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Research

Heterogeneity of demands for nature's contributions to people and nature's values by farmers: insights from the Kilimanjaro social-ecological system

John Sanya[1,2], Milena Gross[1], Tuyeni H. Mwampamba[3], Jasmine Pearson[1,4], Jennifer K. Sesabo[5], Maraja Riechers[1,6], Neema R. Kinabo[2,7,8], Viviane Krail[1] and Berta Martín-López[1]

ABSTRACT. Farmers are not a homogeneous social actor group, particularly regarding their demands for nature's contributions to people (NCP) and how they value nature. Overlooking internal heterogeneity prevents them from implementing inclusive conservation that aligns with their needs and interests. We aimed to explore the internal heterogeneity of the NCP demands and values of nature expressed by farmers, considering their socio-demographic characteristics, pro-environmental behavior, and geographical context. Additionally, we aimed to understand how perceptions of NCP supply trends over the last decade affect demands for NCP. Using a socio-cultural valuation approach, we conducted face-to-face surveys with 364 farmers residing in 14 villages located on the southern slope of Mount Kilimanjaro, Tanzania. Based on descriptive and redundancy analyses (RDAs), we found that farmers primarily preferred material and regulating NCP: food, feed, and regulation of freshwater quality, whose supply is perceived as decreasing, i.e., "critical" NCP. Regarding values of nature, we found the highest farmers' share of agreement for statements representing intrinsic value (97.1% of respondents who agreed or strongly agreed), relational values (94.8%), and instrumental values (94.1%), although the pattern for individual value statements varied slightly. The RDA findings indicated that altitudinal and longitudinal gradients, the place of birth of both respondents and their parents, and engagement in conservation activities strongly influenced the distinctive demands for NCP and nature's values. Values of nature were also influenced by age, education, and membership in any association. Moreover, we found seven bundles of NCP demands that represent distinct ways in which farmers use and appreciate nature. These findings deepen the understanding of the interlinkages between NCP demands, perceived NCP supply trends, and the valuation of nature according to the internal heterogeneity of farmers, which is essential to elaborate evidence-based strategies for nature conservation that align with their interests and needs.

Key Words: *farmers; interwoven NCP approach; mountain ecosystem; plural valuation; social preferences*

INTRODUCTION

Despite conservation's crucial role in enhancing people's quality of life (Turner et al. 2012), balancing conservation goals with the livelihood needs of local communities in and around protected areas remains challenging (Rodríguez et al. 2006). Understanding people's needs and values of nature can help to support informed decision making for inclusive conservation that would effectively mitigate the social costs of conservation (McShane et al. 2011, Palomo et al. 2014). Nature's contributions to people (NCP) and values of nature are increasingly considered essential to support informed decision making in conservation because both concepts contribute to understanding the diverse ways people benefit from and value nature (Palomo et al. 2014, De Vos et al. 2018, Villarreal-Rosas et al. 2020, Martinez-Harms et al. 2021). The concept of NCP is defined as all benefits and detriments of nature to people's quality of life, including material NCP, such as food and energy; regulating NCP, such as water quantity and quality regulation; and non-material NCP, such as recreational and social-cohesion experiences (Díaz et al. 2018). Values of nature are broadly defined as the importance, worth, and usefulness ascribed to nature, including NCP (hereafter referred to as "nature's values"; Díaz et al. 2015). Values of nature can be classified into intrinsic, instrumental, and relational values (Pascual et al. 2017). Intrinsic values refer to the inherent value of nature independent of any human experiences, instrumental and relational values are human-driven (Díaz et al. 2015). The notion of intrinsic values itself reflects morality and the expression of humans' regard for nature (Arias-Arévalo et al. 2017, O'Connor and Kenter 2019). Instrumental values refer to the importance of nature and NCP as a means to achieve specific ends, such as fulfilling people's basic needs or providing economic benefits (Arias-Arévalo et al. 2017). Relational values relate to the importance of nature for supporting meaningful relationships between people that are mediated by nature and between nature and people (Chan et al. 2016). Tailoring conservation planning to diverse people's NCP needs, interests, and preferences (hereafter referred to as "demands for NCP") and nature's values creates the opportunity for conservation to become more inclusive and to transparently present diverse trade-offs between conservation and other social goals, such as livelihood security (Ban et al. 2009, McShane et al. 2011).

Numerous studies have shown that there are differentiated levels of dependence on ecosystems and biodiversity by different social actors and that subsistence farmers, herders, and fishers are often the most directly dependent on nature (Iniesta-Arandia et al. 2014, Cáceres et al. 2015, Martín-López et al. 2019). Farmers interact with nature in diverse ways depending on daily life experiences, cultural identities, and socio-demographic characteristics (Lazos-Chavero et al. 2016), which can result in

[1]Social-Ecological Systems Institute, Leuphana University of Lüneburg, Germany, [2]College of African Wildlife Management, Mweka, Tanzania, [3]The Nature Conservancy, Africa Program, [4]ICON Science, School of Global, Urban and Social Studies, RMIT University, Melbourne, Australia, [5]Mzumbe University, Department of Economics, Tanzania, [6]Thünen Institute of Baltic Sea Fisheries, Rostock, Germany, [7]Senckenberg Biodiversity and Climate Research Institute (SBiK-F), Germany, [8]Department of Biological Sciences, Institute for Ecology, Evolution and Diversity, Goethe University, Frankfurt am Main, Germany

unique and plural demands for NCP (Tauro et al. 2018) and values of nature expression (Topp et al. 2022, Chapman and Deplazes-Zemp 2024). As such, in a given landscape, farmers are rarely a homogeneous social actor group, especially with regard to their NCP demands and values of nature (Lakerveld et al. 2015, Cuni-Sanchez et al. 2019). For example, existing research shows that farmers demand NCP differently, often based on socio-demographic characteristics such as gender (Mensah et al. 2017, Lau et al. 2019), age (Schmitt et al. 2022), education (Tauro et al. 2018, Lau et al. 2019), or access to land (Caballero-Serrano et al. 2017); their perceptions of environmental change (Oteros-Rozas et al. 2014); pro-environmental behaviors, such as participation in environmental organizations (Martín-López et al. 2012); and geographical contexts, such as urban-rural gradients (Martín-López et al. 2012, Boafo et al. 2014) or altitudinal gradients (García-Llorente et al. 2015). Likewise, recent research shows that farmers value nature differently according to their farming practices (Topp et al. 2022) and their views about their own role in nature (Chapman and Deplazes-Zemp 2024). Nevertheless, empirical research often overlooks the interplay of factors that affect the heterogeneity of plural values (Jacobs et al. 2023) and NCP demands by local farmers (Tauro et al. 2018, Cuni-Sanchez et al. 2019), resulting in vague over-generalizations about how farmers express the importance of nature (Hicks et al. 2015, Tauro et al. 2018). Accounting for wider socio-demographic and geographical contexts that affect farmers' demands for NCP is needed to support the design of more legitimate and inclusive conservation actions (Tauro et al. 2018, Cuni-Sanchez et al. 2019, CBD 2022).

To address this knowledge gap, we investigate the internal heterogeneity of NCP demands and expression of values of nature through a socio-cultural valuation approach in an iconic African mountain: the social-ecological system of Mount Kilimanjaro (hereafter referred to as Kilimanjaro). Mountains are considered pivotal ecosystems for supporting farming livelihoods (Iniesta-Arandia et al. 2014, Cuni-Sanchez et al. 2016, Masao et al. 2022) and fulfilling more intangible farmers' needs such as cultural and spiritual meaning (Boelens 2014, Ndayizeye et al. 2020). We believe that Kilimanjaro provides an excellent platform to understand the internal heterogeneity of NCP demands and values expressed by farmers because their livelihood is connected in different ways with diverse ecosystems, such as forests, homegardens, or crop fields (Fernandes et al. 1985). At the same time, Kilimanjaro has passed through different conservation phases that have often entailed limiting resource access by local farmers (Sébastien 2010). Understanding the different farmers' perspectives on the importance of nature and its NCP in Kilimanjaro can provide useful insights for designing inclusive conservation. Our main goal was to explore the internal heterogeneity of the NCP demands and values of nature expressed by a social actor group, i.e., farmers of Kilimanjaro, considering socio-demographic characteristics, pro-environmental behavior, and geographical context. We specifically aim to (1) identify the demands for NCP and expression of nature's values along the altitudinal and longitudinal gradients; (2) detect "critical" NCP that are highly demanded and perceived as vulnerable because of loss or degradation along the altitudinal and longitudinal gradients; and (3) unravel bundles of NCP demands and nature's values and determine the influence of respondents' socio-demographic characteristics, pro-environmental behavior, and geographical location. This study provides an understanding of NCP demands, perceived NCP supply trends, and values of nature, representing the significance of NCP on farmers' livelihoods. This assessment would be essential for decision makers to elaborate evidence-based strategies for sustainable nature conservation.

