserna förekom en aktiv förvaltning av vedartade växter för att bevara och skydda dem, dock med mer fokus på naturlig föryngring i Rupa. Trots detta var den allmänna uppfattningen att andelen inhemska träd på båda platserna minskade. I Chepareria förknippades minskningen med förändrad markanvändning, samt högt betestryck. I Rupa var huvudorsaken att en betydande förlust av boskap lett till att många övergått till produktion och försäljning av träkol

för att försörja sig, vilket orsakat en ökad avverkning av träd. I Chepareria var sambandet mellan förekomst och abundans av vedartade växter i landskapet, preferenser, tillgänglighet och markanvändning oklart, på grund av begränsad tillgång till data. På grund av de många skillnaderna mellan de två platserna krävs lokalt anpassade restaureringsåtgärder, där lokalbefolkningarnas kunskaper, erfarenheter, behov och önskemål står i centrum.

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Supplementary material

SM 1. Methods for random selection of households during individual interviews in Chepareria and Rupa

In Chepareria, after selecting 20 villages inside the LDSF site, 3 participants from each village were selected, following the following approach:
Usually, the villages had a road going through it. Along this road, the search for the first interviewee started from the second household after entering the village. The second interviewee was selected starting from the second last household along the same road. The search for the third interviewee started from the middle of the village when there was only one road. If there was a road crossing or a side road near the middle of the village, the search for the third interviewee started from the second last household along this road. In the cases where there was a road crossing or no other road than the main road, the direction for the search of the last interviewee was chosen so that the distance between the previous interviewees was as large as possible to cover a larger area and decrease the risk of homogenous answers. In the cases when the targeted household was not available for an interview, the next nearest household was selected, and so on.

In Rupa, 20 villages were selected randomly, using the same approach as in Chepareria. Three interviewees were selected randomly per village. However, since the outline of the villages in Rupa was very different from those in Chepareria, another strategy for randomly selecting interviewees was applied. In Chepareria, the villages are large, the households are scattered, and the distance between the different households can be up to several hundred meters. In Rupa, the villages are small, and the houses are usually placed in a circle around a larger open area, with only a few meters between every household. A tall fence usually surrounds the whole village. When selecting interviewees in Rupa, the main entrance to the village was identified, and the search for interviewees started from the 5th household on the right side. If no one in the targeted household was available for an interview,

the following household was targeted, and so on. After the first interview, the search for the next participant started from the 5th household after the first one. The search for the third interviewee started from the 5th household after the second interviewee.

In both sites, finding men at their homes was often challenging, except early in the morning. In these cases, it was necessary to ask for the nearest household where it might be possible to find a man. If this also failed, the village centre had to be located. Here, it was always possible to find men to interview. In Chepareria, the village centre was usually a small marketplace, and in Rupa people gathered under the trees outside the main gate of the village. Men from homesteads in another part of the village than the previously interviewed persons were favoured.

SM2. Ethical and methodological considerations during interviews

1. Methodology

All individual interviews, FGDs, and key informant interviews were voluntary and held with informed consent from all participants. To prevent interviewees from being influenced by other people's opinions, the participants of the FGDs and individual interviews were not the same. All photographs of people were taken after they signed a consent form. Signatures were exchanged with stamped fingerprint in cases where the participant was illiterate. Except for the key informant interviews all FGDs and most individual interviews in both sites were conducted in the local language with the assistance of local interpreters.

Before each interview, both individual and group interviews, I introduced myself and my interpreter, and explained the purpose of the interview. After each interview, I asked the interviewees if they had any questions, if something was unclear, or if there was something they wanted to add. The most common question was how the information from the interviews was going to benefit them. I explained that I was part of a larger research project, and that the information was going to be shared with the people involved in the project as well as local authorities, and that it was going to be used to find better strategies to solve some of the challenges that people in the area faced.

I was advised to give a small appreciation to all the people I interviewed, as this was a common practice when conducting interviews in the area. The appreciation could be in the form of a light meal or an equivalent sum of money. However, the appreciation should not be the motivation for participation and was always given after the interview.

For the FGDs I mostly followed recommendations from Kumar (1987). During the discussions I acted as a moderator, while the main interaction was between the participants, who stimulated each other. A limited number of topics were discussed at each session to allow for in-depth discussions. The group size was small enough to create good group dynamics, and it was rare for one person to dominate the discussion. However, when this happened, I turned to other participants and asked follow-up questions to involve more people in the discussion. To facilitate interaction among the participants, they were usually seated in a circle so that they could face each other. Participants were provided with seats, if they did not carry their own, and the discussions were held in a shaded place to protect participants from the sun. The duration of a session should not be too long and was usually

around an hour. I aimed for a relatively homogeneous group of participants with similar experiences and backgrounds to facilitate open and relaxed discussions, and therefore the groups were arranged according to gender. However, I also tried to make the groups representative of the local community by asking for participants of different age, statuses, and from different villages.

2. Challenges and potential weaknesses

Culture, taboos, and low level of education

Coming from a different culture often resulted in me having different experiences and perceptions compared to the local population. This could sometimes make me perceive some things more clearly, but it also increased the risk that I missed important information during the data collection process. Living in the homes of local families during the data collection process and working only with local interpreters was very valuable in this context. I had the opportunity to discuss my work, results, and methods with other people, clear out mistakes, make adjustments when necessary, and place my results and methods in a cultural context.

Since charcoal production in Chepareria was associated with poverty, few people wanted to be associated with this activity. Therefore, it is possible that more people were involved in charcoal production than what was reported during the interviews, and that problems related to charcoal production was more prominent than my results indicated. If people were not entirely honest, this might also have resulted in a too low Likert score for this ecosystem service in Chepareria.

To use Likert score to distinguish between ranking of different ecosystem services was challenging. Due to the low level of education among many of the interviewees, it was difficult to explain the concept. To determine the correct ranking, often required some discussion. After the first few interviews, I found a strategy that made the process easier. My first question was: Is this ecosystem service important for you? This question usually helped me to identify the right end of the scale or whether the ranking should be in the middle. To gain a better understanding of the value of the particular ES, I then asked: Why is it important/not important? To distinguish between Likert score number four and five, I asked: What would be the consequence if this ES was not available? Score number one was used if the respondent never heard of the ES or if it was associated with a strong negative value. Before recording the score, I explained how I perceived that the respondent valued the ecosystem service, to ensure that we agreed.

Working with interpreters

My options for choosing interpreters were limited, and none of my interpreters were female. However, I did not ask particularly sensitive or private questions, so it is unlikely that the gender of the translator had a major impact on the answers. None of my interpreters had previous experience from similar work. However, the fact that they were all local with insight on local traditions and culture was important and added substantial value to their interpretation in ways than an educated interpreter from outside could not have done. Also, most of my interpreters were young men, not authorities, and they were good listeners, who made the interviewees relaxed. My main interpreter in Rupa was a local chief who used to work as a teacher. As a chief, he was an authority, and many people knew him. The respect people felt for him could potentially make people more reluctant to answer certain questions. However, he was a humble and friendly man, and he was also familiar to the area, and for my own security he was the best choice, so in this case I had to make a trade-off.

Using local interpreters could lead to misunderstandings related to cultural differences and language barriers. To ensure that we were on the same page, I always discussed the aim of my interviews and went through all the questions in my questionnaires with every new interpreter before we started the interviews. I was also clear about what type of information I was looking for and encouraged them to ask questions along the way if something was unclear, and I always asked them to explain better if something was unclear to me. The local languages Pokot (Chepareria) and Ngakarimojong (Rupa), are both very different from English, and together with the cultural differences, this sometimes made it challenging to make an accurate translation. In Rupa, the concept of beauty was for example difficult to explain to many of the respondents, as they found it hard to separate it from other benefits of woody vegetation. Also, the level of English language skills varied among my different interpreters, especially in Rupa. This resulted in a few misunderstandings, for example, about the difference between preserving agent and preserved food, which resulted in the large variation of scores for the ecosystem service of food preservation.

In Chepareria, most of my interpreters had degrees in agronomy and possessed detailed knowledge of woody plants. Due to the low level of education in Rupa it was challenging to find interpreters to English that both knew the area and had knowledge of woody plants. Therefore, I mostly worked with interpreters with a social science background. The interpreters with more knowledge on local trees and shrubs could detect if names mentioned in association with different ES was an item made of a specific type of wood, or if the name was plural or singular, the young or mature plant, or if a species that was not woody was mentioned. They were also more consistent with spelling. This made it easier to identify the correct species with scientific name at a later stage.

SM 3. Suggestions for further research

1. Investigate changes in tree cover over time in Chepareria and Rupa, and how this has affected people's ability of accessing important ecosystem services. If certain species are becoming rare, how can these species be promoted? Are some ecosystem services becoming more threatened than others? A combination of remote sensing analyses and interviews may be useful methods. What are the main drivers of reduced native tree cover in the two sites, and how can this problem be addressed? Is there a connection between reduced tree cover and the amount of land a land manager can access?

2. Further explore the links between land use and land characteristics on woody species density, species presence, and distribution in the landscape in both sites. To better cover land characteristics and land uses represented by smaller land areas a more targeted sampling technique may be appropriate to pilot. Can one predict woody species density and what species are found where?

3. Further explore the practice of assisted natural regeneration in the community grazing lands in Rupa and assess the status of success for sustained tree cover. Are there ways to promote assisted natural regeneration of woody vegetation also closer to the villages?

4. Investigate alternative sources of income than charcoal in Rupa, that do not involve an unsustainable use of local resources. This could perhaps be related to beekeeping or production of foods or handcrafts that can be sold.

SM4. Motivations for Likert score in Chepareria and Rupa

Table 1. Motivations for Likert score of ecosystem Services in Chepareria and Rupa

Ecosystem service	Motivation for ranking Chepareria	Motivation for ranking Rupa
Beauty	(+) Trees beautify the landscape by making it green. All trees are beautiful, they have to be there. A landscape without trees is boring. When it rains, the trees transform the landscape with green leaves. The evergreen species adds beauty during dry season. The flowering trees beautify the landscape and compound. All trees are beautiful. Green leaves are essential, they are like the cloths of the trees and make the landscape beautiful. A place without trees is ugly, it's not a good place to stay. The diversity of trees and their colors makes the landscape beautiful. (-) The trees are not enough to be able to add beauty.	(+) An open landscape is ugly. I admire the beauty of trees; the diversity makes the landscape look good. Trees is the canopy of the land; they add variation and beauty to the landscape. All trees are beautiful. Bare ground is bad. I like to see trees, even at a distance, the landscape is ugly without. It is more pleasant to look at a landscape with tree cover. Trees beautify the compound. I would not want to stay in a pace where trees are far, the landscape is ugly when it is bare. The shifting canopy brings variation to the landscape. All the trees become beautiful and green after the rain. I like to see trees growing together. Trees make distance feel closer. Green leaves and flowers make the heart happy. Trees makes you feel more at home when they are planted in the compound, they make the home more colorful. To see trees makes you feel good. Trees make the land more colorful. Everything would be quieter without trees, no sound of wind in the leaves could be heard. You feel better when something is blocking the horizon, and you don't just see blue sky. It feels lonely without trees. (-) The aesthetic value of trees itself is not important.
Building material	(+) They are important for self-use and income. I always use local trees for building and construction. There would be no house without the local trees. Any strait tree can be used as building material. The local trees have to be there. I only use trees from the farm for construction. If you don't have enough trees on your own land, you can get/buy from neighbors. I prefer to use local materials rather than buying those that are not local. They	(+) I only use local trees as building material. There would be no houses without trees. The local trees are resistant to termites and weevils. Without the right species, houses will not be built well. The local species are strong. A good house made of the right trees can last for 3-4 years. The local species are the only source of building material. The houses look nice. Building material from local species are also used to make houses for the

	can be used to make houses, dish racks, granaries and sheds. (-) The local trees are not enough for timber; some has to be accessed elsewhere. I use some local wood but buy most from the market that are not local. The local trees are not enough for timber. I buy building material from elsewhere sometimes. It is good to have alternative sources when you need it.	animals, dish racks and granaries. You need several different species for building, some flexible, and some firm. Without these trees people would be sleeping under the open sky, people would live like animals. I can't afford other building material. If the right trees for building material was not there, people would have to move. A well-built house gives you respect. (-) People walk long distances to get the right type of trees for building, sometimes for days. Before, these species could be found nearby. Overpopulation have made these species rare.
Charcoal	(+) Provides important income. I only use dead trees, so that live trees are not killed. We make to sell sometimes. Any species can be used. Both live and dead trees can be used. Charcoal is very important, both for self-consumption and for income. The money can be used to buy food. We don't make it a lot, but we can cut a tree when ware financially pressed. I only make charcoal when the tree is dry, or has fallen. The income can be used to pay school fees, or things for the household, like cloths, soap, sugar etc. If a tree is cut for other use, the residues can be made into charcoal, but it is not good to cut trees. (-) Many people make and sell, but it is problematic. I never make it. I never use it. It is bad for the environment. It is not common to make charcoal.	(+) Charcoal is the main source of income. The money you get from selling charcoal can be used to buy medicine for people and animals. We sell charcoal to buy food, food would not be enough without it. If you make enough charcoal you can buy a goat, or even a cow. The local species make good quality charcoal that catches fire fast. Life would be difficult without the money from charcoal production. We cannot manage without. People would steal if they could not make charcoal and sell. I make charcoal every week. I make charcoal every 4th day. People would die without charcoal. Because of insecurity and disease, people don't have enough cows, burning charcoal is the only way to survive in the village. It is important for food security when the crops fail. With the money from charcoal you can buy food, tobacco, shoes, soap and sheets, the alternative would be to sell livestock. I walk far to make charcoal, to protect the trees close to home. When the price for charcoal is good you can save and make investments. Large trees give the best charcoal. Poverty makes charcoal essential. (-) Because of insecurity, many people are prevented from making charcoal now. I never make charcoal. I don't have the strength to make charcoal, because of old age. People walk far to find trees to make charcoal.

Cultural	(+) Leaves from certain trees are used for blessings during ceremonies like marriage, Sapana (initiation of elders), when a child is born, or when someone needs more cows. The old traditions should be kept. It is important to teach the children about the old traditions. No one can get married without sealing the contract of marriage by giving away a walking stick made from the right tree. Trees are important for traditional practices; the right species have to be there to perform the ceremonies correctly. Trees are important in many traditions and ceremonies. Men need a stool and a walking stick made of the right species to be allowed to participate in certain rituals. Cheptuya is used in church and to celebrate the rains. Branches from specific trees are used for decoration and placed in or on the car or motorbike for safe travels, they can also be used during fund raising for blessing. During initiation of boys, they gather around specific trees to sing. (-) The old traditions are not as important as before. I don't use trees much for cultural purposes. People are leaving the old traditions behind. I don't use it a lot. As a Christian, I don't use any tree for traditional practices. Personally, it is not important. I never use trees for traditional purposes. I don't believe in old traditions; it is not important. The old traditional are not in line with my religion, these rituals are not needed.	(+) Trees are important for the culture. Shrines are always located where there are large old trees. Specific species are essential when performing cultural practices and ceremonies. Items made of specific species have to be present when important ceremonies are held, like blessings, marriage, initiation of boys and childbirth. The old traditions are important for identity, they have been passed on from the ancestors. It would be dangerous if the trees were not there, ceremonies and traditions would not be possible to perform in the right way. Ceremonies need to be performed in the shade, for that reason large old trees are important. Large old trees are places for prayers, if you cut them without permission, you will get mad. Cultural practices are important for a meaningful life. The old traditions make people happy. Ritual foods from trees are used in many ceremonies, like initiation of boys. The cultural practices unite people and is important for the identity of the different clans. Women from specific clans use necklaces made of seeds from Ekorete. Bark from specific trees is tied around the wrists, neck and waist of small children, for protection. All the old traditions involve trees, there would be no culture without. The gods live in the old trees. All people have important items made of local trees that they bring for ceremonies, women and men have different items that they need to bring. (-) Today the old traditions are not as important as before, it is a new era.
Erosion control	(+) Both planted trees and dead branches and logs can be used to stop water flow. Almost all trees are good for erosion control. The trees protect the soil from being transported away with the water. I protect the trees that are good for erosion control. Trees are planted to stop gully erosion. After planting trees along ridges to stop water flow, my farm has recovered. Without the trees the erosion would be much more severe. Without the trees the land would be bare and eroded.	(+) All woody species are good for erosion control, trees reduce the speed of water. Without trees and shrubs, there would be a lot of gullies. I planted trees to reduce the speed of water, it works well. Dead logs can be used to stop water flow. Trees protect the riverbanks. When trees are enough, erosion is controlled. We plant trees across the direction of the water flow, both in the garden and in the compound, it is the best way to stop erosion. Trees protect ponds. I have

	Thanks to the trees in the live fences, erosion is not a big problem. Tree cover in general is important for erosion control, especially the trees with large root systems. Without the trees the topsoil with all the nutrients would be washed away from the farm. Trees are planted where erosion is a problem, to heal and prevent more erosion. When I sees that an area is eroded, I plant trees to stop it. They used to have gully erosion in the area, but now they have enough trees. In the eroded areas they put seeds of Tuyunwo, it will bind the soil. Areas with many trees are less eroded, the trees add texture to the soil and increase soil fertility. Trees along the river protects the riverbank. I take seedlings and plant in eroded places. (-) There is not a lot of erosion in the area. The tree cover is not enough here to stop erosion. More trees are needed. Sometimes trees are not enough to stop erosion, also other methods might be necessary.	planted many different species of trees in places where there is a problem with erosion, also along the river. Trees in the garden protects the crops, they are planted along the boundaries. Enough trees hold the soil. Live fences reduce the speed of water and protects the crops in the garden. I cut branches from trees and use it to stop water flow. It's good to pile thorny branches around the garden, it stops the water better than live trees. The only tree that can stop erosion is Sisal. It is not possible to stop erosion without trees. Only shrubs can stop soil erosion. Trees in the garden protects the fertile topsoil and keeps the moisture in the ground. (-) The trees are not enough, more trees are needed, but not many people plant them. Erosion is not a big problem in the area. Erosion can be controlled by digging ditches and put stones in it, it is more common. Where there are many trees there is more erosion, just look at the riverbanks. Heaps of grass is used to stop erosion. I don't use trees for erosion control but I want to learn about it. I have tried to plant trees, but they died. When the trees are few, they have no effect against erosion. Plant residues, like sorghum stocks is the best way to stop erosion. Trees and shrubs cannot stop erosion. Trees can only be used to redirect water, not to stop erosion. Erosion is a problem in the area, but I am not doing anything to stop it. I only use plant residues to stop erosion. I only plant aloe vera to stop erosion, it helps.
Fences	(+) It helps to take care of the land. It stops animals from entering the homestead and garden. It protects the crops. It protects you from thieves and animals, both wild and domestic. It can be used to protect the pastures. Grasslands are preserved by restricting animals from grazing for longer or shorter periods of time with the help of fences. It is important for demarcation. It is important for protection; it is a security for the family and animals. It	(+) Fences protects the crops from thieves and animals. Fences keeps you safe from enemies. Fences are important for demarcation. It is important for security; it protects the home. It beautifies the compound. It is a way to avoid land conflicts. Fences keeps you safe at night. Live fences are planted by the bore hole. Live fences last longer but is more difficult to establish. Dead branches can be used to close the gaps in live fence.

	keeps the animals in place. Keeps other people's animals away. Keeps animals and people from trespassing. Helps to avoid conflicts with neighbors. Dead fences are changed every year and can be used as firewood. Live fences last longer and add beauty. There would be no crops without fences. A fence helps to stop water flow and prevents erosion. When you plant something, you need to fence it to protect it from grazing. Thorny branches make good dead fences. (-) Barbed wire is much better, it takes skills to make a good fence, it's difficult. It is possible to manage without fences if you must. Live fences are difficult to establish in dry areas.	Fences protects the livestock from thieves and wild animals. The fence around the house gives you more privacy, it is also good for shade. When enemies come, you will be prepared, it takes time to break through the fence. Fences are a symbol of home, when you are behind the fence you know that you are home. The fence helps keeping you warm at night. Fences act as windbreaks. It prevents the livestock from running off. Fences protects human lives. Fences controls the movement of animals. When people migrate, they bring seeds and cuttings from live fences to the new place. To be able to fence your home brings you pride, it is offensive to destroy someone's fence. The government promotes live fence, it keeps people from cutting trees. Fences keeps the animals safe in the Awi (livestock camp). You will wake up from the noise, of someone tries to break in at night if you have a good fence. You feel more at home when you have a gate to close. (-) People have to walk far to get fencing material. The species used for making dead fences grow very far. I tried to plant live fences, but it failed. Dead fences only last for a year. Live fences take time to establish, and before they are fully grown it is easy to break through if you don't enforce it.
Fibers	(+) Ropes made of local species can be used to carry water, firewood and to tie animals. I always use local ropes, you can't carry anything without it. Fibers can be used to make brooms. I use homemade brooms every day. I always use locally made ropes for house construction. Locally made ropes are important for construction and thatching. Threads made of fibers are used to decorate the calabash. Making ropes for sale generates important income. I use mostly ropes that are made from local species. Locally made ropes are used to hang things like beehives in a tree. Fibers can be used to make baskets. Fibers can be used for cleaning things like a calabash. You	(+) Fibers from trees are used for tying houses and fences. They are essential for construction and thatching. Fibers from local species are the only ropes, there is no other alternative. Homemade ropes are used to tie granaries, they are like the "nails". The inner part of the bark has the best fibers. Homemade ropes are important for tying animals. Ropes are also important for tying firewood. Homemade ropes are used during pruning of trees. These species are essential, people depend on them for tying. Fibers are used for making winnowers. These species are easily accessible. I sell ropes sometimes. Fibers from specific species can be

	can make ropes that helps you to carry heavy loads. The species for making ropes are always available when you need to tie something. Either you make ropes or you buy from neighbors. The women make ropes from fibers. I make brooms to sell from local fibers. (-) Ropes can also be made from old plastic sacks. I usually buy ropes from town I likes plastic ropes. I never use homemade ropes I always buy from town.	made into threads, these can be used for mending shoes. You cannot do anything without these fibers. I use homemade ropes to tie kids in the shade. Fibers from specific species can be used for scrubbing. Fibers are used for tying the yoke to the ox when ploughing. I use homemade ropes or buy from neighbors. I only use locally made ropes. Fibers are used when making necklaces. There would be no house without these fibers and people would be living like animals. (-) The best species for tying is found in the bush, they are far. Polyethene bags can be used for making ropes as well. Because of the raids the places where the best species are found cannot be accessed. There are other alternatives for tying. Ropes can be used by people who wants to commit suicide by hanging, that is worrying. Ropes can also be made from skin.
Firewood	(+) You can't survive without firewood. It is essential for cooking. Nothing can happen without firewood. I always use it for cooking and warming. It provides a source of light. Any dry wood can be used as firewood. No food without firewood. You need it every day. You cannot survive without it.	(+) Firewood is essential for cooking, there would be no food without it. Firewood is necessary for cooking, warming and for light. Both dead and live trees can be used, but people mostly collect dead wood. You can sell firewood to get income. Life would be impossible without firewood. Firewood can be exchanged for other things that you need. Fire keeps wild animals away. Fire is as important as water. The fire keeps you warm at night when you are in the Awi (livestock camp). Fire is used during ceremonies; often specific species are used. All species can be used as firewood. Fire can be used for light signals. After rain, the fire helps you to get warm and dry. Firewood is a gift from god. (-) People walk far to get it, and they have to stay together in a group because of insecurity.
Fodder	(+) Trees provide essential fodder for all animals during dry season. Goats can't survive on grass alone, they need trees. We cut branches from trees for the animals every day during dry season. If you don't have enough trees	(+) During dry season the grass is not always enough. Leaves and pods are harvested and given to the sick and young animals. Even if I only have one cow fodder from trees is important for the community that I am a part of,

	on your land you have to buy fodder from neighbors during dry season. I cut branches for the cows mainly, the goats can manage on their own. All livestock depend on fodder from trees. Cows and sheep cannot survive during dry season if you don't feed them with branches from trees, but maybe goats. Trees provide the most important fodder during dry season. The health of your animals is secured by the trees on your land. It is the only source of fodder during dry season. (-) I buy grass during dry season for the livestock.	therefore it is also important for me. The goats would not survive without the woody species. To have trees means food security for the animals. The animals survive on fodder from trees and shrubs during dry season. Fodder from trees makes the animals strong. The animals cannot survive only on grass. Pods is good for the cows. The goats love seeds from specific trees. Fodder from trees fattens the livestock and increases milk production. Sometimes the herders cut branches from trees for the animals to eat, but usually they feed themselves. This fodder can be medicinal for the animals. The herders shake the tree sometimes, so that the pods fall on the ground. Fodder from trees is also important during wet season. (-) Fodder from trees used to be essential, but now all the animals are gone. During wet season the animals can get diarrhea from eating fodder from trees. Grass is the most important fodder; it is always there.
Food	(+) Food from trees is a big part of the diet during dry season. Children needs vitamins, and exotic fruit trees often fail. Fruits from local species are filling and can sustain you for hours. We don't get other fruits from the local species, they are vital. The family depend on Sokoria (young leaves of *Balanites aegyptiaca*) as a vegetable during parts of the year. We rely on vegetables from trees for 5 months every year. Many fruits from local species can be preserved and stored for later, others are eaten raw. Food from trees is important for food security. Food from trees is an important part of the diet towards the end of dry season. Wild fruits contain important vitamins and is a good lunch when working away from home. The children can go for a full day eating only fruits. Fruits from wild species is very important when in season, constitutes a large part of the diet. Wild food from trees is nutritious and keeps you healthy. Wild foods from trees can be accessed all year around. Without these trees the	(+) Foods from local woody species are very nutritious and filling. These foods are eaten every day during dry season, people would suffer without. It is a major part of the diet during dry season, it is a staple food. Some years these foods are always available. People would die without foods from local trees and shrubs. It is important for food security. It really helps to be able to harvest wild foods during times of scarcity. People walk long distances to get enough food from local woody species. The whole village go together to collect wild fruits in sacks. The children depend on wild fruits a lot. During these times of insecurity, wild foods from trees is even more important than before, it is a backup and it has to be there. The wild food is free, buying food from the market is expensive. Some wild foods from woody plants have medicinal effects and strengthen the body. Seeds can be stored and saved for later. When the crops fail, we depend on wild foods from woody species. Wild food from

	family would go hungry. The children rely on fruits as food when they are out herding animals. Local fruits gives you a stronger immune system. Trees is a reliable source of food. The children eat fruits from the trees most days when they are in season. Sokoria is the main vegetable during dry season, without it they would sleep hungry. (-) The season for Sokoria is short. Food from trees is not available throughout the year, only when in season. Food from trees is not an absolutely essential part of the diet. Foods from trees is not a staple food. It is not a large part of our diet. It is seasonal, sometimes it is a lot, and sometimes it is nothing, it is not reliable.	trees is a staple food for the herders, when they are away from home. It is tradition to eat food from trees and shrubs, it is part of the culture. Wild fruits and seeds are good food to serve visitors. Leaves from some trees can be dried and stored for later. (-) It is just a supplement; you need other foods as well. They are only available when they are in season. Some years it is not a lot of fruits. People have to walk far to access these foods. It is not safe to send the children to collect fruits anymore, they will be chased by enemies. The places where we used to go to collect these foods is not safe anymore. It is not tasty, I only eat it because of huger.
Food preservation		(+) Fruits and seeds are pounded, dried, and stored in the granaries. Fruits and seeds are mixed with things like meat, butter, white ants, and honey, and can be stored for months. Food from local trees is emergency food. Preserved food with fruits and seeds from local trees is good, it can be served for guests. Most people preserve food from trees, they harvest a lot when the right species are in season. To preserve food from trees is important for food security. Preserved food is an important part of the culture, it has been used for generations. Bark from a specific tree is used when making butter. Ash from a specific tree can be mixed with milk to make it last longer. Some preserved foods are important during ceremonies, it has to be there. Some species can be made into a powder that acts as a preserving agent. Smoke from Ebobore is used to sterilize food containers, that makes food last longer. Roots and seeds from specific woody species are used to solidify milk or make it sour. Preserved food from trees can be given as a gift if you need blessing from an elder. (-) I don’t preserve food. I only eat fresh food.

Handcraft material	(+) We use wood to make furniture and beehives. Local wood is cheap to use, and it is always available when you need it. I use local wood to make necessary items. I preferer to use wood, rather than plastic. You can make things to sell from wood and get income. You can make the things you need from local wood. I use wood to makes necessary items for the household. The material from local trees is cheap, and the quality is good. I use items made of local wood every day. When someone in the family needs something, the neighbor makes it from wood from their land. We save money by making things from local wood. Even the items you buy from the market is made from local trees. I make chairs and stands for selling fruits from wood. In the home we have chairs, benches, and a plough made of local wood. We have chairs and a table made of local wood. Many species can be used as handcraft material. I use local wood to make water containers and feeding troughs for the animals etc. You can make toys for the children from local wood. (-) Handcrafts and handcraft material can be accessed from other sources. I don't have a lot of items made of local wood. You can buy handcraft material, but it's better to use your own. You can also buy the things you need; they don't have to be made from local wood.	(+) Things used for cooking, like food bowls and mingling sticks are made from local wood. Handcraft material from local wood is really important. All the men have a stool and a walking stick made of local wood. It is important to have access to handcraft material when you need to make something. Containers for milking are made of local wood. The quality of local handcrafts are better than the things you get from town. From the local wood you can make the things that you need according to your own preferences. Many necessary items in the home are made of local wood. Containers used for storing food are made of wood, with a lid from goat skin. When the items get old, it's easy to make new. You need access to local wood to be able to get all the things you need. Milk needs to be stored in wood containers, it is important for the taste and for the cream to form. It is tradition to make items from local wood. These items are more durable. If you don't have money, you can make what you need from local wood. The handmade items look better. Many items made of local wood are important during ceremonies and traditional practices, some items bring luck when you carry them. Feeding trough and water trough for the animals are handmade from local wood. It is good to have many handmade items at home, and to be well equipped, it gives you status and it shows that you have skills. Toys for the children can be made of wood, like bows and arrows. Many of the things you buy from town is also made of local wood. The food gets spoiled faster if stored in containers from town. You cannot prepare or serve food properly without specific items made of local wood. These items are part of the culture. The men make handcrafts while in the Awi (livestock camp). These materials are easy to access at any time. Access to local handcraft material gives you the opportunity to explore your talent. In

		my clan, local wood is believed to be the best material, they never use anything from plastic. (-) You can also use clay pots and plastic containers. It is better to get the things you need from town. I don't make anything from local wood. It is possible to manage without wood as handcraft material. When you don't have cows anymore, many of the items that used to be important before are useless. I lost everything when I had to abandon my home because of insecurity.
Honey	(+) There will be no honey without the trees. Trees are important both for flowers and nectar, and for making beehives. Medicinal trees make medicinal honey. Honey can be sold to get income. Honey is medicine and food for children. Honey is used as food and medicine. I have no hives but get honey from the neighbors. Honey is important medicine for children, it supports digestion and prevents and heals fractured bones. Honey is important for the children's health. People in the area use a lot of honey. Many people have hives. When you don't have you need to buy. Honey is used to make local brew. Honey treats dizziness. Honey is essential for its medicinal properties. Honey treats fever in cows. Honey makes food tastier. Most flowering species of trees are good for the bees. Honey can be used to treat chest pain. It is good to eat honey as a way to stay healthy. You can sell beehives to get an income. I buy local honey. Honey can treat constipation. Honey is medicine for heart pain and sore tong. Honey treats stomach pain and skin burns. It is the only medicine for source in the mouth. (-) I don't use it much. I like honey, but I don't depend on it. It takes time before you can harvest, and sometimes harvest fails.	(+) Without the trees there would be no bees. Honey is used as medicine to treat cough, hepatitis and chest problem in children. It is good food. It has medicinal properties also for adults. I really love the taste of honey. Honey treats chest problems and pneumonia in children better than the medicine from the health clinic. Most flowering trees give good honey. Honey is used for preparing traditional food. If you don't have honey, you can access from neighbors. It is common to collect wild honey from the bush. Honey can be mixed with vegetables and other foods for better taste. Honey prevents disease and keeps the children away from the hospital. If you get enough honey, you can sell the surplus. Honey is used for making local brew. Homemade beehives are made of wood. Honey can be used as sweetener in tea. Honey is used as a preserving agent. Wild bees often live in old, hollow trees. Bees get nectar from medicinal trees, that gives the honey medicinal properties. Honey is important in specific traditional ceremonies. (-) It is difficult to harvest honey from the bush, because of insecurity these days. Honey is just a supplement. Bees might force people to move if they come to your house. I never use honey. You can get used to living without honey when it is not there. I rarely get honey nowadays. The hives cannot be accessed because of insecurity. My