METHODS

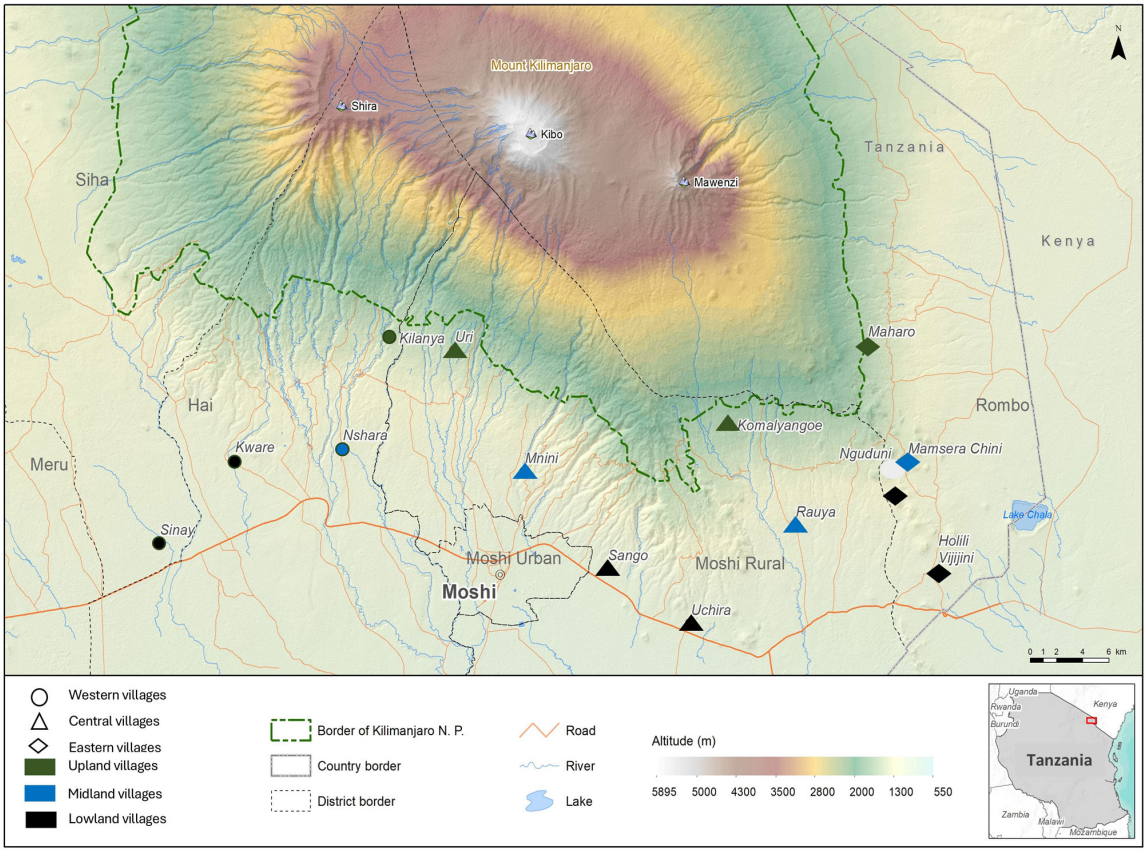
Study site

The targeted social-ecological system comprised the southern slopes of Mount Kilimanjaro, the highest free-standing mountain in the world (5985 m.a.s.l.), which is located 300 km south of the equator in northeast Tanzania. Along its altitudinal gradient, the mountain is characterized by distinguishable ecosystems that range from dry and hot savannah (700–1000 m) to a nival zone, mainly bare vegetation and with the presence of glaciers (4600–5895 m) with submontane and montane *Ocotea* (Camphor) forests (1100–3100 m); *Erica* bushland and forest (3100–4000 m); and alpine *Helichrysum* vegetation (4000–4600 m; Hemp 2006) in between (Fig. 1). The mountain is within a global biodiversity hotspot: Eastern Afromontane (Hrdina and Romportl 2017).

The Chagga tribe mainly inhabits the southern slopes of Kilimanjaro. Chagga are Bantu speakers who migrated from multiple African tribes and settled in the once-forested Kilimanjaro foothills (Fernandes et al. 1985). Traditional Chagga livelihood is centered around the homegarden (*Kihamba* in Chagga) that consists of a multilayered coffee-banana agroforestry system with a vegetation structure similar to that of humid tropical forests containing trees, shrubs, herbs, lianas, and epiphytes (Hemp 2006, Mbwiga 2016). Homegardens are mainly found between 1200 and 1700 m (Von Clemm 1964), and their average size is 0.5–1.7 ha (Mdoe and Wiggins 1997). Good climatic conditions, fertile volcanic soils, and a dense network of streams and springs that feed an efficient furrow irrigation system favor biodiversity (Masao 1974, Fernandes et al. 1985) and the supply of various NCP. Other Tanzanian tribes settle in the lowlands below 1200 m for socioeconomic activities such as agriculture and livestock keeping (Kilima et al. 2015, Mushi et al. 2020).

Material NCP, such as food, medicine, feed, and firewood, are mostly supplied in the croplands located in the lower elevation (< 1000 m) and in the croplands and homegardens located at 1000–1700 m (Kilima et al. 2015). Regulating NCP, such as the regulation of freshwater quantity, climate, and air quality, is mainly provided by the submontane and montane forests located at 1100–3100 m (Hemp 2006, Kilima et al. 2015). However, in the last decades, some changes in climatic conditions have affected the supply of material and regulating NCP, such as food and energy (Said et al. 2019), soil fertility in homegardens (Ichinose et al. 2023), and water quantity regulation because of the near-total collapse of the irrigation furrow system (Kimaro and Bogner 2019). Finally, non-material NCP are associated with places and species with symbolic, cultural, and spiritual meaning, such as rituals and ceremonies, across elevations (Sébastien 2010, Mtallo and Rubagumya 2015). Tourism, particularly multi-day hiking to get to the highest peak in Africa, is an important source of income for local communities who are employed as guides, porters, park rangers, and other service providers in the hospitality industry (Adili and Robert 2016, Ngowi and Jani 2018).

Fig. 1. Map of the study area showing the sampled villages along the altitudinal and longitudinal gradients. N. P. = National Park (ESRI 2019).

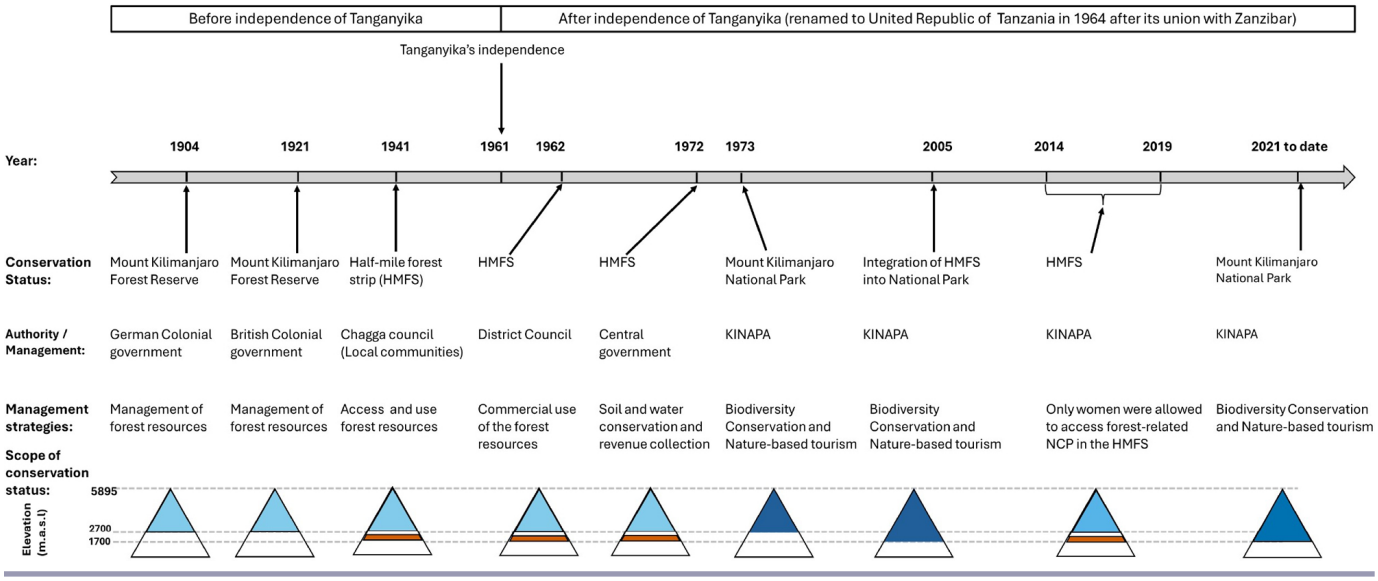


Although our study site is located outside Kilimanjaro National Park (KINAPA), the park significantly affects access and user rights to forest-derived NCP since its gazetting. The conservation history of Kilimanjaro started during the colonial period (Fig. 2); in 1904, the German colonial government converted more than half a million hectares of crown land into forest reserve under the Forest Conservation Ordinance, however, active management of the forest reserve began in 1908 (Schabel 1990, Newmark 1991). In 1921, the British colonial government established all forests above 1700 m as a natural reserve, the Mount Kilimanjaro Forest Reserve (Wood 1965, Newmark 1991). The establishment of Kilimanjaro Forest Reserve started to limit local communities' access to and use of NCP, leading to prolonged disputes over natural resource control (Bender 2013). In 1941, a Chagga council, a political body managed by Chagga chiefs, declared a social buffer zone and catchment forest of approximately 8800 ha, i.e., the Half Mile Forest Strip (HMFS), to grant local communities access to forest-related NCP with successful reforestation projects (Newmark 1991, William 2003). However, after Tanzania's independence in 1961, authority over the HMFS shifted from local communities to district councils in 1962, emphasizing the commercial use of forest products. Still, the management faced the challenge of less profit success (Newmark 1991). In 1972, the central government took over the control of HMFS, emphasizing soil and water conservation, but the government collected revenues from the HMFS with less reforestation success. In 1973, KINAPA was established, and the HMFS was integrated into the national park in 2005 (KINAPA 2006). The independent government of Tanganyika justified banning local communities from accessing the HMFS based on population increase, encroachment, and overexploitation of forest resources (Sébastien 2010). In personal communication with a Kilimanjaro National Park Authority officer, he explained that local farmers adjacent to KINAPA struggled to fulfill their needs for forest-related NCP and demanded to re-open the HMFS. Consequently, between 2014 and 2019, only women were permitted access to the HMFS without cutting tools to gather firewood. Within this period, there were reforestation programs in the degraded areas of the HMFS and surrounding villages, reducing pressure on the forest-related NCP supplied by HMFS. After a period of assessing the status of the HMFS, an official ban on firewood collection, including women, was implemented in 2021 (Fig. 2).