		hives were stolen. Some people get sick from taking honey.
Hygiene	(+) We always use twigs from trees as toothbrush. Twigs is an effective way to clean the teeth. Many toothbrush trees have medicinal properties. The market is far, and local trees provides just as good toothbrushes as the once you can buy. Trees provide the only toothbrush; it is essential for gum hygiene. Toothpaste is not available in the villages. Toothbrushes from trees work better than the once from the shop because they have medicinal properties. I use toothbrushes from trees daily, don't know another way to clean the teeth. I get soap from specific trees when financially pressed. I use soap from trees when there is no other option. The toothbrush made from twigs is always available, and you can always afford it. The twig toothbrush gives the mouth a nice smell. You don't need water when you use the twig toothbrush. (-) Twigs can be used to clean the teeth, but it is possible to manage without. It is not essential.	(+) Some species of trees and shrubs can be used in the bath for good smell. The trees used as toothbrush is always there free of charge. When there is no money, some trees can be used to produce soap. Some of the trees used for making a toothbrush is medicinal. Your mouth will smell nice when you use the local toothbrush, and your teeth will look smart. In the Awi (livestock camp) there is no soap, there the only soap you get comes from woody plants. Hygiene products from trees are important for you to stay healthy. I use a twig toothbrush every day. I always use toothbrushes from twigs, there is no other option. I always make soap from woody species. If you mix the wood-soap with normal soap, it will be more effective. Even people in town prefers to use the twig toothbrush made from local species. There is no other alternative to toothbrush than twigs. (-) I always buy modern soap.
Local climate	(+) Trees are very important for shade. Trees are important as wind breaks. All species can be good wind breaks. Trees makes the climate better. The climate would be very difficult without the trees. The trees have to be there. It is not possible to remain without shade. Trees are important for temperature regulation. Trees attract rain. Trees provide shade for the animas. Trees protects the house from strong wind. It is important to have trees around the home, they give shade and fresh air. Trees in the garden protects the crops from strong wind. The evergreen trees are the best. Trees attract rain. (-) It is possible to get shade without trees.	(+) All tree species are good for improving the local climate. Shade rom trees is important when you need to rest, it makes you feel fresh. Trees protect the house from wind. Trees attract rain. Trees regulates the sun and the wind. Without trees there would be no cool breeze, and the temperature would be too hot. Trees blocks the wind. Without the trees it would be too hot and dry. Trees are not cut around the homestead, they regulate the temperature, generates fresh air, and attract rain. Without trees there would be no rain. It is more comfortable to stay where there are trees. You need trees to have somewhere to relax when you take a break from the work on the fields. Too much sun and wind, causes discomfort and disease. The elders pray that the trees will continue to be there. You will not be as tired from walking if you walk where there are

	enough trees. Large trees are the best trees for improving the local climate. Where there are no trees, the wind brings dust and sand in the air. I spend most of my time in the shade of the trees during daytime. All trees are good for shade. I take care of seedlings to make sure that the trees are enough around the house, and in the garden. I planted Neem trees by the house. Both people and animals depend on shade from trees. It is good to protect the trees that are close to the village. The trees will protect the children from being sunburned. (-) Trees have no effect as wind breaks. The trees are not enough to attract rain and act as wind breaks. Trees will only attract rain if they are many. Trees create more wind. The trees are not enough to create a good local climate, people need to plant more. Trees can attract lightening.
Meeting places	(+) Young couples meet under trees during courtship, it gives them privacy. Community meetings and discussions are held under large trees. When you plan a gathering of people you always ask for a place with trees, where people can sit in the shade. The trees help gathering people by providing good shade. When you have visitors, and you don't have enough space at home, you can take them to the shade of the trees. The men gather in the shade of the trees outside the village gate. The large trees provide a space for all in the shade when important information has to be shared. Conflicts are solved and thieves explain themselves under the trees outside the village. There are no halls for community meetings here, like in the city, we use the trees as meeting places. Old people are placed in the shade of the trees, it would be a punishment to let them sit in the sun. No one would come to a meeting if it was held under the sun. People play games in the shade of trees during free time. Women sit together under the trees while they work during the day.

		There are specific places with trees for community meetings. To arrange meetings under trees makes it easy to join in, and everyone will know about it. The houses are small, but the large trees give room to many people. Children meet to dance and play in the shade of the trees inside the village. Both men and women can meet in the shade of trees outside the village to discuss private matters, without anyone else listening. The air is fresh and cool in the shade of the trees, it is more comfortable to meet there. Men gather under the trees to drink and share important ideas. The trees can be a place to have a business and sell things. During celebrations, men and woman can be separated under different trees without disturbance.
Medicine	(+) Traditional medicine is often made from different parts of trees and shrubs, often bark or roots are used. I mostly use medicine from local species, I almost never go to the hospital. Medicine from trees and shrubs are used as first aid. The traditional medicine from trees really helps people. I consult a local herbalist when there is a problem. We always try traditional medicine first, if the problem persists, we go to hospital. Sometimes the hospital cannot treat the problem you have, but traditional medicine can. Traditional medicine works preventively if you take it. The traditional medicine is always available when you need it. It is cheap. Traditional medicine from trees and shrubs is a backup when the hospital can't help. Traditional medicine works better and faster than medicine from the hospital. Sometimes you don't have enough money to go to the hospital. Traditional medicine is better for long-term treatment, you can continue the treatment after you get back from hospital. (-) Sometimes the traditional medicine is not enough, and you need to go to the hospital to get help. The hospital and pharmacy are usually enough, then	(+) Traditional medicine is mostly made from trees, from the roots and the bark, and sometimes from seeds or leaves. The traditional medicine is cheaper than going to the health clinic. When you are in the Awi (livestock camp), there is no other option. Traditional medicine is always used as first aid. Some conditions can only be treated with the traditional medicine. Usually, the animals are treated with traditional medicine, it is too expensive to take them to the veterinary. Drugs from the pharmacy don't work well, the traditional medicine works better. I don't like the health clinic, I only go there if the traditional medicine cannot help, and the problem persists. The traditional medicine works faster and is easier to access. Just until recently, the traditional medicine was all that we had, people are more used to it. Traditional medicine is just as effective as drugs from the pharmacy, and it is free. The traditional medicine can help you until you are able to reach the health clinic, or till you have enough money to pay for the treatment. Problems caused by witchcraft can only be cured with traditional medicine. Both the

	you don't need the traditional medicine. We cannot depend on traditional medicine entirely. I never use traditional medicine.	medicine from the health clinic and the traditional medicine is equally essential. People would die without the traditional medicine. There is a local herbalist in the village that can be consulted. The health clinic is too far. Traditional medicine is what keeps you alive if you get sick and don't have money to go to the health clinic. Sometimes they advise you to use traditional medicine at the health clinic. (-) Some conditions can only be treated at the health clinic. I never use traditional medicine. I always go to the health clinic first, before I try something else. Some of the species used in traditional medicine are very far. I prefer to go to the health clinic, the traditional medicine is very bitter. I go to the veterinary when the animals are sick.
Pest control	(+) Some species keeps snakes away, it really works. Specific species with thorns keeps snakes away, but it does not always work. I plant specific species to keep snakes and other bad animals away, it works well. (-) I never use trees and shrubs as pest control. Specific species can be used to keep snakes out, but only if you have enough.	
Protection and shelter		(+) Trees provide shelter from rain when you are away from home. You can escape wild animals if you climb a tree. When you walk in the bush, and see an enemy approaching, you can hide among the trees and shrubs, and let him pass. Trees gives you privacy when you ease yourself. Trees gives the animals shelter from rain. When you walk far, the trees provide a place to rest in the shade. When you work outside the village, you can take a break in the shade of a tree, and if you leave your water there it will stay cool. The trees can save your life; if you meet enemies in the bush they give you a chance to escape. Trees and shrubs makes it easier to hunt, the pray will not see you. You can hide the

		livestock from raiders in the bush, they will not be able to take all if they are scattered. If you are chased by enemies, you can hide among the trees in the bush. In the bush you can be left alone, with no interference from other people. Without trees you have to depend on the mercy of God to keep you safe when you are away from home. You can hide behind trees and shrubs from dangerous animals, like hyenas. Where there are no trees, you are exposed to danger. (-) When there is lightning, it is dangerous to shelter under a tree. When there is strong wind, the tree can fall on you. Trees are not enough to protect you from rain. If the enemy sees you first, it is dangerous, the trees will enable him to sneak up on you. You should not hide under a fig tree, they harbour ghosts.
Soil fertility	(+) I put leaves from trees in the garden as green manure, most species can be used, but Acacia is the best. When the trees in the garden sheds their leaves they fertilize the crops, but there is no active management. Trees have a positive effect on soil fertility. We use farm residues to make compost and spread it on the crops. I make compost, I was educated on this. I use leaves to fertilize the bananas. (-) I never use trees to fertilize anything. We only use animal dung as fertilizer. I put farm residues on the fields, but I was not aware that it could be a fertilizer. It can work, but the leaves are eaten by the animals. I have heard about agroforestry, but I have never tried it.	(+) Leaves from the trees fall on the ground and mix with the sol. The crops grow better where there are trees. The leaves from the trees in the garden fertilises the crops, together with the manure from the cows. Sol fertility will drop if you remove the trees from the garden. I learned about how to cover the crops with leaves and grass for soil fertility at school. More people should have trees in the garden for this reason. I was trained about using compost and mulch by an NGO. The crops grow better when they are covered with residues from charcoal production. The crops will do better if there are trees in the garden. I practice agroforestry in my garden. Trees improve soil fertility by protecting the topsoil from erosion by wind and water. (-) Trees have no effect on soil fertility, only animal manure has. I never use trees, or leaves from trees to improve soil fertility. Tress can help with water retention, but it will not act as fertiliser. I always remove leaves from the garden. The goats eat the leaves from the trees when they fall on the ground. I only keep the trees in the

		garden for shade. I have never heard that woody plants can have an effect on soil fertility. Trees improve soil fertility, but it is not enough, you also need animal dung.
Support economy	(+) To sell products from trees gives an important income. The money can be used to buy a goat if the market price is good, even a cow. Products from woody species can be sold when the family needs money. The income we get from selling products from trees is paying university school fees for my son. (-) I rarely sell anything. I never sell anything from trees.	(+) To sell products from trees is a way to survive. The money can be used to buy food. The money can be used to buy things like clothes, new saucepan, shoes, or books for the children. The money can be used for investments in livestock. You can buy food and necessary items. The money can be used to buy medicine. You don't have to go hungry the days you have something to sell. The money you get from selling products from trees makes it possible to have a more balanced diet, it is important for the children. The men often make handcrafts while in the Awi (livestock camp), and sell on the market. During times of scarcity, it is good to have something to sell. It is not possible to support the family without these money. The money can be saved as a security, or for future investments. This income is essential. These money is the only source of income. The money can be used to buy medicine for the animals. Most of the things the family owns comes from these money. (-) Because of insecurity it is difficult to go and make charcoal to sell. It is difficult to harvest honey from the bush, because of insecurity. I used to sell things, but not now. I never sell anything that comes from woody species.
Water retention	(+) Important trees for water retention are protected from cutting. When the river is dry, water can be dug out from the root system of specific trees along the river. These trees are the only source of water during dry season, people and animals depend on them. The water retention trees are the main source of water during dry season. The water retention trees are an important back-up to get water during dry	(+) Where there are trees and shrubs, the ground will stay moist longer. Trees and shrubs prevent evaporation. The grass will stay green longer where there is woody vegetation, the animals can graze there during dry season. Woody vegetation protects the pastures. Surface water will be retained longer where there are enough trees. Where there is trees, it is never completely dry. Seeds and grass can

	season. The water retention trees are important if the bore hole fails to deliver water. The water from the root system of the trees is cold, it is the best water. (-) I never use water from water retention trees.	sprout fast when they are not in direct sunlight. This place would be very dry without trees. The trees retain the water in the river. There would not be enough grass without the woody vegetation. Trees retain water after rain, the ground will retain the moist longer when not exposed to direct sunlight. Shade from trees helps the crops to do well. All woody species are good for this purpose. Trees makes the soil more productive. The grass grows tall under the trees and can be harvested for thatching. Where the trees are is where the herders take the animals to graze. More trees should be planted for water retention. Trees retains water and keeps the landscape green. (-) The trees are not enough for water retention. Where there are trees and shrubs, there is also snakes.
Wildlife	(+) Trees protect wild animals like antelopes and rabbits, and are the homes of insects that can be beneficial to people. Antelopes and rabbits can be hunted for food. Trees shelter wild animals like birds. Wild animals add beauty to the landscape. Fruit trees are important food for birds. Trees shelter birds, and the birds can warn us when danger is near, they are like an alarm. There is a lot of wild animals where there are enough trees. Wild animals depend on trees. It is important to have wild animals; the children need to be though about them and to enjoy the nature. It is exciting to see new species of wildlife. To see wild animals brings good fortune. The trees have to be enough to protect the wild animals. God created all animals, they have to be there, but without trees they cannot exist. Wild animals are there for a reason, they should not be disturbed, there are many of them where there are many trees. Wildlife is a sign of wealth. (-) I don't care about wildlife. Wild animals kill the domestic animals, and I would prefer to only have domestic animals. Wild animals destroy crops,	(+) Wild animals are found where there are enough trees and shrubs. The wild animals depend on trees and shrubs. Wildlife provides bush meat and hides. You can sell bush meat. The bush is a hideout for animals, it is so beautiful there. Wild animals are beautiful. I like to hear the sounds of the wild animals in the bush. Animals like birds, can warn you for danger, but they need trees to thrive. The wild animals would disappear without the trees. To see wild animals makes one happy. Skin from wild animals is important during specific ceremonies, like marriage. All the wild animals should be there, they are future references, but without trees they would disappear. It is better to hunt for wild animals than having to kill the domestic once for meat. All animals are part of goods creation and should be protected. Wild animals are just as important as the domestic, we pray in the shrine that the wild animals will keep existing. During dry season, hunting in the bush gives a good food supplement. The wild animals that can be food are good, the others are not important. Wildlife is important for

	they are destructive. Wildlife must be there, but the habitat for them is not enough. Wildlife should only be in parks and protected areas. Most trees have been cleared from the area, and most of the wildlife are gone, but they will come back if the trees come back. Most of the wildlife is gone, now only squirrels and rabbits are remaining. Only the friendly animals should be there.	education and tourism. Bush meat is important food for herders. It is comforting to see wildlife. Where the wildlife is, you know it is safe. The wild animals keep the herders and people who go to burn charcoal company. Bush meat is the most important source of meat. Wildlife is important for the culture. Trees and shrubs give food and shelter for wildlife. (-) The dangerous animals are not good; they should not be there. Wildlife should not be too close to where people live. The wildlife in the bush cannot be accessed because of insecurity. The bush and the wild animals used to be closer before, today it is more open landscape. Many of the wild animals are gone, it used to be more before. Domestic animals are enough, except birds, they should be there. The bush meat is not enough to satisfy you. I never see the wildlife, I am only staying home. Trees attract birds, that feed on crops. Woody vegetation harbors snakes.

SM 5. Likert score based on gender, age, and level of education

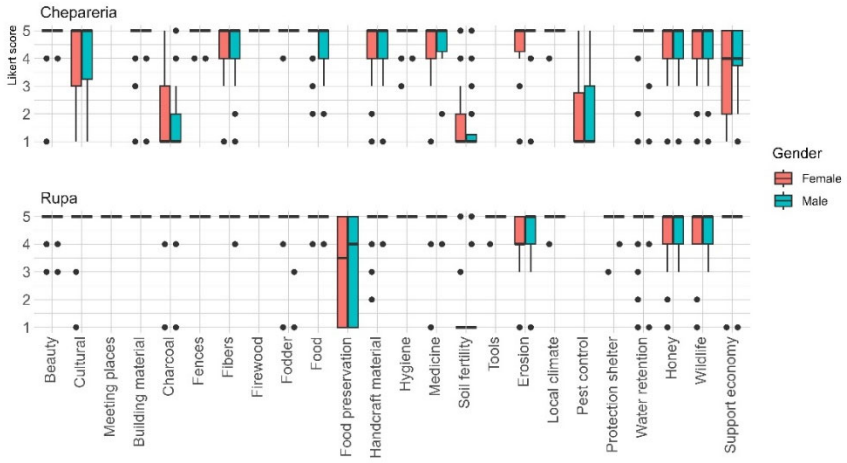


Figure 1. Boxplots (Q1, median, Q3) showing the ranking (Likert score) of each ecosystem service based on gender

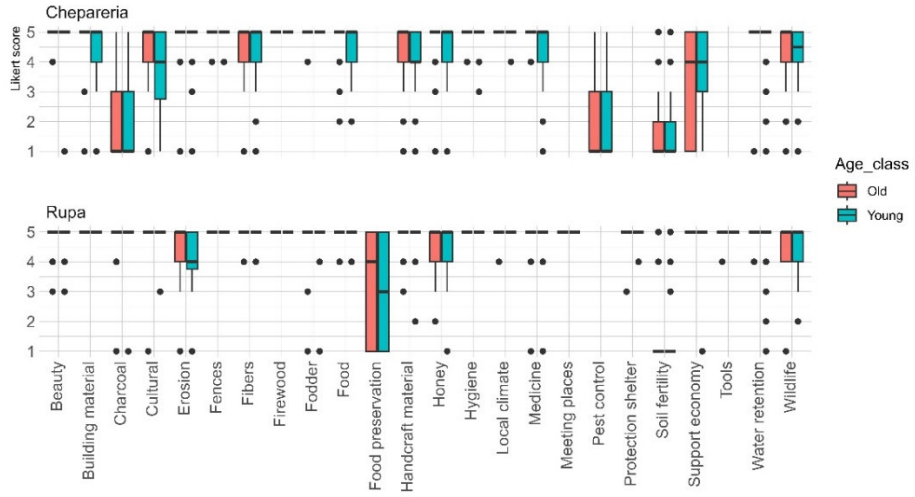


Figure 2. Boxplots (Q1, median, Q3) showing the ranking (Likert score) of each ecosystem service based on age class. Young = < 40 years, Old = >40 years