Sampling strategy for villages and households

To unravel the heterogeneity of demands for NCP and values of nature expressed by farmers in Kilimanjaro, we applied a stratified sampling based on the longitudinal gradient based on the districts, i.e., East (Rombo district), Central (Moshi Rural district), and West (Siha and Hai districts) and the altitudinal gradient,

Fig. 2. Timeline (not true to scale) of the conservation management history of Mount Kilimanjaro (5895 m.a.s.l.) in Tanzania. The triangles are a sketch of Mount Kilimanjaro with a roughly geographical scope, i.e., not true to scale, illustrating the conservation status of the mountain's location. Light blue color represents the forest reserve, brown color represents the Half-Mile Forest Strip (HMFS), and dark blue color represents the National Park. NTFP = Non-timber forest product; KINAPA = Kilimanjaro National Park; HMFS = Half-Mile Forest Strip social buffer forest (Wood 1965, Schabel 1990, Newmark 1991, Durrant 2004, Sébastien 2010).



according to the three agro-ecological zones (Soini 2005). The lowland zone extends below 1000 m and comprises intensive and mechanized cultivation of maize, beans, sunflower, sorghum, and extensive grazing pastureland. The natural vegetation of the lowland is savanna, and the average annual rainfall is 400–1500 mm. The midland zone is between 1000 and 1200 m and includes monocrops of maize and beans, with a few patches of monocrops of coffee and banana and open grazing pastureland. The natural vegetation of the midland is natural dry forest vegetation, bushland, and grassland, and receives an average annual rainfall of 1500 to 2000 mm. The upland zone is between 1700 and 1200 m and borders the National Park. It receives an average annual rainfall of 2000 mm and hosts most of the Chagga homegardens (Fig. 1).

To ultimately achieve a representation within the altitudinal and longitudinal gradients, we randomly sampled 14 out of 224 villages, ranging from 4 to 6 villages in each zone (Table 1). We calculated representative sample sizes of respondents to be surveyed at a 95% confidence level and with a margin of error between 8% and 11%. To identify respondents, we then used a geospatial sampling approach. We randomly selected coordinates in each village and chose the closest household, where the survey was administered to the head of the household when possible or, if the head of the household was absent, to any adult (18+ years old) present. We sampled 364 farmers evenly distributed across the altitudinal and longitudinal gradients (Table 1).

Table 1. Population size (N), sample size (n), and sampling error based on a confidence level of 95% for the zones of altitudinal and longitudinal gradients. Population data were sourced from the preliminary census results for population and housing in 2022 (URT 2022). NA = data is not available.

	Number of sampled villages	Population (N)	Margin of error (%)	Calculated sample size (n)	Sample size (n) in data set
Total	14	1,191,135			364
Altitudinal gradient					
Lowland	6	NA	NA	NA	159
Middle	4	NA	NA	NA	104
Upland	4	NA	NA	NA	101
Longitudinal gradient					
West	4	380,018	10	97	114
Center	6	535,803	8	151	160
East	4	275,314	11	80	90

Questionnaire design and data collection

The questionnaire comprised three main sections: (1) demands for NCP, (2) expression of values of nature, and (3) respondent's pro-environmental behavior, socio-demographic characteristics, and geographical location of the village (see Questionnaire in Appendix 1). We applied an interwoven approach to elicit NCP (Hill et al. 2021) that weaves the generalizing and context-specific NCP perspectives (Díaz et al. 2018). We first applied the context-specific perspective by conducting 130 semi-structured interviews from May 2021 to March 2022 with people residing in, working in, and traveling to Kilimanjaro. We provide the four versions of interview guidelines conducted with farmers (n = 44) in Kiswahili, nature conservationists (n = 28), tour guides (n = 20), and tourists (n = 38) in Appendix 2. For further detailed information about the interview collection and content analysis, see Appendix 3. Through these interviews, we identified 25 context-specific NCP provided by nature in Kilimanjaro, which we linked back to the generalizing classification of NCP (Díaz et al. 2018). We grouped them into regulating NCP (n = 10), material NCP (n = 6), and non-material NCP (n = 8). Intergenerational benefits of NCP, i.e., the capacity of

nature to provide benefits to future generations, cuts across all three NCP groups (Díaz et al. 2018), hence, we did not associate with any NCP group (Fig. 3).

In the second phase (August–October 2022), we conducted face-to-face surveys using a Kiswahili-translated questionnaire implemented in ArcGIS Survey 123 (Version 3.15.165; ESRI 2021). The survey covered different topics, of which four were used to elicit the demands for NCP and plural values of nature: (1) NCP demands, (2) expression of nature's values, (3) pro-environmental behavior, and (4) socio-demographic attributes (Appendix 1).

To detect NCP demands, we asked respondents to select the five NCP out of 25 NCP that are most important to them and which most contribute to their quality of life. To facilitate the exercise, we provided separate laminated A4 sheets with a list of the 25 NCP (Appendix 1), which included not only the NCP name but also an explanation with examples taken from the interviews and two photos illustrating each NCP (see, e.g., Iniesta-Arandia et al. 2014, Oteros-Rozas et al. 2014). After respondents selected an NCP, we asked them whether they perceived an "increasing," "stable," or "decreasing" trend in its local supply over the past 10 years. Although relying on respondents' memory can lead to biases as the accuracy of the information collected is likely to decline with interviewees' age, the 10-year time frame is considered a short enough period to reliably reflect respondents' recent memories while long enough to capture potential environmental change (Castro et al. 2016).

To elicit the diverse values of nature in Kilimanjaro, we used 20 value statements related to intrinsic (n = 2), instrumental (n = 2), and relational values (n = 16; Table 2). The intrinsic values statements were derived from the notion that nature has the right to exist independently of its usefulness for humans (Díaz et al. 2015, Arias-Arévalo et al. 2018). The instrumental value statements refer to the notion that nature has value as a means to achieve specific ends, such as fulfilling people's basic needs or providing economic benefits (Arias-Arévalo et al. 2017). Regarding relational values, we considered 16 statements representing meaningful relations between people and nature as well as those meaningful human-human relations mediated by nature (Chan et al. 2016), such as individual and collective identity, social cohesion, responsibility and stewardship, cognitive development, or aesthetics (Pratson et al. 2023).

We created the value statements based on a review of empirical research on the plural valuation of nature (Riechers et al. 2022a) and research targeting specific relational values, such as social cohesion (de la Torre-Castro and Lindström 2010, Riechers et al. 2022b), the maintenance of cultural and collective identities (McCright and Dunlap 2015, Schröter et al. 2020), and cultural heritage (Daniel et al. 2012, Pearson et al. 2019). We adapted the statements to the local context by relying on the information gathered through the 130 interviews (Appendices 2). For example, a farmer stated, "I feel also connected with nature because nature is me, and I am nature. Nature protects me, cares for me, and provides me with many things I need for my life ..." referring to their connectedness with nature. The selection of statements for each value was based first on previous empirical research (Arias-Arévalo et al. 2017, Riechers et al. 2022a, Schmitt et al. 2022). We later tuned the statements (including the number of statements) based on the nuances given by the former 130 interviews through content analysis (Appendix 3). For example, Arias-Arévalo et al. (2017) and Schmitt et al. (2022) coded instrumental values as a single category, however, through the content analysis we identified two different ways that they were expressed by interviewees: (1) nature as a means to satisfy basic needs, and (2) nature as a means to gain economic profit. Appendix 4 provides verbatim examples from the interviews representing each value statement. We asked respondents to assess the provided value statements using a four-point Likert scale, i.e., 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree (Appendix 1).

To generate information about respondents' pro-environmental behavior, i.e., any action that might minimize any adverse effects on nature (do Paço and Laurett 2018), we asked whether they were engaged in conservation activities. Finally, the socio-demographic section included questions on age, level of formal education, the place of birth of respondents and their parents, religion, and whether respondents entered KINAPA and were members of any association.

Before fieldwork, we recruited field assistants through local announcements in newspapers, the College of African Wildlife Management, Mweka, social media, and based on previous work experience in the project. We trained them during a six-day program that specifically focused on conducting face-to-face surveys, for instance, collecting data using the application Survey 123 (ESRI 2021) and research ethics. We pre-tested the questionnaire with the field participants in iterative rounds to make sure that the questions were well understood.

Ethical considerations

Before data collection, we informed respondents about our research aims and requested their verbal consent to participate in this study. We also informed them that all data would be treated confidentially and pseudo-anonymously. This research received ethical clearance from the Ethics Committee at the Leuphana University of Lüneburg (reference numbers: EB-Antrag_202104-07-Martin-Lopez_KiliSES; EB-Antrag_202111-17- Martin-Lopez_KiliSES-03; EB-Antrag_202109-12-Martin-Lopez_KiliSES-02; and EB-Antrag_202206-11-Martin-Lopez_KiliSES 02) Additionally, we were granted all necessary permits to conduct this research by the different Tanzanian institutions: i.e., Tanzania Commission for Science and Technology (COSTECH; reference number: 2021-363-NA-2021-09 and 2022-537-NA-2021-09), Tanzanian Wildlife Research Institute (TAWIRI), and executive commissioners at regional, district and local levels.