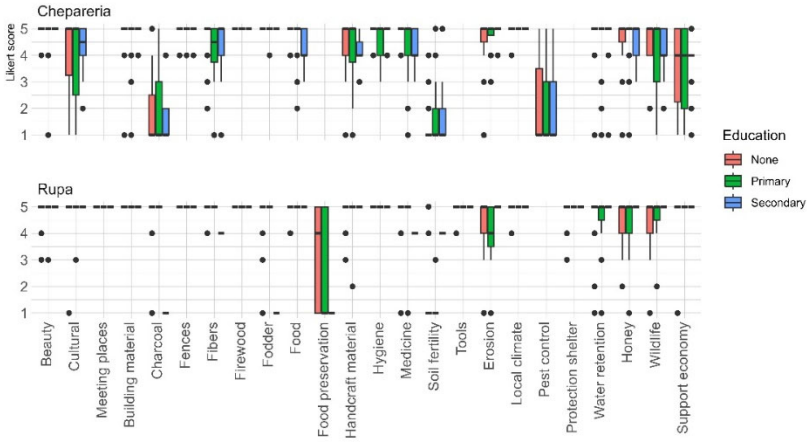


Figure 3. Boxplots (Q1, median, Q3) showing the ranking (Likert score) of each ecosystem service based on level of education

SM 6. Most and least important ecosystem services based on gender, age and level of education

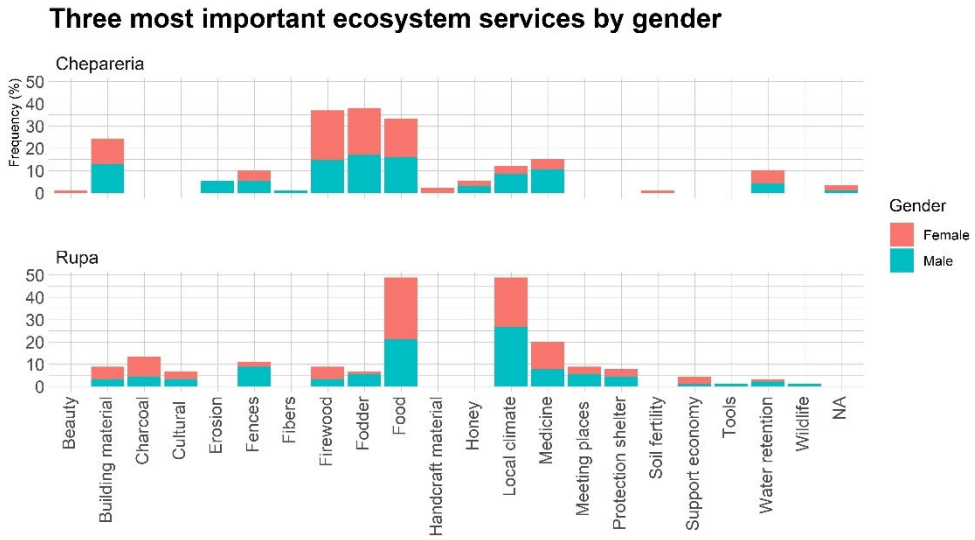


Figure 1. Frequency of responses corresponding to the three most important ecosystem services by gender

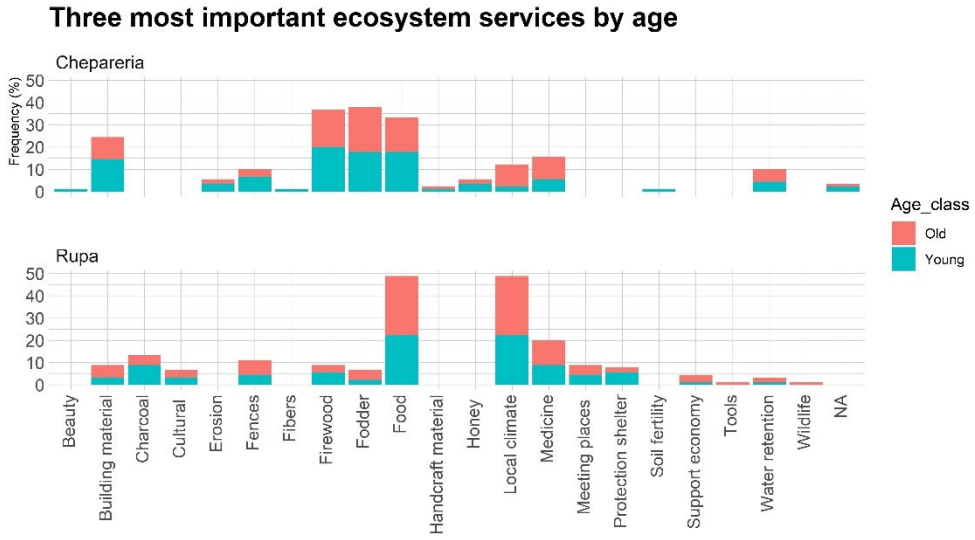


Figure 2. Frequency of responses corresponding to the three most important ecosystem services by age class. Young = < 40 years, Old = >40 years

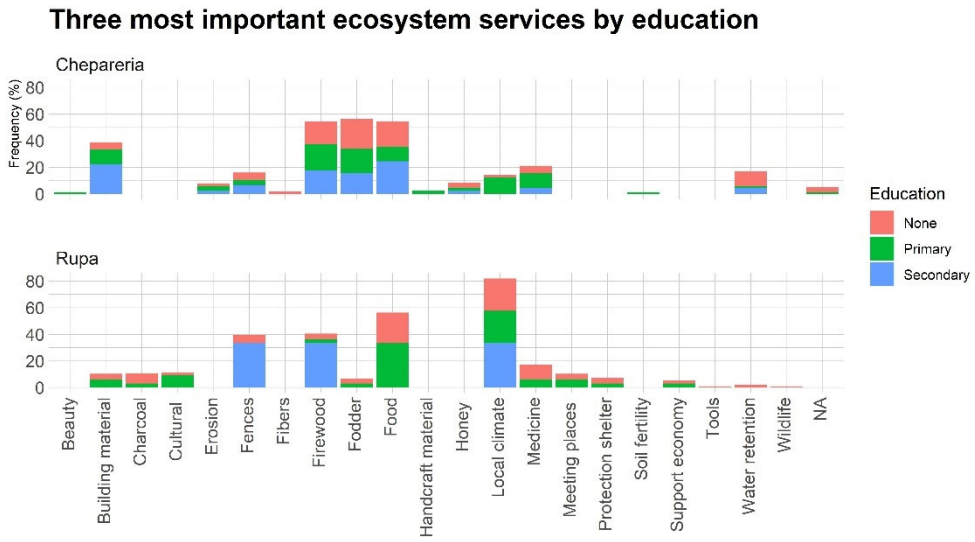


Figure 3. Frequency of responses corresponding to the three most important ecosystem services by level of education

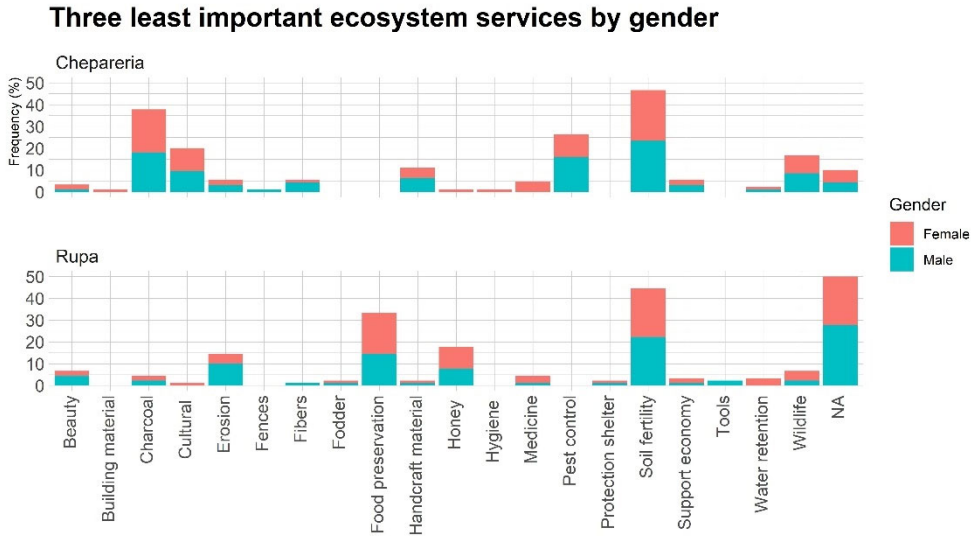


Figure 4. Frequency of responses corresponding to the three least important ecosystem services by gender

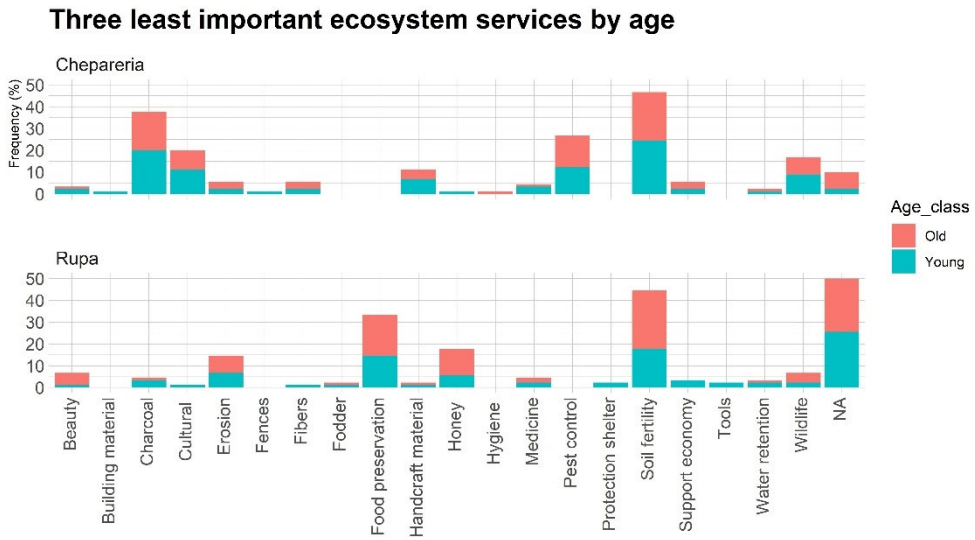


Figure 5. Frequency of responses corresponding to the three least important ecosystem services by age class. Young = < 40 years, Old = >40 years

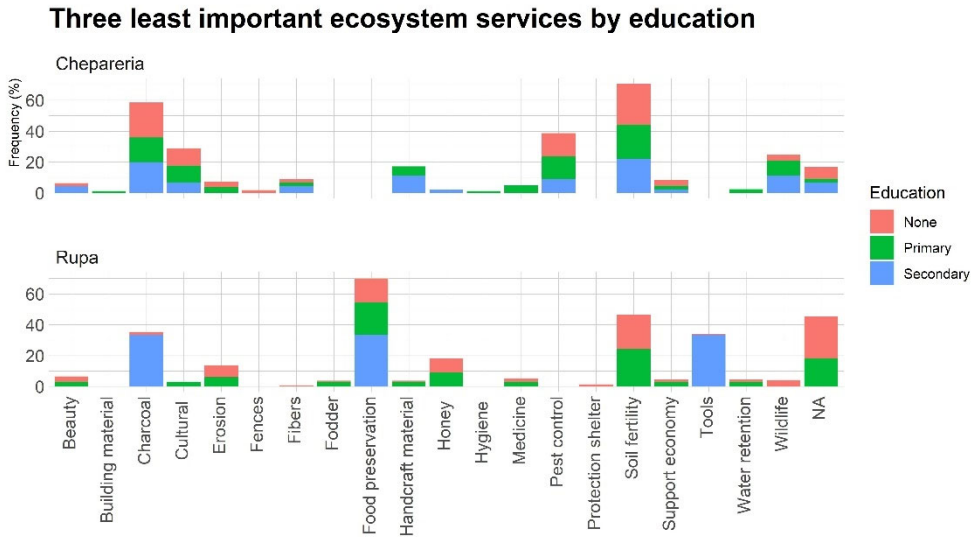


Figure 6. Frequency of responses corresponding to the three least important ecosystem services by level of education

SM 7. Complete species list with local and botanical names

Table 1. Species list with scientific and local names mentioned as important during individual interviews in Chepareria and Rupa.

Scientific name	**Local name Chepareria**	**Local name Rupa**
Abutilon hirtum		Ekwanga
Acacia abyssinica	Tikwo	Eminit
Acacia brevispica	Ptarin	Akurao
Acacia drepanolobium	Sitowonyon	Eyelel
Acacia etbaica	Tingwo	
Acacia gerrardii	Chesams	Enyathan
Acacia hockii	Chuwuw	
Acacia mellifera	Talamoghion	Eregae
Acacia nilotica	Kopko	Ekapeliman
Acacia nubica		Epetet
Acacia reficiens		Anywa
Acacia senegal	Panyirit	Ekodiokodioi
Acacia seyal	Rena	Ekaramwae
Acacia sp.	Sakoarumwo	
Acacia tortilis	Ses	Eeoi
Acalypha fruticosa	Kembirwo	
Achyranthes aspera		Lokiriketa
Acokanthera schimperi	Kolion	
Adenium obesum		Aparutakwee
Agave sisalana	Makonge	Amojo
Alantsilodendron pilosum	Tiyin	Etirae
Albizia amara	Akwakwa/Panan	Ekwakwa
Albizia coriaria		Ekapangiteng
Any species used to light fire		Epipiot
Any thorny species	Sangak	
Aspilia mossambicensis		Ekuyon
Azadirachta indica	Mwarumbaini	
Balanites aegyptiaca	Tuyunwo	Ekorete
Balanites rotundifolia		Ebei
Barleria acanthoides	Kelkela	Emekui
Berchemia discolor		Emanyan
Boscia angustifolia	Likuon	
Boscia coriacea	Sarach	Eedung
Bougainvillia sp.	Bougainvillia	
Cadaba farinosa		Erereng
Calotropis procera		Epuu

Capparis fascicularis		Ekadeliwai
Capparis tomentosa		Eduel
Carica papaya	Powpow	Papaya
Carissa spinarum	Lakatetwo	Ekamuriai
Cascabela thevetia	Yellow oleander	
Casimiroa edulis	White Sapota	
Chasmanthera dependens		Lodwar
Cissus quadrangulari		Egigith
Cissus rotundifolia		Emoroth
Citrus x aurantium	Orange	
Coleus barbatus	Angurwo	
Combretum pisoniiflorum	Cheprosto	
Commiphora africana	Katagh	Ekadeli
Commiphora sp.	Chitchit	
Cordia monoica	Chukurtutwo	
Cordia sinensis		Edome
Crateva adansonii		Eyoloit
Croton dichogamus	Kerelwo	
Croton megalocarpus	Korrelach	
Cupressus sp.	Cypress	
Dichrostachys cinerea		Atirai
Dodonaea viscosa	Topolokwo	
Dovyalis caffra		Ekaburu
Dracaena angolensis	Sorokit	
Dracaena conspicua	Ewak	
Erythrina abyssinica	Korkorwo	
Eucalyptus camaldulensis		Aforester
Eucalyptus sp.	Eucalyptus	
Euclea divinorum	Cheptuya	
Euphorbia bicompacta		Ejuluma
Euphorbia candelabrum	Kreswo	
Euphorbia gossypina		Echogorom
Euphorbia heterochroma		Echorokongu
Euphorbia murielii		Epopong
Euphorbia nubica		Emus
Euphorbia ridleyi	Rerondo	
Euphorbia sp.		Lokile
Euphorbia tirucalli	Tumwon	Eligoi
Euphorbia trigona	Matokorwo	
Fagaropsis angolensis		Ekekeriate
Faidherbia albida	Adurkoit	Edurukoit
Faurea sp.	Mturwo	
Ficus natalensis	Cheptimonwo	

Ficus sp.	Nyorpotwo	
Ficus sp.	Poywto	
Ficus sp.	Siyoyowo	
Ficus stuhlmannii	Sosotwo	
Ficus sycomorus	Mokongwo	Ebobore
Ficus thonningii	Simotwo	
Ficus unspecific	Ketpcho	
Flacourtia indica	Tingoswo	
Gardenia ternifolia		Ekore
Gloriosa superba		Lokeretin
Grevillea robusta	Grevellea	
Grewia bicolor	Sitet	Ekaliye
Grewia tenax	Taran	Engomo
Grewia villosa		Epongae
Gutenbergia cordifolia		Ekoutapem
Gymnosporia senegalensis	Karwakwarian	
Haplocoelum foliolosum	Moriokwo	
Harrisonia abyssinica	Mokurkong	Ekere
Hibiscus micranthus		Adupamal
Ipomoea kituiensis		Elamach
Jatropha pelargoniifolia		Ebul
Kigelia africana	Rotin	Edodoi
Lannea fulva	Lolotwo	
Lannea humilis		Etopojo
Lannea schimperi	Cheprukwa	
Lannea triphylla	Tapoyo	
Lantana camara	Lantana	
Leptadenia hastata		Ekamongo
Lippia carviodora		Ekur
Maerua decumbens		Eerut
Maerua triphylla		Eyarabosi
Mangifera indica	Mango	
Marsdenia rubicunda		Lokakwan
Melia azedarach		Elira
Mimusops andongensis	Murkutwo	
Mimusops kummel	Poshon	
Olea europaea subsp. cuspidata	Yemtii	
Ormocarpum kirkii	Kamaran	Etheperwae
Ormocarpum trichocarpum		Eseperwuai
Ozoroa insignis	Kromwo	
Pappea capensis	Priokwo	
Persea americana	Avocado	

Phoenix reclinata	Sosion	
Pittosporum ellipticum	Chelewew	
Pleurostylia africana	Apele	
Plumbago zeylanica		Eteteleit
Rhoicissus tridentata	Turotwo	
Ricinus communis		Ebune
Rubus pinnatus	Monmon	
Saba comorensis		Ekimune
Salvadora persica	Asekonion	Ethiokan
Sclerocarya birrea	Arolwo	Ekajikait
Searsia natalensis	Siriowo	Ekadetewa
Senna didymobotrya	Senetwo	
Senna occidentalis		Etiatia
Senna siamea	Egathiya	Egathiya
Senna singueana	Chepkobil	
Sesbania sesban	Sesbania	
Solanum incanum	Lopotwo	Etulelo
Steganotaenia araliacea	Chekwo	
Strychnos spinosa	Kukuwo	Aturukethoit
Syzygium cordatum	Reperwo	
Talinum caffrum		Ekuri
Tamarindus indica	Aron	Epeduru
Terminalia brownii	Koloswo	Epie
Terminalia neotaliala	Umbrella tree	
Urochloa brizantha		Elet
Vangueria infausta	Komolwo	Alamarukara
Vangueria schumanniana		Epodo
Vangueria volkensii	Tapirpirwo	
Vepris glomerata	Manapelion	
Vepris nobilis	Akurion	
Warburgia salutaris		Abwac
Withania somnifera	Kakagh	
Ximenia americana	Kunyotwo	Elamai
Zanthoxylum chalybaeum	Songowo	Eusugu
Ziziphus abyssinica	Angaw	
Ziziphus mauritiana	Akalaleyon	Ekale
Ziziphus mucronata	Tirokwo	
Not identified	Akan	
Not identified	Chemindarotwo	
Not identified	Chepangi	
Not identified	Chepkalowon	
Not identified	Chepkolomot	
Not identified	Cheptapesha	

Not identified	Kabkecheyan	
Not identified	Karamires	
Not identified	Kelekelewo	
Not identified	Kengiswo	
Not identified	Ketpomarcha	
Not identified	Kolokit	
Not identified	Konwo	
Not identified	Koprion	
Not identified	Krendus	
Not identified	Kweit	
Not identified	Malut	
Not identified	Mokugho	
Not identified	Muchua	
Not identified	Mugurswo	
Not identified	Ngurion	
Not identified	Niniya	
Not identified	Paratarit	
Not identified	Parpara	
Not identified	Sana	
Not identified	Sapkwa	
Not identified	Sekonion	
Not identified	Selta	
Not identified		Ablococh
Not identified		Akinmu
Not identified		Akobekobe
Not identified		Akuri
Not identified		Akurukurui
Not identified		Alagoroite
Not identified		Alamaru
Not identified		Alurukethoit
Not identified		Angomon
Not identified		Apodo
Not identified		Apule
Not identified		Aram Tokeni
Not identified		Arengen
Not identified		Aruka
Not identified		Asigiriat
Not identified		Atamarukwa
Not identified		Atheperwait
Not identified		Atuba
Not identified		Auriongo
Not identified		Awapet
Not identified		Ayoloit

Not identified	Echokelite
Not identified	Edongodongomurio
Not identified	Edwar
Not identified	Edwol
Not identified	Eegong
Not identified	Eegong root
Not identified	Eehuehuka
Not identified	Egara
Not identified	Egech
Not identified	Egongot
Not identified	Egothet
Not identified	Ekadomo
Not identified	Ekamit
Not identified	Ekathuru
Not identified	Ekeriaul
Not identified	Ekerri
Not identified	Ekeru
Not identified	Ekicholony
Not identified	Ekile alookon
Not identified	Ekirim
Not identified	Ekleataloko
Not identified	Ekurichanit
Not identified	Elogot
Not identified	Emalitenyit
Not identified	Emudit
Not identified	Emuria
Not identified	Engogoi
Not identified	Epipa
Not identified	Erokon
Not identified	Etamaruka
Not identified	Etethuro
Not identified	Ethegethege
Not identified	Ethiyapot
Not identified	Ewapet
Not identified	Idemwo/Lolemwo
Not identified	Lakakwen
Not identified	Loderekae
Not identified	Lodwee
Not identified	Lomukinei
Not identified	Ngauriong
Not identified	Ngikoli
Not identified	Ngimomwa
Not identified	Ngiroruwa

Not identified	Ngiruko
Not identified	Ngiyan
Not identified	Toto Atekoyo

SM 8. Species list with number of associated ecosystem services

Table 1. Species list with number of associated ecosystem services for Chepareria and Rupa. Only species identified with botanical name is included.

Chepareria		**Rupa**	
Species	*Number of ES*	*Species*	*Number of ES*
Balanites aegyptiaca	16	*Balanites aegyptiaca*	20
Grewia bicolor	14	*Acacia tortilis*	18
Zanthoxylum chalybaeum	14	*Ziziphus mauritiana*	17
Albizia amara	13	*Acacia nilotica*	15
Terminalia brownii	13	*Acacia senegal*	15
Acacia hockii	12	*Ficus sycomorus*	13
Acacia nilotica	12	*Grewia bicolor*	13
Acacia tortilis	12	*Acacia mellifera*	11
Euclea divinorum	12	*Acacia nubica*	11
Ficus sycomorus	12	*Acacia seyal*	11
Ziziphus mauritiana	12	*Commiphora africana*	11
Acacia gerrardii	11	*Melia azedarach*	11
Agave sisalana	11	*Terminalia brownii*	11
Searsia natalensis	11	*Cordia sinensis*	10
Pappea capensis	10	*Lannea humilis*	10
Acacia abyssinica	9	*Albizia coriaria*	9
Acacia senegal	9	*Balanites rotundifolia*	9
Ficus natalensis	9	*Faidherbia albida*	9
Mimusops andongensis	9	*Grewia villosa*	9
Acacia etbaica	8	*Acacia reficiens*	8
Ozoroa insignis	8	*Alantsilodendron pilosum*	8
Sclerocarya birrea	8	*Grewia tenax*	8
Tamarindus indica	8	*Tamarindus indica*	8
Acacia mellifera	7	*Euphorbia nubica*	7
Euphorbia candelabrum	7	*Plumbago zeylanica*	7
Ficus stuhlmannii	7	*Agave sisalana*	6
Croton dichogamus	6	*Cadaba farinosa*	6
Euphorbia tirucalli	6	*Capparis fascicularis*	6
Faidherbia albida	6	*Euphorbia murielii*	6
Haplocoelum foliolosum	6	*Ipomoea kituiensis*	6
Lannea schimperi	6	*Lippia carviodora*	6
Vepris nobilis	6	*Salvadora persica*	6
Ziziphus mucronata	6	*Acacia gerrardii*	5
Acacia brevispica	5	*Albizia amara*	5
Azadirachta indica	5	*Dovyalis caffra*	5

Carissa spinarum	5	*Zanthoxylum chalybaeum*	5
Ficus unspecific	5	*Acacia brevispica*	4
Gymnosporia senegalensis	5	*Berchemia discolor*	4
Acacia seyal	4	*Euphorbia tirucalli*	4
Alantsilodendron pilosum	4	*Jatropha pelargoniifolia*	4
Any thorny species	4	*Kigelia africana*	4
Commiphora sp.	4	*Ximenia americana*	4
Flacourtia indica	4	*Acacia drepanolobium*	3
Kigelia africana	4	*Boscia coriacea*	3
Lantana camara	4	*Cissus quadrangulari*	3
Pleurostylia africana	4	*Gardenia ternifolia*	3
Vangueria infausta	4	*Maerua triphylla*	3
Vangueria volkensii	4	*Ormocarpum kirkii*	3
Acokanthera schimperi	3	*Sclerocarya birrea*	3
Cascabela thevetia	3	*Acacia abyssinica*	2
Coleus barbatus	3	*Adenium obesum*	2
Croton megalocarpus	3	*Barleria acanthoides*	2
Dracaena angolensis	3	*Calotropis procera*	2
Euphorbia ridleyi	3	*Carissa spinarum*	2
Harrisonia abyssinica	3	*Crateva adansonii*	2
Lannea fulva	3	*Dichrostachys cinerea*	2
Lannea triphylla	3	*Euphorbia heterochroma*	2
Phoenix reclinata	3	*Harrisonia abyssinica*	2
Boscia coriacea	2	*Marsdenia rubicunda*	2
Combretum pisoniiflorum	2	*Searsia natalensis*	2
Mangifera indica	2	*Senna siamea*	2
Salvadora persica	2	*Solanum incanum*	2
Senna singueana	2	*Strychnos spinosa*	2
Vepris glomerata	2	*Talinum caffrum*	2
Ximenia americana	2	*Abutilon hirtum*	1
Ziziphus abyssinica	2	*Achyranthes aspera*	1
Acacia drepanolobium	1	*Aspilia mossambicensis*	1
Acalypha fruticosa	1	*Capparis tomentosa*	1
Barleria acanthoides	1	*Carica papaya*	1
Boscia angustifolia	1	*Chasmanthera dependens*	1
Bougainvillia sp.	1	*Cissus rotundifolia*	1
Carica papaya	1	*Eucalyptus camaldulensis*	1
Casimiroa edulis	1	*Euphorbia bicompacta*	1
Citrus x aurantium	1	*Euphorbia gossypina*	1
Commiphora africana	1	*Fagaropsis angolensis*	1
Cordia monoica	1	*Gloriosa superba*	1
Cupressus sp.	1	*Gutenbergia cordifolia*	1

Dodonaea viscosa	1	*Hibiscus micranthus*	1
Dracaena conspicua	1	*Leptadenia hastata*	1
Erythrina abyssinica	1	*Maerua decumbens*	1
Eucalyptus sp.	1	*Ormocarpum trichocarpum*	1
Euphorbia trigona	1	*Ricinus communis*	1
Faurea sp.	1	*Saba comorensis*	1
Ficus thonningii	1	*Senna occidentalis*	1
Grevillea robusta	1	*Urochloa brizantha*	1
Grewia tenax	1	*Vangueria infausta*	1
Mimusops kummel	1	*Vangueria schumanniana*	1
Olea europaea subsp. cuspidata	1	*Warburgia salutaris*	1
Ormocarpum kirkii	1		
Persea americana	1		
Pittosporum ellipticum	1		
Rhoicissus tridentata	1		
Rubus pinnatus	1		
Senna didymobotrya	1		
Senna siamea	1		
Sesbania sesban	1		
Solanum incanum	1		
Steganotaenia araliacea	1		
Strychnos spinosa	1		
Syzygium cordatum	1		
Terminalia neotaliala	1		
Withania somnifera	1		

SM 9. Five most frequently mentioned species associated to different ecosystem services in Chepareria and Rupa

Table 1. The five most frequently mentioned species associated with different ecosystem services

Ecosystem service	Chepareria	Count	Rupa	Count
Beauty				
	Balanites aegyptiaca	22	*Melia azedarach*	3
	Euclea divinorum	11	*Acacia tortilis*	2
	Terminalia brownii	9	*Balanites aegyptiaca*	2
	Acacia tortilis	6	*Ficus sycomorus*	2
	Acacia gerrardii	5	*Ziziphus mauritiana*	2
	No species mentioned	25	No species mentioned	54
Building material				
	Terminalia brownii	46	*Grewia bicolor*	53
	Acacia nilotica	26	*Acacia mellifera*	37
	Acacia gerrardii	15	*Acacia brevispica*	32
	Balanites aegyptiaca	14	*Acacia nilotica*	27
	Acacia tortilis	13	*Plumbago zeylanica*	18
	No species mentioned	4	No species mentioned	1
Charcoal				
	Balanites aegyptiaca	11	*Acacia mellifera*	46
	Acacia nilotica	8	*Balanites aegyptiaca*	44
	Albizia amara	8	*Acacia tortilis*	33
	Acacia abyssinica	4	*Acacia seyal*	27
	Acacia gerrardii	4	*Acacia reficiens*	26
	No species mentioned	43	No species mentioned	7
Cultural				
	Euclea divinorum	38	*Grewia bicolor*	38
	Grewia bicolor	30	*Ficus sycomorus*	25
	Ficus unspecific	11	*Lannea humilis*	19
	Ficus sycomorus	10	*Commiphora africana*	18
	Balanites aegyptiaca	7	*Euphorbia nubica*	14
	No species mentioned	7	No species mentioned	2
Erosion				
	Agave sisalana	29	*Agave sisalana*	12
	Euphorbia candelabrum	13	*Balanites aegyptiaca*	8
	Acacia nilotica	11	*Cissus quadrangulari*	7
	Balanites aegyptiaca	10	*Acacia tortilis*	6
	Terminalia brownii	5	*Dovyalis caffra*	6
	No species mentioned	15	No species mentioned	32
Fences				

	Euphorbia candelabrum	58	*Acacia nilotica*	49
	Acacia nilotica	37	*Acacia tortilis*	48
	Balanites aegyptiaca	32	*Acacia senegal*	43
	Acacia senegal	31	*Balanites aegyptiaca*	43
	Agave sisalana	29	*Commiphora africana*	37
	No species mentioned	0	No species mentioned	0
Fibers				
	Agave sisalana	50	*Agave sisalana*	60
	Grewia bicolor	23	*Acacia nubica*	44
	Lannea fulva	15	*Lannea humilis*	33
	Ozoroa insignis	13	*Grewia bicolor*	24
	Acacia abyssinica	8	*Acacia tortilis*	21
	No species mentioned	4	No species mentioned	0
Firewood				
	Acacia nilotica	24	*Acacia mellifera*	46
	Balanites aegyptiaca	22	*Acacia nilotica*	43
	Acacia tortilis	10	*Balanites aegyptiaca*	30
	Albizia amara	10	*Acacia tortilis*	29
	Searsia natalensis	8	*Acacia reficiens*	20
	No species mentioned	24	No species mentioned	4
Fodder				
	Balanites aegyptiaca	60	*Acacia tortilis*	56
	Terminalia brownii	45	*Faidherbia albida*	39
	Pappea capensis	26	*Balanites aegyptiaca*	32
	Ficus sycomorus	16	*Acacia nilotica*	27
	Grewia bicolor	11	*Ficus sycomorus*	15
	No species mentioned	0	No species mentioned	5
Food				
	Balanites aegyptiaca	62	*Balanites aegyptiaca*	57
	Ximenia americana	30	*Ziziphus mauritiana*	37
	Carissa spinarum	29	*Ficus sycomorus*	36
	Mimusops andongensis	28	*Capparis fascicularis*	29
	Tamarindus indica	22	*Ximenia americana*	29
	No species mentioned	1	No species mentioned	0
Food preservation				
	ES not identified		*Ziziphus mauritiana*	24
			Ficus sycomorus	22
			Balanites aegyptiaca	15
			Grewia tenax	11
			Capparis fascicularis	9
			No species mentioned	23
Handcraft material				