Data analysis

We conducted descriptive analyses of pro-environmental behavior and socio-demographic variables to determine the proportion of respondents for each variable. We determined the relative share of respondents who selected each NCP as one of the five most important NCP for their quality of life for the total sample and according to the altitudinal and longitudinal gradients. We used a dummy entry to code "1" if the respondent selected the NCP and "0" otherwise. Furthermore, we used the four-point Likert scale of the value statements to determine the percentage of respondents who (strongly) agree or (strongly) disagree with each value statement for the overall sample and zones of the altitudinal and longitudinal gradient.

Fig. 3. Overview of the 25 context-specific nature's contributions to people (NCP) used in this study, identified in interviews with people residing in, working in, and traveling to Kilimanjaro. Descriptions based on the interviews (e.g., Pearson et al. 2024) and Díaz et al. (2018); and NCP linked with the generalizing NCP category (Díaz et al. 2018), using an interwoven approach (Hill et al. 2021). The table is adapted from Gross et al. (2025). Icon design credit and gratitude to Jelke Meyer.

Regulating NCP	Generalizing NCP
Habitat creation and maintenance refer to nature's processes and conditions to form a place for people and non-human organisms to live and thrive and to continue providing such.	1. Habitat creation and maintenance
Pollination refers to animals' contribution of distributing pollen among flowers.	2. Pollination and dispersal of seeds and other propagules
Dispersal of seeds refers to animals' contribution to moving seeds.	
Regulation of air quality refers to nature's processes of purifying air to improve its quality for people.	3. Regulation of air quality
Regulation of climate refers to nature's regulation of atmospheric conditions, including effects on greenhouse gases and temperature, carbon sequestration and storage, and pleasant weather conditions.	4. Regulation of climate
Regulation of freshwater quantity refers to nature's hydrological processes to regulate the water flow and function as a source of water for various people-related purposes, such as irrigation and water for domestic use.	6. Regulation of freshwater quantity, location and timing
Regulation of freshwater quality refers to nature's processes of purifying water to improve its quality for people.	7. Regulation of freshwater and coastal water quality
Regulation of soil fertility and protection of soils refers to nature's processes to create and maintain soils and soil fertility, and to prevent soil erosion.	8. Formation, protection and decontamination of soils and sediments
Regulation of hazards and extreme events refers to nature's processes to prevent people and their infrastructure from damage caused by, for example, strong winds, and storms.	9. Regulation of hazards and extreme events
Regulation of detrimental species refers to the controlling effects derived from organisms and abiotic conditions on organisms that are pests or transmit diseases, e.g., the temperature limits the spatial coverage of anopheles mosquitos that can transmit the Malaria disease.	10. Regulation of detrimental organ-isms and biological processes
Material NCP	
Energy refers to the production of timber-based fuels such as firewood and hydropower.	11. Energy
Food refers to the production of food and beverages derived from wild, managed, or domesticated organisms such as maize, banana, coffee, milk, and meat.	12. Food and feed
Feed refers to the production of forage and fodder for domesticated animals such as grasses.	
Building materials refer to producing materials derived from nature to construct buildings such as timber.	13. Materials, companionship and labor
Materials for domestic use refer to producing materials derived from nature to make furniture, everyday objects, tools, aids, and accessories	
Medicine refers to the collection and production of materials derived from non-human organisms used for medicinal purposes such as insects and herbs.	14. Medicinal, biochemical and genetic resources
Non-material NCP	
Learning refers to the different levels of learning that can be experienced by and through nature, from education on different species to gaining new profound insights, which can influence one's outlook on life.	15. Learning and inspiration
Aesthetic enjoyment refers to the pure enjoyment of the aesthetic appearance and beauty of nature.	16. Physical and psychological experiences
Recreation refers to the provision of opportunities for physical, including recreational and touristic, activities in nature.	
Therapeutic and restorative benefits refer to nature's opportunities for therapeutic and restorative benefits such as healing, stress-relief, and relaxation.	
New and unique experiences refer to the provision by nature of new and unique opportunities for the human experience.	*Context-specific NCP that cannot be linked*
Connectedness with nature refers to the opportunities for people to develop or deepen a feeling of being part of and immersed in nature.	17. Supporting identities
Cultural heritage and identity refer to the opportunities in which nature and cultural rootedness, traditions, historical incidences, and people's identification blend, e.g., a whole country identifies with a natural entity.	
Social cohesion and bonding refer to the basis of nature for people to develop new connections or nurture their existing relationships with other people.	
Intergenerational benefits	
Intergenerational benefits refer to maintaining the existence of nature for future generations to experience.	18. Maintenance of options

Table 2. Overview of value statements used to assess the respondents' (dis)agreement level regarding nature's values. Value statements were created based on previous empirical research, which highlights the value (sub)categories (Arias-Arévalo et al. 2017, Riechers et al. 2022a, Schmitt et al. 2022, Pratson et al. 2023).

Category and name of nature's value	Value statement
Intrinsic values	
Right to existence and conservation	I value each species at Kilimanjaro because it has its reason for its existence and is, therefore, worthy of conservation.
Right to existence and prosperity	I value nature at Kilimanjaro because it has its own right to exist and prosper.
Instrumental values	
Basic needs	I value nature at Kilimanjaro because it contributes to meeting my/our basic needs, such as clean air and water.
Economic benefits	I value nature at Kilimanjaro because I/we economically benefit from it.
Relational values	
Cultural identity	I value nature at Kilimanjaro because it connects me/us with who we are as a culture/ethnic group/community.
Individual identity	I value nature at Kilimanjaro because our/my relationship with it is an important part of my/our culture.
Cultural heritage	I value nature at Kilimanjaro because it is relevant to the heritage and history of myself/our people/the nation.
Tradition	I value nature at Kilimanjaro because it connects me/us with my/our traditions and the way of life of my/our ancestors [former family members].
Social cohesion	I value nature at Kilimanjaro because it enables a sense of community.
Social relations	I value nature at Kilimanjaro because being in nature at Kilimanjaro gives me the opportunity to enjoy and deepen relationships with friends, family, and other people.
Cognitive	I value nature at Kilimanjaro because it is relevant for wisdom and knowledge of myself/our people.
Learning	I value nature at Kilimanjaro because I/we learn from and with it.
Stewardship	My/our care for nature at Kilimanjaro helps me/us to lead a good and fulfilling life.
Responsibility	I value being responsible for nature at Kilimanjaro and caring for it.
Aesthetic	I value nature at Kilimanjaro because I/we enjoy the beauty of its sights/sounds/smells.
Inspiration	I value nature at Kilimanjaro because it inspires me/us with new ideas and creativity.
Kinship	I value nature at Kilimanjaro because it is like family/friend/community to me/us.
Individual connectedness	I value nature at Kilimanjaro because I/we feel part of it.
Uniqueness	I value nature at Kilimanjaro because its uniqueness fulfills me/us.
New/special experiences	I value nature at Kilimanjaro because it fulfills me/us with new/special experiences that I have not experienced elsewhere.

To explore whether the NCP demands were affected by the perceptions of changes in the NCP supply, we first estimated the perceived trend index proposed by (Oteros-Rozas et al. 2014):

$$Overall\ perceived\ trend = (I - D)/(I + S + D) \quad (1)$$

Where I is the frequency of respondents who perceived an increasing trend, D is the frequency of respondents who perceived a decreasing trend, and S corresponds to the frequency of respondents who perceived no changes over the last 10 years. Second, we created biplots with the demand for NCP (y-axis) and the perception of NCP supply trends (x-axis) for the whole sample and the altitudinal and longitudinal gradients. Such biplots allow us to identify "critical" NCP, i.e., those NCP that are highly important for farmers' quality of life and are perceived as decreasing in supply, and those "important but not vulnerable" NCP, i.e., those NCP that are highly important for farmers' quality of life and are perceived as increasing in supply (Iniesta-Arandia et al. 2014).

Finally, to explore whether the NCP demands and values of nature were influenced by socio-demographic, pro-environmental behavior, and geographical variables, we conducted two redundancy analyses (RDAs): one for NCP demands and one for nature's values. RDA is a multivariate analysis used to analyze the relationship between multiple response variables and several explanatory variables (Legendre and Legendre 1998). In this study, response variables were the demands for NCP and the agreement level of nature's value statements. In the RDA regarding the NCP demands, we only considered those NCP selected by more than 10% of respondents, resulting in 15 NCP as response variables. To conduct the RDA for nature's values, we transformed the four-point-likert-scale of the value statements to binary variables, whereby "1" represents overall agreement with the value statement, i.e., 4 = strongly agree or 3 = agree, and "0" represents overall disagreement, i.e., 2 = disagree or 1 = strongly disagree. The explanatory variables comprised seven socio-demographic variables, two variables representing respondents' pro-environmental behavior, and the altitudinal and longitudinal location. Appendix 5 provides an overview of the variables used in RDAs. We log-transformed the variable age. The association revealed by both RDAs can be interpreted as bundles of NCP demand and nature's values, respectively. Here, bundles refer to those NCP or nature's values that repeatedly appear together because of diverging people's preferences and interests that ultimately shape their socio-cultural and environmental context (Martín-López et al. 2012, Klain et al. 2014). In both RDAs, we performed Monte Carlo permutation tests (500 permutations) to determine the significance of the explanatory variables. We used XLSTAT software Version 2020.3.1 (Addinsoft 2020) for statistical analyses.