	Grewia bicolor	40	*Ficus sycomorus*	39
	Ficus sycomorus	29	*Commiphora africana*	38
	Euphorbia candelabrum	14	*Lannea humilis*	27
	Sclerocarya birrea	13	*Grewia bicolor*	23
	Zanthoxylum chalybaeum	13	*Albizia coriaria*	15
	No species mentioned	10	No species mentioned	3
Honey				
	Agave sisalana	26	*Ficus sycomorus*	29
	Acacia senegal	24	*Terminalia brownii*	23
	Acacia mellifera	18	*Faidherbia albida*	18
	Acacia gerrardii	13	*Acacia tortilis*	16
	Albizia amara	13	*Ziziphus mauritiana*	10
	No species mentioned	7	No species mentioned	15
Hygiene				
	Euclea divinorum	31	*Salvadora persica*	55
	Balanites aegyptiaca	20	*Cadaba farinosa*	37
	Zanthoxylum chalybaeum	20	*Grewia bicolor*	32
	Searsia natalensis	18	*Balanites aegyptiaca*	26
	Vepris nobilis	17	*Grewia villosa*	23
	No species mentioned	4	No species mentioned	0
Local climate				
	Balanites aegyptiaca	42	*Ficus sycomorus*	21
	Euclea divinorum	20	*Acacia tortilis*	19
	Terminalia brownii	16	*Balanites aegyptiaca*	19
	Albizia amara	12	*Melia azedarach*	13
	Ficus sycomorus	12	*Ziziphus mauritiana*	12
	No species mentioned	7	No species mentioned	30
Medicine				
	Zanthoxylum chalybaeum	52	*Plumbago zeylanica*	24
	Harrisonia abyssinica	22	*Acacia nilotica*	16
	Albizia amara	17	*Balanites aegyptiaca*	16
	Acacia nilotica	15	*Ziziphus mauritiana*	16
	Terminalia brownii	12	*Salvadora persica*	12
	No species mentioned	1	No species mentioned	0
Meeting places				
	ES not identified		*Acacia tortilis*	2
			Balanites aegyptiaca	2
			Acacia mellifera	1
			Acacia nilotica	1
			Acacia nubica	1
			No species mentioned	57
Pest control				

	Lantana camara	12	ES not identified	
	Euphorbia candelabrum	5		
	Agave sisalana	2		
	Euphorbia synadenium	1		
	Euphorbia tirucalli	1		
	No species mentioned	42		
Protection shelter				
	ES not identified		No species mentioned	60
Soil fertility				
	Acacia undefined	1	*Balanites aegyptiaca*	4
	Balanites aegyptiaca	1	*Acacia seyal*	2
	Pappea capensis	1	*Acacia tortilis*	2
	Sesbania sesban	1	*Cordia sinensis*	1
			Ficus sycomorus	1
	No species mentioned	59	No species mentioned	54
Tools				
	ES not identified		*Plumbago zeylanica*	40
			Balanites aegyptiaca	39
			Lannea humilis	27
			Acacia tortilis	25
			Cordia sinensis	14
			No species mentioned	4
Water retention				
	Ficus sycomorus	39	*Acacia tortilis*	1
	Mimusops andongensis	33	*Alantsilodendron*	1
	Ficus unspecific	21	*pilosum*	
	Syzygium cordatum	6	*Balanites aegyptiaca*	1
	Ficus stuhlmannii	3	*Faidherbia albida*	1
	No species mentioned	7	No species mentioned	58
Wildlife				
	No species mentioned	62	No species mentioned	60

SM 10. List of unwanted species

Table 1. Unwanted species with motivations from individual interviews and FGDs in Chepareria and Rupa. Species with a star are species not mentioned, at least once, as one of the 5 most important species for a specific ecosystem service during individual interviews.

Scientific name	Local name	Site	Times mentioned	Reasons for clearing
Acacia brevispica	Ptarin	Chepareria	1	Many thorns, not wanted near the home.
Acacia drepanolobium	Eyelel	Rupa	2	It is not useful and have sharp thorns.
Acacia gerrardii	Chesams	Chepareria	4	Compete with crops. Thorny.
Acacia mellifera	Talamoghion	Chepareria	2	Reduce grass growth in the pasture.
Acacia mellifera	Eregae	Rupa	2	Destroys the pastures, supress other species.
Acacia nilotica	Ekapeliman	Rupa		Thorny, and prevents grass growth.
Acacia nilotica	Kopko	Chepareria	5	Too many thorns.
Acacia nubica	Epetet	Rupa	1	Poisonous, and surpasses other species.
Acacia senegal	Panyarit	Chepareria	4	Very common. Reduce grass growth. Many thorns.
Acacia senegal	Ekodiokodioi	Rupa	2	Destroys the pastures, supress other species.
Acacia seyal	Ekaramwae	Rupa	3	Many thorns, not wanted near the home.
Acacia tortilis	Ses	Chepareria	6	Compete with crops. Thorny. Attracts flies. that spread disease.
Acacia tortilis	Eeoi/Etirir	Rupa	2	Many thorns, not wanted near the home.
Acokanthera scimperi	Kalyong	Chepareria	30	Poisonous to humans and animals.
Agave sisalana	Mokonge	Chepareria	3	Attract snakes.
Agave sisalana	Amojo	Rupa	2	Surpasses other species and harbour snakes.
Alantsilodendron pilosum	Etirae	Rupa	2	Destroys the pasture and is cleared continuously.
Albizia amara	Akwakwa/Panan	Chepareria	4	Competes with the crops.
Any thorny species	Sangak	Chepareria	5	Have sharp thorns, often cleared.
Barleria acanthoides	Emekui	Rupa	1	Poisonous.
**Biancaea decapetala*	Mondore	Chepareria	1	Many thorns, not wanted near the home.
Boscia angustifolia	Likuon	Chepareria	1	Can be poisonous if not prepared right.
Calotropis procera	Epuu	Rupa	23	A weed. Poisonous to animals.
Capparis fascicularis	Ekadeliwai	Rupa	1	Poisonous. Parasite on other species.
Capparis tomentosa	Eduel/Erogorogo wete	Rupa	22	Poisonous, harbours snake, has sharp thorns, and a bad smell.

Cissus quadrangulari	Egigith	Rupa	2	Harbours snakes.
Coleus barbatus	Angurwo	Chepareria	1	Poisonous to animals.
Croton megalocarpus	Korrelach	Chepareria	2	Prevents grass growth. Competes with crops
Dodonaea viscosa	Topolokwo	Chepareria	5	Prevents grass growth
**Datura stramonium*	Monwo	Chepareria	3	Poisonous to people.
Dracaena angolensis	Sorokit	Chepareria	2	Attract snakes.
Euphorbia heterochroma	Echorokongu	Rupa	1	Poisonous to people and animals. Harbours snakes.
Euphorbia candelabrum	Kreswo	Chepareria	3	Poisonous to people. Stains the skin.
Euphorbia murielii	Epopong	Rupa	1	Poisonous.
Euphorbia nubica	Emus	Rupa	2	Poisonous.
Euphorbia ridleyi	Rerondo	Chepareria	2	Poisonous to get in the eye.
Euphorbia tirucalli	Tumwon	Chepareria	2	Poisonous sap. Harbours snakes.
Euphorbia tirucalli	Eligoi	Rupa	2	Poisonous.
Ipomoea kituiensis	Talamach	Chepareria	8	Prevents grass growth in pastures
Ipomoea kituiensis	Elamach	Rupa	5	Poisonous if not prepared right.
Lannea chimperi	Cheprukwa	Chepareria	1	Serves no purpose.
Lantana camara	Lantana	Chepareria	7	Prevents grass growth in pastures.
Maerua decumbens	Eerut	Rupa	1	Poisonous.
Gymnosporia senegalensis	Karwakwarian	Chepareria	1	Prevents grass growth in pastures.
**Opuntia sp.*	Edapal	Rupa	1	Poisonous, and surpasses other species.
Pleurostylia africana	Apele	Chepareria	25	Poisonous to humans and animals.
Ricinus communis	Ebune	Rupa	2	Poisonous.
Sclerocarya birrea	Arolwo	Chepareria	1	?
Senna didymobotrya	Senetwo	Chepareria	1	Prevents grass growth in pastures.
Solanum incanum	Lopotwo	Chepareria	2	Poisonous. A weed.
Terminalia brownii	Koloswo	Chepareria	1	Competes with crops in the garden.
**Trichilia emetica*	Ekuyen	Rupa	3	Poisonous to animals.
**Vangueria rotundata*	Emaret	Rupa	3	Kills animals.
Ziziphus mauritiana	Ekale	Rupa	1	Destroys the pasture, are cleared continuously.
**Not identified*	Echomochomo	Chepareria	1	Poisonous to animals and people.
**Not identified*	Ekaletete	Rupa	7	Poisonous to animals. Burn.
**Not identified*	Ekayot	Rupa	1	Bark poisonous to animals.
**Not identified*	Ekiliron	Rupa	2	Poisonous. Cause skin rash.
**Not identified*	Elit	Rupa	1	Poisonous.
**Not identified*	Emotwae	Rupa	3	Attracts termites that finish it.
Not identified	Enyathan	Rupa	1	?

**Not identified*	Konochon	Chepareria	1	?
Not identified	Lodirekae	Rupa	1	?
Not identified	Lokile	Rupa	1	Poisonus.
**Not identified*	Luma	Chepareria	1	?
**Not identified*	Toto ananya	Rupa	1	Painful to touch. A weed.
Not identified	Trichon	Chepareria	2	?

SM 11. Heat maps based on gender, age, and level of education from Chepareria and Rupa

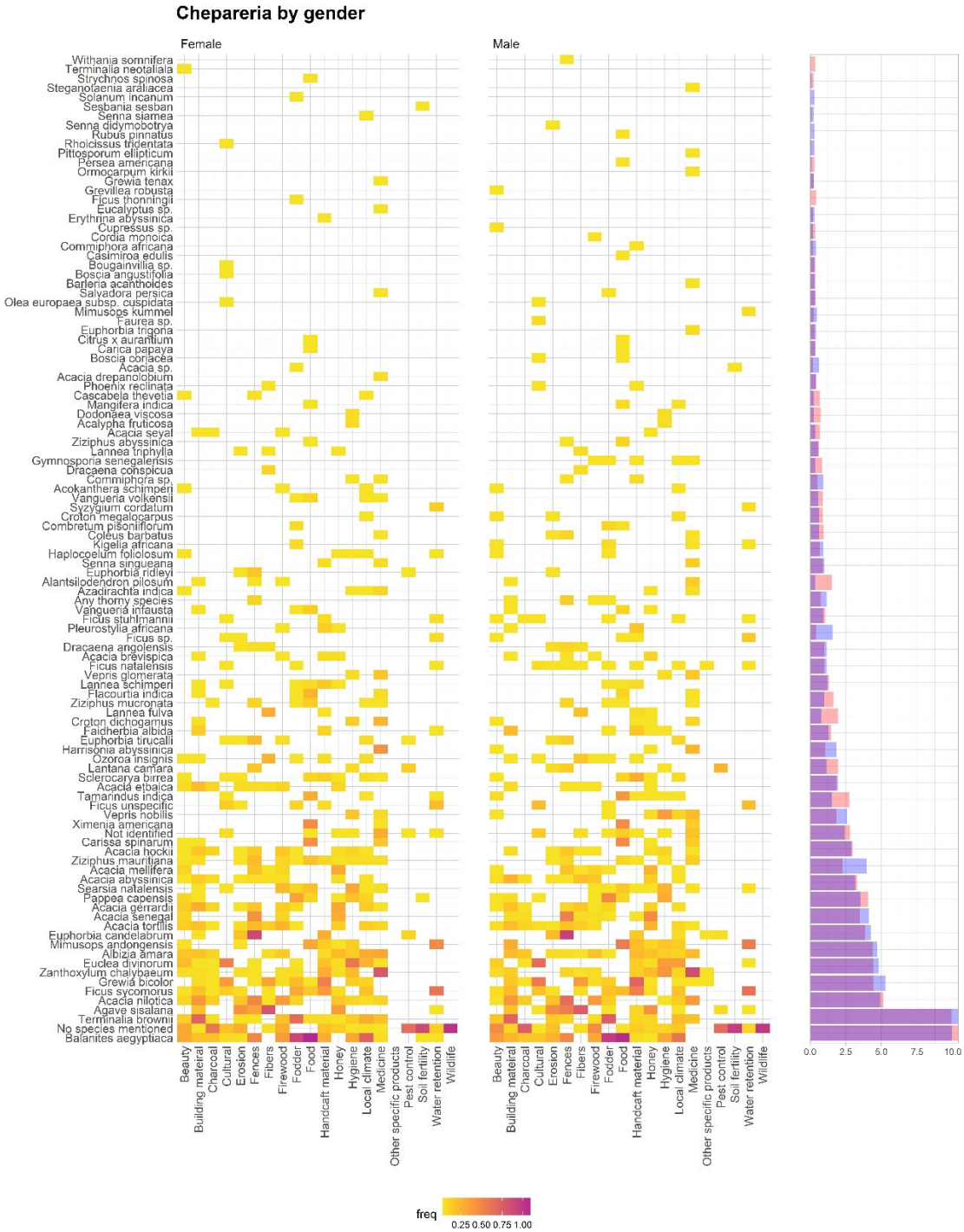


Figure 1. Heat map of woody species and associated ecosystem services, according to frequency for Chepareria. Species mentioned less than 5 times during the interviews have been excluded.. The histogram side panel shows total frequency (%) of species mentioned during interviews: Blue = male, red = female, purple = overlap.

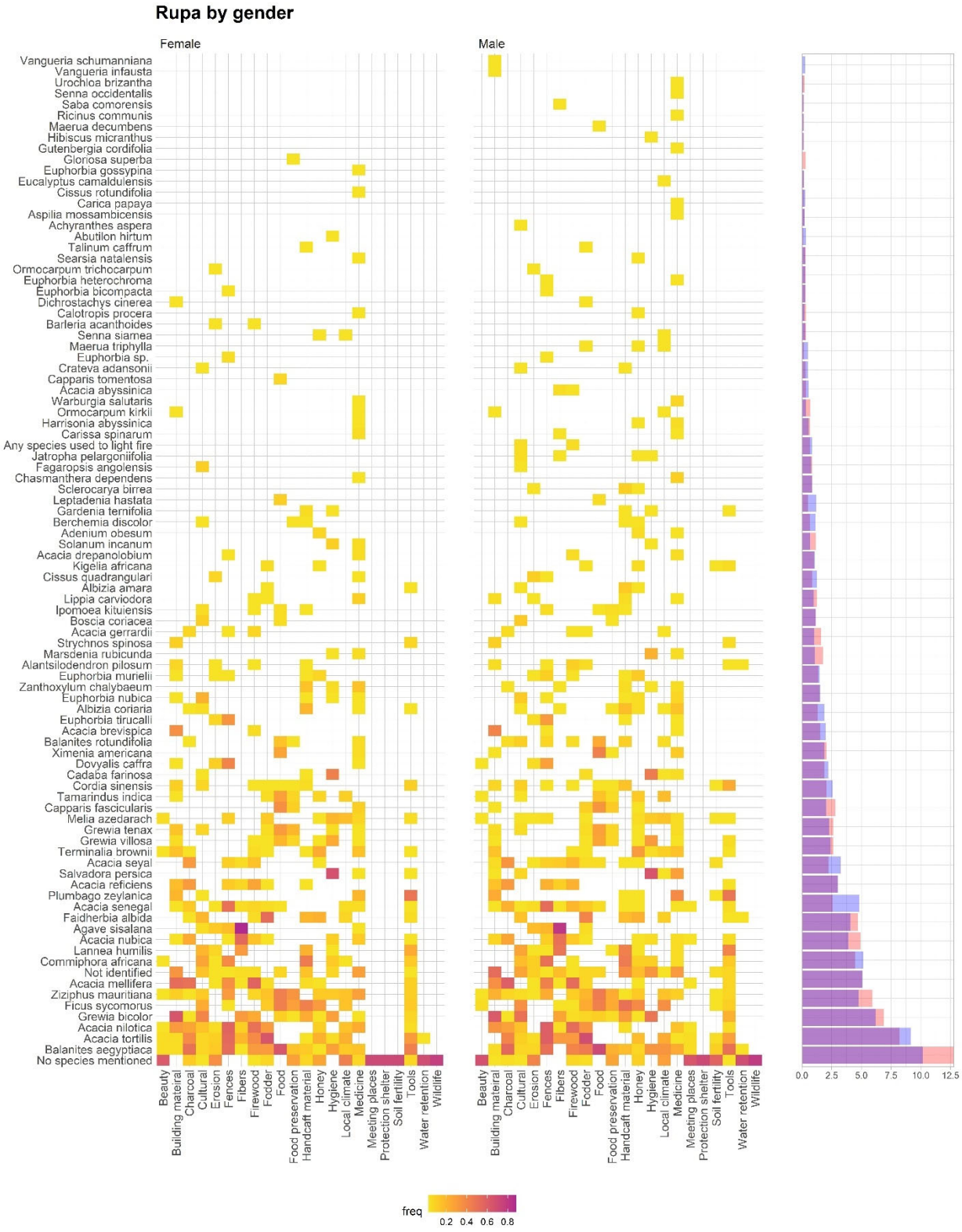


Figure 2. Heat map of woody species and associated ecosystem services, according to frequency for Rupa. Species mentioned less than 5 times during the interviews have been excluded.. The histogram side panel shows total frequency (%) of species mentioned during interviews: Blue = male, red = female, purple = overlap.

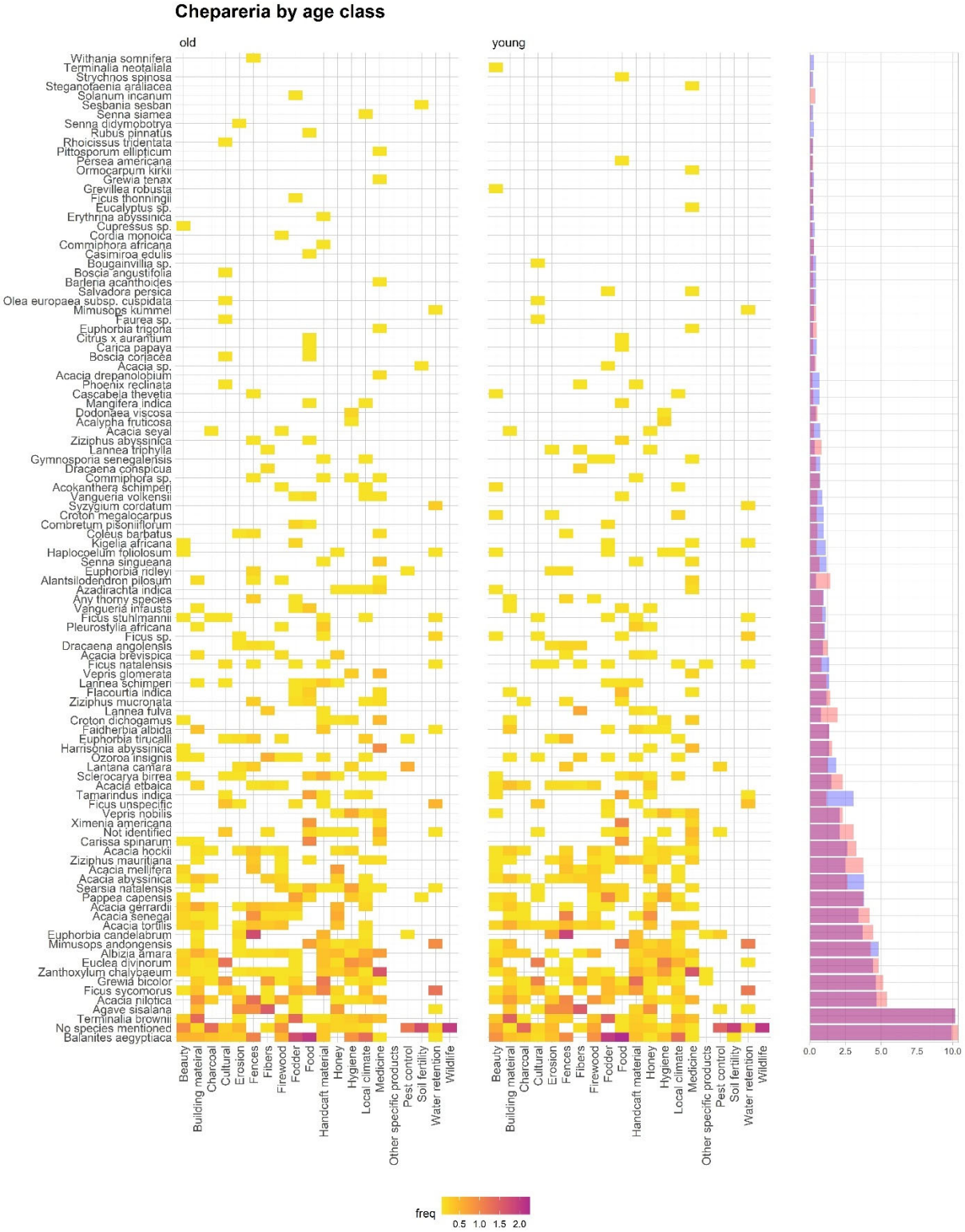


Figure 3. Heat map of woody species and associated ecosystem services, by age class for Chepareria. Species mentioned less than 5 times during the interviews have been excluded.. The histogram side panel shows total frequency (%) of species mentioned during interviews: Blue = old, red = young, purple = overlap.

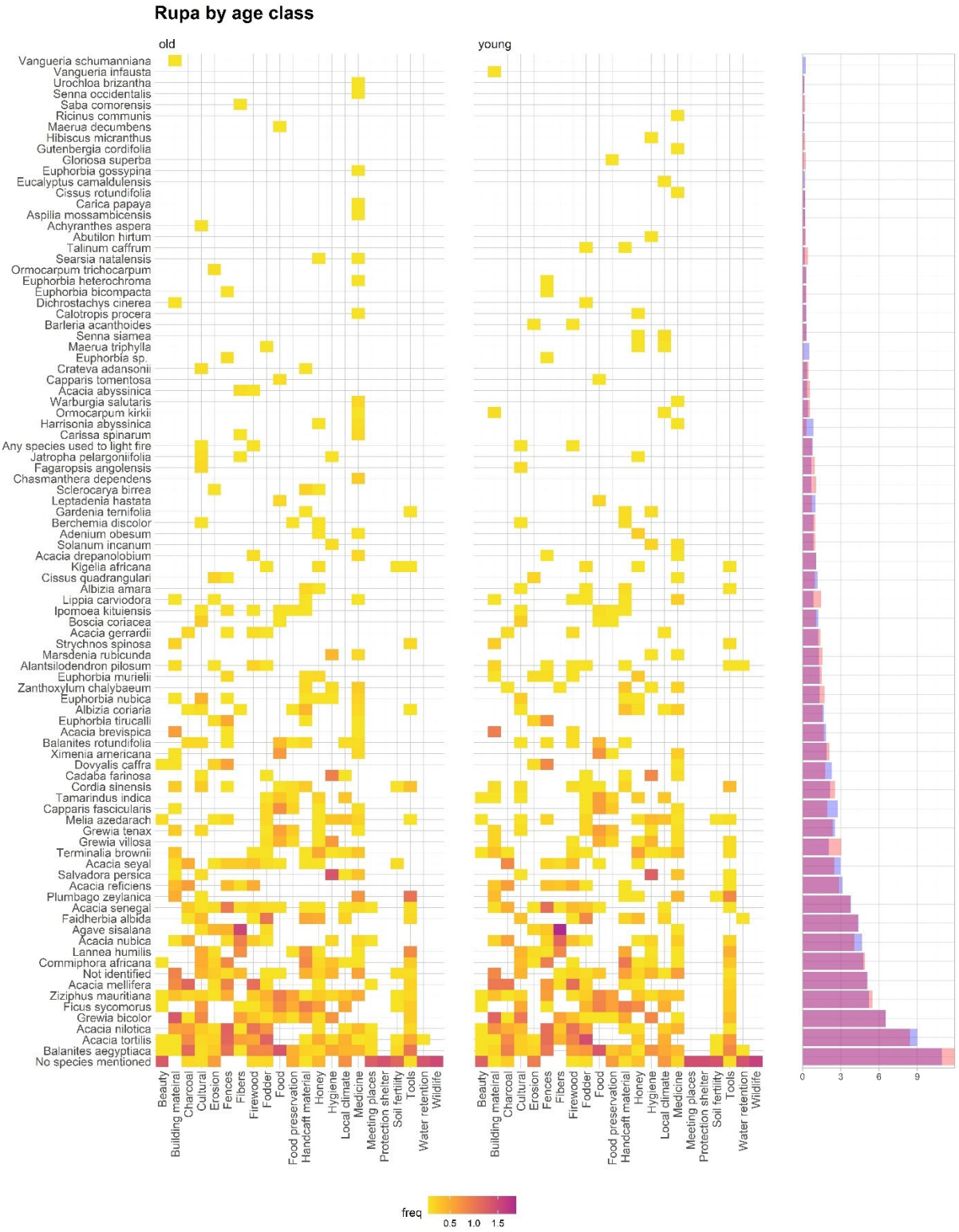


Figure 4. Heat map of woody species and associated ecosystem services, by age class for Rupa. Species mentioned less than 5 times during the interviews have been excluded.. The histogram side panel shows total frequency (%) of species mentioned during interviews: Blue = old, red = young, purple = overlap.

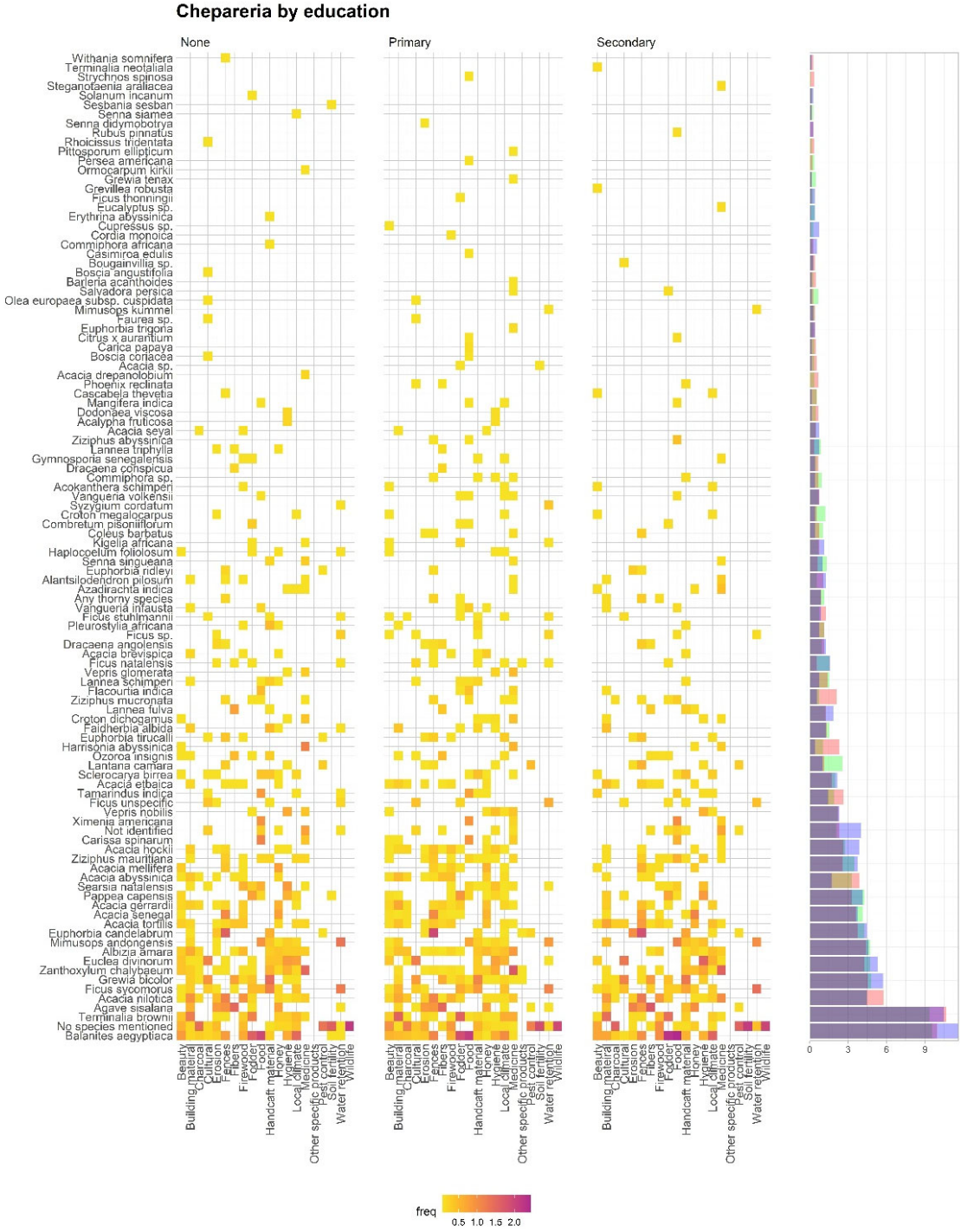


Figure 5. Heat map of woody species and associated ecosystem services, by level of education for Chepareria. Species mentioned less than 5 times during the interviews have been excluded.. The histogram side panel shows total frequency (%) of species mentioned during interviews: Blue = secondary, red = primary, green = none, other coulour = overlap.

Figure 6. Heat map of woody species and associated ecosystem services, by level of education for Rupa. Species mentioned less than 5 times during the interviews have been excluded. The histogram side panel shows total frequency (%) of species mentioned during interviews: Blue = secondary, red = primary, green = none, other colour = overlap.

SM 12. Number of species associated with different ecosystem services according to gender, age, and level of education

Table 1. Number of species identified for different ecosystem services according to gender. Total count is based on local names. n= number of species, %=percentage of total count of species

Chepareria				**Rupa**		
ES	**Gender**	**n**	**%**	**Gender**	**n**	**%**
Beauty	Female	25	3.62	Female	7	1.04
	Male	23	3.33	Male	5	0.74
Building mateiral	Female	28	4.05	Female	23	3.42
	Male	22	3.18	Male	24	3.57
Charcoal	Female	15	2.17	Female	15	2.23
	Male	10	1.45	Male	13	1.93
Cultural	Female	16	2.32	Female	21	3.13
	Male	15	2.17	Male	27	4.02
Erosion	Female	20	2.89	Female	15	2.23
	Male	19	2.75	Male	17	2.53
Fences	Female	23	3.33	Female	20	2.98
	Male	25	3.62	Male	26	3.87
Fibers	Female	15	2.17	Female	11	1.64
	Male	18	2.60	Male	17	2.53
Firewood	Female	21	3.04	Female	20	2.98
	Male	19	2.75	Male	21	3.13
Fodder	Female	26	3.76	Female	19	2.83
	Male	25	3.62	Male	24	3.57
Food	Female	22	3.18	Female	16	2.38
	Male	23	3.33	Male	16	2.38
Food preservation	x	x	x	Female	12	1.79
	x	x	x	Male	14	2.08
Handcaft material	Female	21	3.04	Female	21	3.13
	Male	26	3.76	Male	25	3.72
Honey	Female	23	3.33	Female	18	2.68
	Male	29	4.20	Male	32	4.76
Hygiene	Female	21	3.04	Female	18	2.68
	Male	17	2.46	Male	15	2.23
Local climate	Female	26	3.76	Female	11	1.64
	Male	25	3.62	Male	17	2.53
Medicine	Female	28	4.05	Female	34	5.06
	Male	28	4.05	Male	37	5.51
Pest control	Female	4	0.58	x	x	x
	Male	3	0.43	x	x	x

Meeting places	x	x	x	Male	6	0.89
Soil fertility	Female	3	0.43	Male	9	1.34
	Male	1	0.14	Female	0	0.00
Tools	x	x	x	Female	20	2.98
	x	x	x	Male	22	3.27
Water retention	Female	11	1.59	Female	1	0.15
	Male	11	1.59	Male	3	0.45
Wildlife	All	0	0.00	All	0	0.00

Table 2. Number of species identified for different ecosystem services according to age class. Total count is based on local names. n= number of species, %=percentage of total count of species

Chepareria				**Rupa**		
ES	**Age**	**n**	**%**	**Age**	**n**	**%**
Beauty	old	21	3.00	old	7	1.02
	young	26	3.72	young	8	1.17
Building mateiral	old	27	3.86	old	24	3.51
	young	23	3.29	young	22	3.22
Charcoal	old	13	1.86	old	14	2.05
	young	13	1.86	young	13	1.90
Cultural	old	17	2.43	old	27	3.95
	young	15	2.15	young	23	3.36
Erosion	old	19	2.72	old	18	2.63
	young	18	2.58	young	11	1.61
Fences	old	25	3.58	old	24	3.51
	young	23	3.29	young	23	3.36
Fibers	old	17	2.43	old	16	2.34
	young	15	2.15	young	11	1.61
Firewood	old	23	3.29	old	19	2.78
	young	17	2.43	young	23	3.36
Fodder	old	25	3.58	old	23	3.36
	young	26	3.72	young	24	3.51
Food	old	24	3.43	old	18	2.63
	young	23	3.29	young	17	2.49
Food preservation	x	0	0.00	old	14	2.05
	x	0	0.00	young	12	1.75
Handcaft material	old	26	3.72	old	24	3.51
	young	24	3.43	young	23	3.36
Honey	old	22	3.15	old	27	3.95
	young	31	4.43	young	25	3.65
Hygiene	old	20	2.86	old	16	2.34
	young	17	2.43	young	18	2.63
Local climate	old	29	4.15	old	14	2.05