RESULTS

Characteristics of respondents

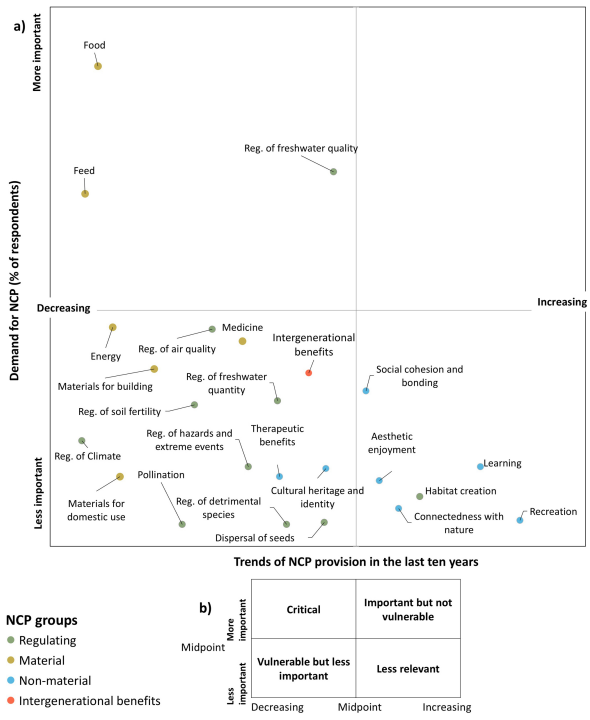
Overall, 58.5% (n = 213 respondents) of the respondents were female and 39.3% (n = 143) were male. The average age of respondents was 55.3 years (SD = 14.9). Most respondents, 59.3% (n = 216), completed primary school, 18.4% (n = 67) did not have formal education, 14.0% (n = 51) attended secondary school, and 6.8% (n = 25) finished vocational training or an undergraduate program. Nearly two-thirds of the respondents (62.6%, n = 228) were born in the surveyed village, and 87.9% (n = 320) stated their parents were born in Kilimanjaro. Only 21.4% (n = 79) of the respondents had entered Kilimanjaro National Park, and 24.7%

(n = 90) of respondents were active members of any association. Most respondents were Christian (89.3%, n = 325). Only a quarter of (24.7%, n = 78) were actively engaged in conservation activities such as tree planting (see sample characteristics in Appendix 6).

Respondents' demand for NCP: critical NCP

Respondents selected 24 out of 25 NCP as the most important for their quality of life. Respondents ranked material and regulating NCP above non-material NCP and intergenerational benefits (Fig. 4). Respondents mainly selected food (14.2%, n = 241), feed (10.5%, n = 177), and regulation of freshwater quality (11.1%, n = 188). We also found that these NCP were frequently selected across the altitudinal and longitudinal gradients (Fig. 5). Yet, some differences between zones emerged regarding regulation of air quality and, energy, and building materials (Fig. 5). Respondents living in upland, central, and eastern zones frequently selected regulation of air quality, while respondents in the midland and western zones prioritized medicine. In addition, respondents in the midland often selected energy, and those in the lowlands prioritized energy and material for building (Fig. 5). The respondents selected pollination (0.7%, n = 11), regulation of detrimental species (0.7%, n = 11), dispersal of seeds (0.7%, n = 12), recreation (0.8%, n = 13), and connectedness with nature (1.1%, n = 19) less frequently (Fig. 4). Overall, respondents did not select new and unique experiences, i.e., the ability of nature to provide opportunities for unique moments and experiences.

Fig. 4. Biplot presents (a) the relative share of 364 farmers regarding their demands for nature's contributions to people (NCP; y-axis) and the perceived NCP provision trends in the last 10 years (x-axis). Habitat creation = Habitat creation and maintenance, Reg = Regulation. (b) Vulnerability matrix presenting NCP demand and trends in NCP supply over the previous 10 years.



Except for habitat creation and maintenance, respondents perceived the 10-year supply trends of all material and regulating NCP as decreasing (Fig. 4). In contrast, they perceived the supply of most non-material NCP, except cultural heritage and identity and therapeutic and restorative benefits, as having increased in the same period (Fig. 4). This pattern of perception of NCP supply trend was almost consistent across altitudinal and longitudinal gradients (Fig. 5). Appendix 7 displays the relative share of respondents' perception of NCP supply trends across altitudinal and longitudinal gradients.

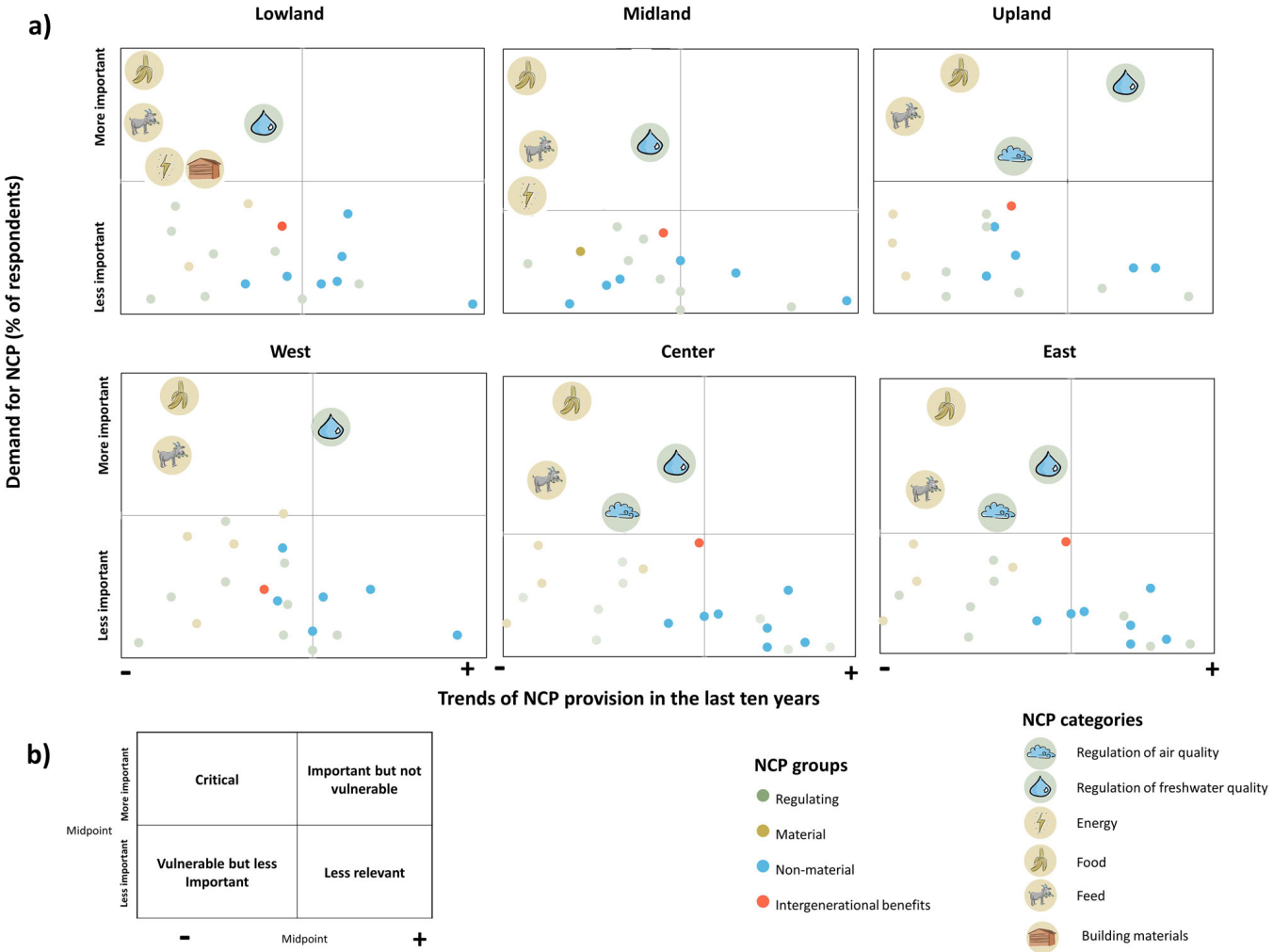
Finally, we found that the supply of frequently selected NCP, such as food, feed, and regulation of freshwater quality, were almost consistently perceived to be decreasing. The NCP food and feed were often referred to as being "critical," NCP that is highly important and perceived as decreasing in supply, across all altitudinal and longitudinal gradients (Fig. 5). The exception to this pattern was found only for the NCP "regulation of freshwater quality": respondents in upland and western zones perceived it to be increasing in supply. Moreover, we found further differences across different altitudinal and longitudinal zones for regulation of air quality and medicine. Regulation of air quality was considered "critical" in upland, central, and eastern zones, and medicine in midland and western zones. Finally, we found differences in the perception of "critical" NCP across altitudinal zones for energy and building materials, whereby energy was considered "critical" in midland and lowland and building materials in lowland (Fig. 5).

Factors influencing the NCP bundles demanded by farmers

We found a significant association ($p < 0.0001$, from 500 permutations) between the selection of NCP (RDA response variables) and the respondent's socio-demographic characteristics, pro-environmental behavior, and location (RDA explanatory variables; Table 3). The first four factors explained 69.6% of the total variance (Table 3). The positive scores of the first factor (F1; 27.5% of the total variance) revealed that those respondents living in the center and midland zone, who were active in conservation activities, and whose parents were born in Kilimanjaro were more likely to demand food, regulation of freshwater quantity, and intergenerational benefits (Table 3). This association conformed to an NCP bundle that we named "Food security for future generations" because it represents the importance of nature for future generations. In the negative scores of F1, we found that those respondents in the center and lowland zone, who belonged to any association and were born in the village, were more likely to demand building materials, feed, learning, social cohesion, and bonding (Table 3). We named this bundle "(Non-)materiality" because it comprises both material and non-material NCP.

The positive scores of the second factor (F2; 16.6%) revealed that regulation of air quality and freshwater quantity was more likely to be demanded by those respondents residing in the west and upland zones (Table 3). We named this bundle "Nature for Ecological Regulation in the Upland." In contrast, the negative scores of F2 revealed that the material NCP energy, food, feed, and building materials, a bundle named "Nature for Materials," were more likely to be demanded by respondents who live in the east zone. The third factor (F3; 14.3%) revealed the relationship between the demands for feed and cultural heritage and identity in its positive scores. These two NCP were more likely to be demanded by younger respondents with low levels of formal

Fig. 5. Biplots presenting (a) the relative share of 364 farmers regarding their demand for nature's contributions to people (NCP; y-axis) and perceived NCP provision trend in the last 10 years (x-axis) for each altitudinal (lowland, midland, upland) and longitudinal (west, center, and east) zone. (b) Vulnerability matrix presenting NCP demand and trends in NCP supply in the last 10 years. - Decreasing trend, + increasing trend in NCP supply. Icon design credit and gratitude to Jelke Meyer.



education and who live in the upland (Table 3). We named this bundle "Nature for Creating Identities" to highlight the connection between cultural identity and the use of nature. In the negative scores of F3, we found an association between the demands for regulation of climate, regulation of soil fertility and protection of soils, and regulation of hazards and extreme events, which was explained by older respondents who have a high level of education and live in the lowland. We named this bundle "Nature for Ecological Regulation in the Lowland." The fourth factor (F4; 11.2%) revealed that those respondents who were born in the village and belonged to any association were more likely to demand medicine, learning, and social cohesion, a bundle named "The Intangibility of Nature in the Lowland."

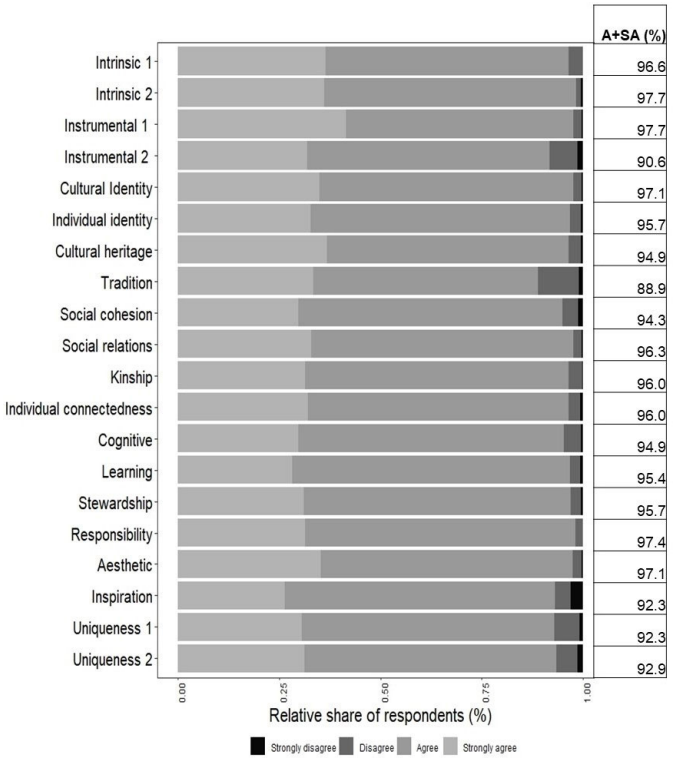
Respondents' expression of nature's values

Many respondents highly agreed with all value statements. We found the highest share of agreement for statements representing intrinsic value (97.1% of respondents who agreed or strongly agreed), followed by relational values (94.8%) and instrumental values (94.1%). Yet, the pattern for individual value statements varied slightly: the statement "I value each species at Kilimanjaro because it has its reason for its existence and is therefore worthy of conservation" referred to intrinsic values, and the statement "I value nature at Kilimanjaro because it contributes to meeting my/our basic needs such as clean air and water" referring to instrumental values were the most agreed upon (97.7% for both statements), followed by the relational value statement representing responsibility (97.4%) "I value being responsible for nature at Kilimanjaro and caring for it." The statement representing the instrumental value "economic benefits derived from nature" scored the second lowest percentage of agreement (90.6%), followed by the statement representing the relational value of tradition (88.9%; Fig. 6). The level of agreement for each value statement is relatively homogeneous along the longitudinal and altitudinal gradient. Appendix 8 displays the agreement level of all value statements.

Table 3. Factor (F) loadings derived from the redundancy analysis (RDA) illustrating the relationship between the demand for nature's contributions to people (NCP) and the socio-demographic, pro-environmental behavior, and geographical variables. We describe the explanatory variables in Appendix 5. RDA statistics are also displayed. Bold values indicate the response variables with the largest squared cosines (> 0.2) and the explanatory variables with the largest standardized coefficients (> 0.1).

	F1	F2	F3	F4
Response variables				
NCP				
Regulation of air quality	0.001	**0.301**	0.151	0.113
Regulation of climate	0.024	-0.083	**-0.145**	0.133
Regulation of freshwater quantity	**0.248**	0.131	-0.061	-0.04
Regulation of freshwater quality	-0.005	0.047	0.027	0.004
Regulation of soil fertility and protection of soils	-0.034	-0.02	**-0.137**	0.118
Regulation of hazards and extreme events	0.006	0.037	**-0.159**	-0.072
Energy	-0.056	**-0.137**	0.082	0.055
Food	**0.234**	**-0.191**	0.082	-0.152
Feed	-0.114	-0.134	**0.272**	0.059
Building materials	**-0.307**	-0.13	-0.094	0.069
Medicine	0.005	-0.085	0.041	**-0.167**
Learning	**-0.123**	0.087	-0.093	**-0.163**
Social cohesion and bonding	**-0.234**	0.078	0.023	**-0.144**
Cultural heritage and identity	0.004	0.11	**0.113**	-0.012
Intergenerational benefits	**0.331**	-0.062	-0.014	0.076
Explanatory variables				
Socio-demographic characteristics				
Age	0.046	-0.004	**-0.131**	0.035
Born in the surveyed village	**-0.059**	-0.019	-0.025	**0.093**
Parents were born in the Kilimanjaro region	**0.228**	-0.04	0.008	0.096
Christian	0.028	-0.039	0.087	**0.124**
Muslim	-0.028	0.039	-0.087	**-0.124**
Education	0.084	**0.088**	**-0.177**	0.033
Female	-0.005	-0.084	-0.011	-0.002
Male	0.005	0.084	0.011	0.002
Member of any association	0.138	-0.026	-0.068	**-0.134**
Entered KINAPA (Kilimanjaro National Park)	0.081	0.033	0.009	0.099
Pro-environmental behavior				
Active in conservation activities	**0.133**	-0.066	-0.056	0.033
Geographical location				
Lowland	**-0.205**	-0.074	**-0.108**	0.02
Midland	**0.164**	-0.077	0.044	-0.076
Upland	0.062	**0.159**	**0.076**	0.055
West	-0.133	0.1	-0.013	-0.077
Center	**0.218**	0.057	-0.009	0.084
East	-0.107	**-0.174**	0.024	-0.014
RDA statistics				
Eigenvalue	0.035	0.021	0.018	0.014
Percentage of variance explained	27.484	16.55	14.307	11.215
Cumulative percentage variance explained	27.484	44.034	58.341	69.556
Total inertia	1.323	0.797	0.689	0.54

Fig. 6. Relative share of respondents for each (dis)agreement level regarding nature's value. We present the value statements in Table 2. Intrinsic 1 = Right to existence and conservation; Intrinsic 2 = Right to existence and prosperity; Instrumental 1 = Basic needs; Instrumental 2 = Economic benefits; Uniqueness 2 = New/special experiences; A = Agree; SA = Strongly agree.



Factors influencing values of nature expressed by respondents

The values of nature expressed by respondents can be explained by socio-demographic, pro-environmental behavior, and geographical variables (RDA, $p < 0.014$, from 500 permutations). The first two factors explained 62.5% of the total variance (Table 4). The first factor (F1; 44.1%) in its positive scores indicated that those elders, i.e., respondents older than 58 years, who live in the village where they were born and reside in the midland zone were more likely to agree with the value statements representing the relational values of learning, cultural heritage, nature's uniqueness, and individual identity (Table 4). The positive scores of the second factor (F2; 18.4%) indicated that those elders who are active in conservation and live in the upland and eastern zones were more likely to agree with the value statements referring to the relational values of nature's uniqueness and responsibility (Table 4). The negative scores of F2 revealed that younger respondents, i.e., respondents younger than 45 years, who were born in the village where they live, had entered KINAPA, belonged to any association, and resided in the center were more likely to agree with statements referring to economic benefits, i.e., instrumental value, and the relational values of inspiration, cultural heritage, and learning (Table 4).

DISCUSSION

In the following sections, we discuss (1) the reasons why farmers in Kilimanjaro considered specific NCP as "critical," i.e., NCP preferred as highly important and perceived as decreasing in their supply, (2) the significance of exploring the internal heterogeneity of demand for NCP, and (3) the need for recognizing the multiple values of nature that farmers hold.

Table 4. Factor (F) loadings derived from the redundancy analysis (RDA) illustrate the relationship between nature's values and socio-demographic, pro-environmental behavior, and geographical variables. We describe nature's values in Table 3 and the explanatory variables in Appendix 5. RDA statistics are also displayed. Bold values indicate the response variables with the largest squared cosines (> 0.2) and the explanatory variables with the largest standardized coefficients (> 0.1).