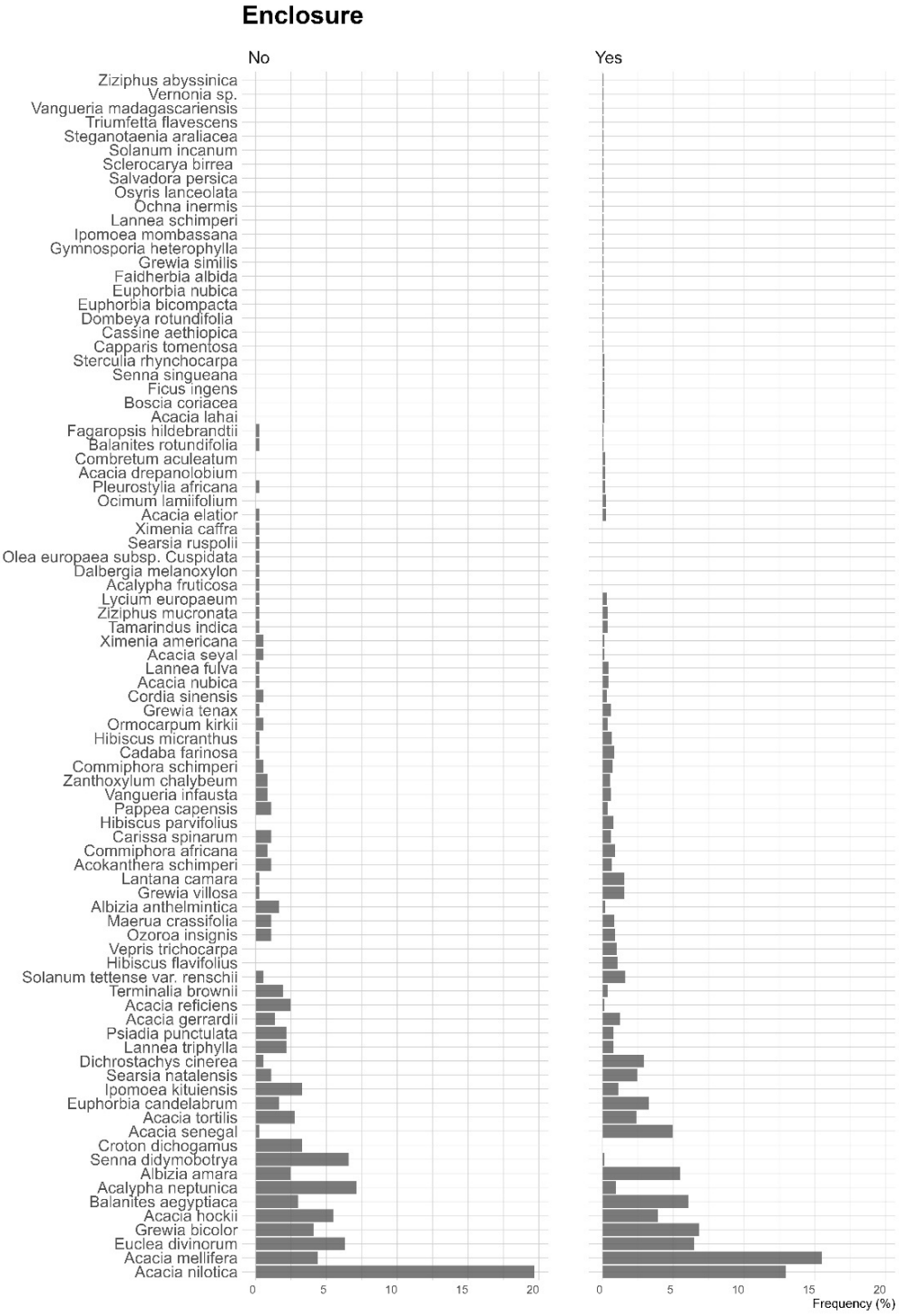
	young	26	3.72	young	16	2.34
Medicine	old	28	4.01	old	39	5.70
	young	28	4.01	young	30	4.39
Pest control	old	4	0.57	x	x	x
	young	3	0.43	x	x	x
Meeting places	x	0	0.00	old	6	0.88
Soil fertility	old	3	0.43	old	7	1.02
	young	1	0.14	young	4	0.58
Tools	x	x	x	old	18	2.63
	x	x	x	young	22	3.22
Water retention	old	12	1.72	old	1	0.15
	young	11	1.57	young	3	0.44

Table 3. Number of species identified for different ecosystem services according to level of education. Total count is based on local names. n= number of species, %=percentage of total count of species

Chepareria				**Rupa**		
ES	**Education**	**n**	**%**	**Education**	**n**	**%**
Beauty	None	18	2.09	None	10	1.48
	Primary	23	2.67	Primary	1	0.15
	Secondary	14	1.63	Secondary	0	0
Building mateiral	None	24	2.79	None	27	3.99
	Primary	21	2.44	Primary	15	2.22
	Secondary	21	2.44	Secondary	5	0.74
Charcoal	None	9	1.05	None	16	2.37
	Primary	12	1.39	Primary	9	1.33
	Secondary	7	0.81	Secondary	0	0
Cultural	None	15	1.74	None	31	4.59
	Primary	12	1.39	Primary	16	2.37
	Secondary	9	1.05	Secondary	1	0.15
Erosion	None	19	2.21	None	19	2.81
	Primary	18	2.09	Primary	7	1.04
	Secondary	8	0.93	Secondary	0	0
Fences	None	22	2.56	None	27	3.99
	Primary	24	2.79	Primary	16	2.37
	Secondary	21	2.44	Secondary	6	0.89
Fibers	None	12	1.39	None	18	2.66
	Primary	18	2.09	Primary	9	1.33
	Secondary	12	1.39	Secondary	2	0.30
Firewood	None	21	2.44	None	26	3.85
	Primary	19	2.21	Primary	14	2.07
	Secondary	12	1.39	Secondary	5	0.74

Fodder	None		19	2.21	None		26	3.85
	Primary		23	2.67	Primary		16	2.37
	Secondary		16	1.86	Secondary		0	0
Food	None		16	1.86	None		17	2.51
	Primary		26	3.02	Primary		13	1.92
	Secondary		17	1.97	Secondary		5	0.74
Food preservation		x	x	x	None		16	2.37
		x	x	x	Primary		8	1.18
		x	x	x	Secondary		0	0
Handcaft material	None		20	2.32	None		31	4.59
	Primary		22	2.56	Primary		15	2.22
	Secondary		20	2.32	Secondary		3	0.44
Honey	None		22	2.56	None		33	4.88
	Primary		26	3.02	Primary		14	2.07
	Secondary		15	1.74	Secondary		2	0.30
Hygiene	None		18	2.09	None		20	2.96
	Primary		21	2.44	Primary		15	2.22
	Secondary		14	1.63	Secondary		2	0.30
Local climate	None		18	2.09	None		19	2.81
	Primary		29	3.37	Primary		9	1.33
	Secondary		17	1.97	Secondary		4	0.59
Medicine	None		19	2.21	None		44	6.51
	Primary		30	3.48	Primary		20	2.96
	Secondary		18	2.09	Secondary		2	0.30
Meeting places		x	x	x	None		6	0.89
		x	x	x	Primary		0	0
		x	x	x	Secondary		0	0
Pest control	None		4	0.46		x	x	x
	Primary		3	0.35		x	x	x
	Secondary		3	0.35		x	x	x
Soil fertility	None		3	0.35	None		9	1.33
	Primary		1	0.12	Primary		0	0
	Secondary		0	0	Secondary		0	0
Tools		x	x	x	None		25	3.70
		x	x	x	Primary		15	2.22
		x	x	x	Secondary		3	0.44
Water retention	None		11	1.28	None		4	0.59
	Primary		11	1.28	Primary		0	0
	Secondary		4	0.46	Secondary		0	0
Wildlife	All		0	0	All		0	0

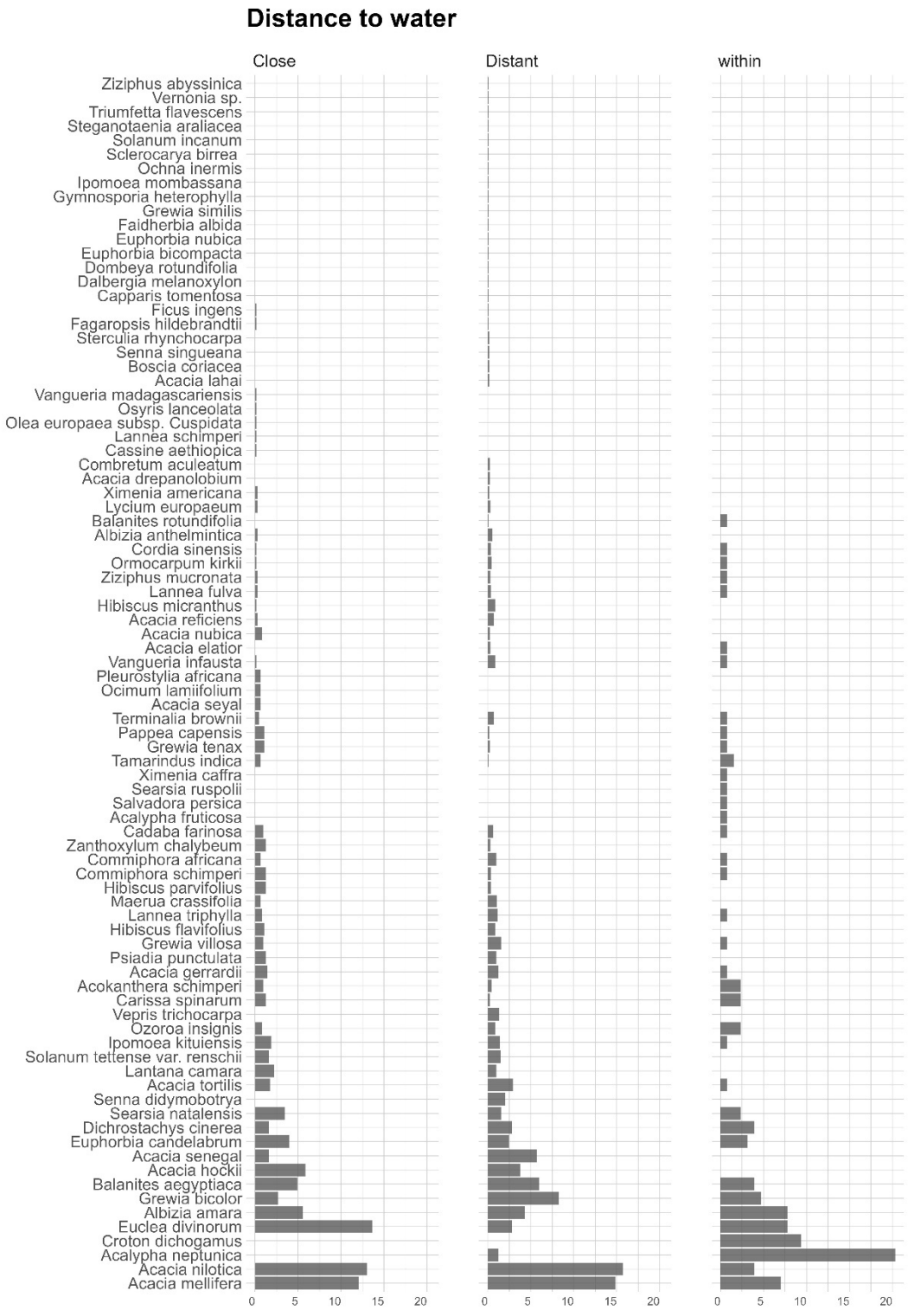
SM 13. Species distribution associated to different plot properties in LDSF plots in Chepareria



Species distribution by individual frequency (%), inside and outside enclosures.

Species distribution by individual frequency (%) for each separate land use. Data from mixed plots that are classified with two, or more, different land-use types is repeated. Land characterized as Other is industrial land and land next to a trading center.

Species distribution by individual frequency (%) for each separate distance to homestead combined (total frequency = 300%). Within = observations inside a homestead, Close = observations <100 m from a homestead, Distant = observations >100 m from a homestead



Species distribution by individual frequency (%) for each separate distance to water combined (total frequency = 300%). Within = observations from plots partly inside a water source, Close = observations <100 m from a water source, Distant = observations >100 m from a water source.

SM 14. Ecosystem service categories

The Millennium Ecosystem Assessment (2005) define four major categories of ecosystem services (ES):

1. *Provisioning ecosystem services* are products obtained from ecosystem services, e.g., food, fuelwood, genetic resources etc.
2. *Regulating ecosystem services* are benefits obtained from regulation of ecosystem processes, e.g., climate regulation, water regulation, erosion control etc.
3. *Cultural ecosystem services* are nonmaterial benefits obtained from ecosystem services, e.g., spiritual, and religious, aesthetic, traditional and formal knowledge systems etc.
4. *Supporting ecosystem services* are services necessary for the production of all other ecosystem services. These services differ from the other categories of ES in that their impact on people is either indirect, or occur over a very long time, e.g., provisioning of habitat, soil formation and retention and nutrient cycling etc.

SM 15. Village names and coordinates

Table 1. Names and coordinates for villages randomly selected for individual interviews in Chepareria.

Village name Chepareria	Coordinates
Koduwen	N 01° 27.066', E 035° 13.524'
Kanyikeny	N 01° 25.771', E 035° 12.791'
Koiket	N 01° 24.837', E 035° 11.943'
Sukait	N 01° 23.548', E 035° 11.799'
Tukumo	N 01° 22.480', E 035° 11.590'
Nasukuta	N 01° 21.534', E 035° 11.898'
Riamakono	N 01° 21.170', E 035° 09.792'
Kakokoo	N 01° 21.986', E 035° 07.976'
Naramam	N 01° 23.933', E 035° 08.891'
Chelongon	N 01° 25.680', E 035° 09.420'
Lokuka	N 01° 25.287', E 035° 10.335'
Kaikai	N 01° 26.283', E 035° 11.009'
Katerit	N 01° 25.687', E 035° 11.917'
Koiket	N 01° 24.837', E 035° 11.943'
Priokwo	N 01° 22.030', E 035° 10.168'
Sangakai	N 01° 24.118', E 035° 10.471'
Chesoyow	N 01° 25.539', E 035° 08.672'
Natuyun	N 01° 24.331', E 035° 09.202'
Kork Po Pyosya	N 01° 21.143', E 035° 14.206'
Mokowon	N 01° 21.651', E 035° 13.210'
Chepukat	N 01° 14.078', E 035° 15.703'

Table 2. Names and coordinates for villages randomly selected for individual interviews in Rupa.

Village name Rupa	Coordinates
Kidepo	N 02° 33.892', E 034° 37.297'
Longoroko	N 02° 34.057', E 034° 36.892'
Atirwae	N 02° 33.860', E 034° 36.025'
Lokitumo	N 02° 33.778', E 034° 35.736'
Namagorat	N 02° 33.988', E 034° 34.028'
Apetirir	N 02° 34.299', E 034° 34.391'
Loboborio	N 02° 34.874', E 034° 34.010'
Amunyodoi	N 02° 34.870', E 034° 35.257'
Kisop	N 02° 34.834', E 034° 35.526'
Kodokei	N 02° 34.941', E 034° 35.508'
Akwaakipi	N 02° 34.858', E 034° 35.907'
Atedeoi	N 02° 34.977', E 034° 36.031'
Lokalimon	N 02° 35.332', E 034° 35.568'
Nangolat	N 02° 35.344', E 034° 35.518'
Lokerwo	N 02° 36.149', E 034° 35.394'
Natikokinei	N 02° 36.200', E 034° 35.441'
Lokapel	N 02° 36.591', E 034° 35.965'
Akwapuwa	N 02° 36.534', E 034° 35.980'
Lokitelakapis	N 02° 36.234', E 034° 36.541'
Napong	N 02° 36.422', E 034° 36.021'

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Kvävegödslingens effekter på bladyta och trädkronor i tallbestånd

2023:04 Författare: Johan Engström
Increased carbon sequestration of actively restored tropical forests in Sabah, Malaysia
A comparison of natural regeneration and active restoration

2023:05 Författare: Magdalena Fassl
Tree-growth and climate-growth relationships of Scots pine and downy birch in a natural forest in northern Sweden

2023:06 Författare: Ruben Baan Hofman
Riparian vegetation ecology
An observational study into the effects of forest management on understory vegetation communities along boreal headwaters

2023:07 Författare: Nils Helge Havertz
GIS and remote sensing based mapping of microtopography and vegetation composition in a boreal mire complex

2023:08 Författare: Lydia Kruse
Identifying training needs for the implementation of Continuous Cover Forestry in Sweden

2023:09 Författare: Ylva Kungsman
Från expansion och äventyr till revolution och landsflykt
Svenska sågverk och sågverksarbetare i norra Ryssland 1898–1925

2023:10 Författare: Elijah Ourth
Consequences of Alternative Forest Management in Different Widths of Riparian Buffer Zones: A GIS Analysis

2023:11 Författare: Eric Lundström
Major forest companies and owner associations interpretation of policies and certification programs regarding riparian buffer zones

2023:12 Författare: Gaya Marike ten Kate
Plant community responses to 15 years of nitrogen and phosphorus fertilization along an elevational gradient in the subarctic tundra

2023:13 Författare: Elle Eriksson
“The reindeer does not move faster than the human walks” – Sámi traditional reindeer herding knowledge in a forest landscape in Váhtjer community

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Demographic equilibrium modelling of single tree selection stands in Siljansfors.
Judging the sustainability of single tree selection systems in Sweden

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The restoration period - A new era in forestry

2023:16 Författare: Anna Swärd
Ecosystem services from woody vegetation in East African rangelands