Variables	F1	F2
Response variables		
Nature's values		
Right to existence and conservation	-0.004	0.012
Right to existence and prosperity	0.019	0.018
Basic needs	0.023	0.032
Economic benefits	0.074	**-0.211**
Cultural identity	**0.059**	-0.011
Individual identity	**0.136**	-0.080
Cultural heritage	**0.162**	**-0.112**
Tradition	**0.430**	0.061
Social cohesion	0.027	0.040
Social relations	0.030	-0.021
Kinship	0.064	0.039
Individual connectedness	**0.091**	0.000
Cognitive	0.039	-0.045
Learning	**0.102**	**-0.104**
Stewardship	0.004	-0.085
Responsibility	0.056	**0.074**
Aesthetic	-0.026	-0.043
Inspiration	0.107	**-0.127**
Uniqueness	0.029	0.081
New/special experiences	**0.241**	**0.139**
Socio-demographic characteristics		
Age	**0.181**	**0.054**
Born in the surveyed village	**0.142**	**-0.110**
Parents were born in Kilimanjaro	**-0.028**	-0.037
Christian	0.029	0.065
Muslim	-0.029	-0.065
Education	-0.056	**-0.108**
Female	-0.116	-0.001
Male	0.116	0.001
Member of any association	-0.012	**-0.167**
Entered KINAPA (Kilimanjaro National Park)	0.054	**-0.113**
Pro-environmental behavior		
Active in conservation activities	-0.011	**0.045**
Geographical location		
Lowland	-0.101	-0.001
Midland	**0.148**	-0.031
Upland	-0.037	**0.032**
West	0.082	0.05
Center	-0.009	-0.103
East	-0.078	0.065
RDA statistics		
Eigenvalue	0.015	0.006
Percentage of variance explained	44.05	18.437
Cumulative percentage variance explained	44.05	62.487
Total inertial	2.139	0.895

"Critical" NCP for farmers: environmental and institutional reasons

Our study provides an overview of the importance of several NCP supplied by nature in Kilimanjaro for farmers. We found that three of the most important NCP for farmers, food, feed, and regulation of freshwater quality, were perceived as having a decreasing supply trend in the past 10 years (Fig. 4). This result aligns with that of other studies, which also reported decreasing supply trends of NCP that were considered important for people's quality of life. For instance, Oteros-Rozas et al. (2014) found that the most important NCP were perceived as a decreasing supply trend in the transhumance social-ecological network in Spain. Hussain et al. (2023) found that villagers in a trans-Himalayan region of Ladakh, India, experienced a significant decline in most NCP.

The perception of food and regulation of freshwater quality as "critical" NCP is consistent with previous research that showed the relevance of mountains in providing food and clean water (Wangai et al. 2016, Ouko et al. 2018). Farmers' high demands for food might reflect that Kilimanjaro is one of Tanzania's largest food and cash crop producers (Sébastien 2010). The high demands for regulation of freshwater quality indicates farmers' increased dependence on streams, rivers, and springs as sources of domestic and agricultural water use (Said et al. 2019). Finally, the high demands for feed underscores farmers' importance on their stall-feeding livestock for their livelihoods, particularly in the absence of open areas for grazing (Soini 2005).

Previous studies revealed that the scarcity that people perceive in the supply of a particular NCP may influence the importance that they give to that NCP (Kaye-Zwiebel and King 2014, Quintas-Soriano et al. 2018). The scarcity of an NCP can result from the impact of environmental drivers, such as land use and climate change, and institutional drivers, such as policy changes (Díaz et al. 2018, Balázsi et al. 2019). For example, the fact that farmers perceived feed as a critical NCP in Kilimanjaro can be explained by the changes in legislation in 2005 (Fig. 2), when the social buffer forest known as Half-Miles Forest Strip (HMFS) was included in the national park, and hence, extracting feed was prohibited (Sébastien 2010, Kilima et al. 2015). Because of the change in conservation management of the HMFS, all consumptive use of resources and access to the park is restricted without a permit (Sébastien 2010). In an attempt to compensate local people for the loss of former rights, Kilimanjaro National Park Authority, through the Community Conservation Services (CCS), set up the "Ujirani Mwema" program (translated as Good Neighborhood in English) to provide alternatives for the feed supply through tree planting in the homegardens (Durrant and Durrant 2008) or buying feed from lowland farmers (Lukuyu et al. 2016). Despite these attempts by the National Park Authority, this study demonstrates that local farmers adjacent to KINAPA still consider feed a critical NCP because they continue struggling to fulfill their needs for forest-related NCP, as the national park officer personally communicated.

Geographical location may also influence people's perception of NCP supply (Cuni-Sanchez et al. 2016). We found farmers residing in the upland zone perceiving regulation of freshwater quality as important but not vulnerable (Fig. 5), which environmental and institutional reasons might explain. First, the vegetation cover is higher in the upland than in the lowland, which allows natural filtering and purifying water (Ensslin et al. 2015). Second, establishing the Rural Water Supply and Sanitation Agency (RUWASA) under the Water Supply and Sanitation Act No. 5 of 2019, an institution aiming to promote and sensitize

rural communities to sanitation, as well as protect and conserve rural water sources, might contribute to providing clean water in rural areas in Tanzania (URT 2019). Under this program, farmers in the upland receive environmental education to understand the importance of the forests as water catchments that benefit all people.

Furthermore, farmers in the midland and lowland zones considered energy and building materials critical NCP (Fig. 5). We argue that environmental, social, and institutional factors might underpin this perception. First, the lower vegetation cover in these zones, compared to the upland, might raise the preference for energy, including firewood and building materials. Similar results were found in the Eastern Arc Mountains in Tanzania, showing the increased demands for energy in recent years (Schaafsma et al. 2014). Moreover, the forest cover on the southern slopes of Kilimanjaro has decreased by about 41.04 km² since 1950 (Yanda and Shishira 2001, Rutten et al. 2015), reducing their capacity to provide material goods to people. Second, the increasing demands for firewood as the main cooking fuel in Kilimanjaro and other rural areas of Africa has led to its scarcity (Cuni-Sanchez et al. 2019, Bär et al. 2021). Finally, the currently enforced bylaw in the region that bans tree harvesting for timber production and firewood has resulted in declined use and production of timber, leading to high demands for firewood and building materials (Lyimo 2015). This ban is implemented by the Village Environmental Committee (VEC), a local institution that penalizes those who harvest timber without a permit. Moreover, the VEC also contributes to raising awareness about the importance of conserving the environment through, for example, tree planting activities. Nevertheless, its activities have not helped to solve the challenge of increasing demands for firewood and building materials (Lyimo 2015).

Based on the discussion on the differential perception of critical NCP along the altitudinal and longitudinal gradient of Kilimanjaro, we argue that both environmental and governance reasons underpin not only how people demand NCP (García-Llorente et al. 2015, Tauro et al. 2018) but also how people perceive the capacity of the ecosystem to supply NCP sustainably. Moreover, this study also shows the relevance of understanding NCP demand to support informed decision making for sustainable and inclusive conservation with the aim of not only conserving biodiversity but more effectively tackling trade-offs and mitigating the social costs of conservation (McShane et al. 2011, Palomo et al. 2014, Martínez-Harms et al. 2024).

Understanding NCP demands through bundles

We found that combining socio-demographic characteristics, pro-environmental behavior, and geographical location variables can explain farmers' differential demands for NCP in Kilimanjaro. Although previous research has acknowledged the importance of socio-demographic characteristics (Mensah et al. 2017, Lau et al. 2019, Porsani et al. 2020), pro-environmental behavior (Martín-López et al. 2007, 2012), and geographical location (García-Llorente et al. 2015, Cuni-Sanchez et al. 2016), our study examines the combination of all factors. Through the synergistic effect of these factors characterizing the internal heterogeneity, we identified seven bundles of NCP demand.

The bundle "Food security for future generations" refers to the importance frequently given to food, regulation of freshwater quantity, and intergenerational benefits by those farmers active in conservation, whose parents were born in Kilimanjaro. These farmers have a strong connection with their ancestral land, which has been conserved through traditional practices to preserve water sources and produce food (Kangalawe et al. 2014) that, in turn, might favor the supply of NCP for future generations.

The bundle "(Non-)materiality" represents the demand for material and non-material NCP by farmers born in the lowland and central zones who belong to any association. Although farmers in the lowland expressed high demand for material NCP, such as feed and building materials, because of the lower vegetation cover. They also demanded non-material NCP for learning, social cohesion, and bonding, possibly because their parents came to Kilimanjaro from other regions. Likewise, the bundle of "The Intangibility of Nature in the Lowland" indicates the importance of learning together and creating communities that foster social cohesion when a person emigrates from other regions of Tanzania (Gordon and Hale 2005). Moreover, the bundle "Nature for creating Identities" represents the need to continue embracing the cultural heritage and identity associated with the Chagga tribe by younger generations of the upland zone.

In addition to the consistent demands for non-material NCP, we also found bundles that mostly target material and regulating NCP. The bundle "Nature for Materials" represents those farmers living east of Kilimanjaro whose livelihood depends on selling their crops and timber in local and national markets (Schaafsma et al. 2014, Fundisha 2019). Finally, we found two bundles representing the demands for regulating NCP in the upland and lowland zones. Although the bundle "Nature for Ecological Regulation in the Upland" might represent the pride that Chagga farmers have for their homegardens and adjacent forest, the bundle "Nature for Ecological Regulation in the Lowland" represents those regulating NCP that are perceived as scarce, i.e., regulation of climate, regulation of soil fertility and protection of soils, and regulation of hazards and extreme events, because of the less vegetated landscapes of Kilimanjaro foothills (Hemp 2009).

These bundles provide evidence that farmers vary in their NCP demands, although farmers are usually studied through the lens of a single social actor group. Based on our results, we argue that we need to consider the internal heterogeneity within social actors and the factors underpinning that heterogeneity to foster meaningful inclusive conservation. This study shows that inclusive conservation planning needs to account for the diverse NCP demands represented in the different NCP bundles and the socio-demographic and geographical factors underpinning these demands. In the particular case of Kilimanjaro, this means, for example, pluralizing the management strategies to meet the diverse NCP demands across the altitudinal and longitudinal gradients and considering different sub-groups of farmers based on education, age or whether they and their families grew up in Kilimanjaro.

Nurturing values of nature: the role of farming practices

Farmers appreciate the nature of Kilimanjaro for multiple reasons, including the notion that nature has the right to exist by itself (intrinsic value), that nature is important to fulfill people's needs (instrumental value), and that its importance relies on those meaningful relations with and fostered by nature (relational value). Respondents highly agreed with all the statements

representing intrinsic, instrumental, and relational values (Fig. 6, Appendix 8). This result contradicts the findings of previous studies indicating that farmers of rural areas mostly expressed relational values (Arias-Arévalo et al. 2017, Klain et al. 2017, Riechers et al. 2021, Topp et al. 2022). Yet, farmers' high appreciation of intrinsic values, alongside instrumental and relational values, can be explained by the role of diverse livelihoods and economies, such as one of the Chagga homegardens, in nurturing diverse values (Ortiz-Przychodzka et al. 2023, Riechers et al. 2025). It is important to note that the high level of agreement with all value statements can be a by-product of the Likert scale because after evaluating each statement, respondents could decide that they agree with the content of all items. However, this is partially mitigated through the RDA, which analyzes the relationship between multiple response variables and several explanatory variables (Legendre and Legendre 1998), which showed that agreement levels with the value statements differed among farmers. Older farmers residing in the midland zone were more likely to agree with the relational values of individual identity and nature's uniqueness; younger farmers residing in the center who had visited the National Park and belonged to any association were more likely to agree with the importance of nature as a means for economic benefits and the relational value of inspiration (Table 4).

The coexistence of relational and instrumental values expressed by farmers living in the center zone and who were born in the surveyed village might support the notion that articulating a morality of care that considers ethical aspects for the conservation of nature is also possible in farming practices (Ortiz-Przychodzka et al. 2023). Farmers in Kilimanjaro simultaneously articulate plural values (Appendix 8), creating space to consider ethical reasons as a morality of care that comprises the importance of relations as ends-in-themselves and nature as a means-to-an-end. The existence of strong intrinsic, instrumental, and relational values expressed by farmers in Kilimanjaro offers opportunities to overcome the utilitarian narrative of farming practices, particularly mainstreamed in Western societies (Sørensen et al. 2023), that separates humans from nature and prioritizes human livelihoods over nature (Himes and Muraca 2018, Ortiz-Przychodzka et al. 2023).

Furthermore, older farmers in the upland who are engaged in conservation genuinely care about nature (Table 4). Chagga farmers have demonstrated a strong attachment to nature and even made concessions to ensure its conservation (Frömming 2009). The organization of the Chagga society is based on collaboration and cooperative principles to reach a balance between peoples' demands and nature conservation (Frömming 2009). This narrative is represented not only by the values (Table 4) but also by the perception of the singular role of nature in preserving and regulating NCP, i.e., the bundle "Nature for Ecological Regulation in the Upland" (Table 3). Nevertheless, future research could further uncover the role of different farming practices in activating, nurturing, and sustaining plural values. For example, Riechers et al. (2025) have found in different local communities' settings that, for instrumental values and livelihood practices to nurture and sustain relational values, the governance structure is essential. For nurturing and sustaining plural values, decision-making processes and governance need to give space for experiencing and expressing relational values (Harcourt 2023) and recognize property rights and access to natural resources in conservation policies (Riechers et al. 2025). This is especially important in Kilimanjaro and other social-ecological systems with protected areas where local communities are banned from accessing protected areas, ultimately leading to an erosion of relational values. Riechers et al. (2025) suggest that the empowerment of local communities in conservation planning can not only promote plural values but also foster transformative actions that strengthen people and nature connections. Therefore, we argue that inclusive conservation requires strategies and actions that purposefully activate, nurture, and sustain local communities' relational values across different social-ecological contexts. In doing so, conservation planning should not only recognize plural values expressed by local communities but also include their knowledge in the design of conservation strategies and engage them in conservation activities (Chaplin-Kramer et al. 2023, Martínez-Harms et al. 2024).

CONCLUSION

With this study, we unraveled the internal heterogeneity of the NCP demands and values of nature expressed by farmers in Kilimanjaro. Although we found that farmers perceived food, feed, and regulation of freshwater quality as the most critical NCP because of the need to fulfill basic needs, we found that considerable differences in the demands for NCP emerged when considering socio-demographic, pro-environmental behaviors, and geographical characteristics. Based on the internal heterogeneity, we found a distinctive demand for NCP, represented by seven bundles: "Food security for future generations," "(Non-)materiality," "Nature for Ecological Regulation in the Upland," "Nature for Ecological Regulation in the Lowland," "Nature for Materials," "Nature for creating Identities," and "The Intangibility of Nature in the Lowland." Likewise, we found that although farmers highly agreed (> 88% of respondents) with all the value statements representing intrinsic, instrumental, and relational values, some differences entailed mostly relational values based on socio-demographic, pro-environmental behavior, and geographical factors. These results might indicate that, although the reasons at a shallow level by which farmers in Kilimanjaro appreciate nature are related to the notion of nature as a means-to-an-end, there is an assembly of values at a deeper level. These values include ethical reasons and morality of care that co-exist with the importance of human-nature relations and human-human relations mediated by nature, as well as the relevance of nature as a means to fulfill basic needs.

Considering the heterogeneity of NCP demands and nature's values within one local social actor group can contribute to inform conservation in three realms. First, knowledge of the NCP demands contributes to being explicit about the losses and costs for local communities and ultimately, tackling unresolved conflicts. Second, knowledge of the diverse NCP demands contributes to diversifying management strategies that account for different sub-groups of local communities based on socio-demographic and geographical factors. Third, knowledge of the plural values of nature held by local communities can contribute to identifying management strategies to activate, nurture, or sustain assemblages of intrinsic, instrumental, and relational values (Riechers et al. 2025). For this to happen, conservation planning should not only respect plural values but also collaborate with local communities in the design, planning, and implementation of conservation strategies.

Author Contributions:

J.S., M.G., J.P., and B.M.-L. conceived the manuscript idea and designed the methodology; J.S., M.G., J.P., and N.R.K. collected the data; J.S., V.K., M.G., J.P., and B.M.-L. analyzed the data and led the writing of the manuscript; all authors interpreted the results, contributed critically to the drafts, and gave final approval for publication

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Data Availability:

All data used for this manuscript are accessible through the institutional repository, Pubdata of Leuphana University of Lüneburg, Germany: https://doi.org/10.48548/pubdata-1775.

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Appendix 1 Survey questionnaire and material

Introduction
Thank you for agreeing to this meeting today. We are conducting a survey that is part of a scientific project, funded by the German Research Foundation. This project is a collaboration between Tanzanian and International Researchers and attempts to better understand how people interact with nature at Mount Kilimanjaro.

For this research, we survey people who live on, work on and travel to Mount Kilimanjaro. You must be 18 or older to participate in the study. The survey will take approximately 90 minutes. As a participant in this research, your participation is entirely voluntary. You are free to leave at any time if you do not feel comfortable being involved in this study. You may refuse to answer any questions you do not feel comfortable answering at any time. Please note that for most of the questions, there is no right or wrong answer. We are interested in your opinion. If you have any questions at any point during the survey, please don't hesitate to ask.

Your identity and information will remain completely confidential and anonymous so we can ensure that this is not revealed in any outcomes from this study. You are also free to ask any questions or raise any concerns you may have about this study at any time. You will also be able to stay in contact after this study has been completed to provide feedback or access the final outputs. Upon completion of this project, all data will be stored in a secure location (and destroyed after exceeding the legal retention period of 10 years).

Do you want to participate in this survey?

Yes / No

Preliminary information
Location [village] *[Variable: altitude and latitude zone]*

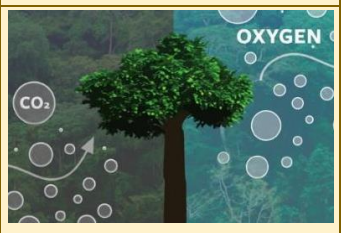
Nature's Contributions to People (NCP)

We are interested in the contributions you gain from nature in Kilimanjaro (from lowlands to the peaks - beyond the border of National Park) which are important for you and your life [For Swahili speakers: nature = mazingira asili.]. We have identified 25 contributions through interviews with people who live on, work at, or visited Kilimanjaro. *[Provide set A/B/C (software randomly selects a set)* to the participant.] I would like to show you a list of these 25 identified contributions. *[Show column 'name']* We added examples that interviewees mentioned for each of the contributions *[Show column 'examples'.],* and example pictures that represent them *[Show column 'exemplary photos'].* You can ignore the letters [Point a first column with letters.] they don't have a meaning for you but help us to correctly insert your responses.

Step 1: Please carefully read the list and select up to 5 contributions according to their importance for you and your life. Which are the five most important contributions – important for you and your life? If you need some aid to memory, feel free to take the pen and add some symbols/comments. When you have finished your selection, please name the contributions you have selected, so we can proceed. Please take your time reading through the list and then read out the contributions you selected. [1. Pick the selected NCP cards mentioned by the participant from the set of all NCP cards (plastic sleeve). 2. Put the NCP set sheets aside to have space for the next step] *[Variable: NCP demand]*

Step 2: Now that you selected the five most important contributions, I would like to ask you about the supply/provision of the contribution provided by nature in Kilimanjaro. How has the supply/provision of the contribution changed in the past 10 years? [state whether the provision has 'increased', "stable" or "decreased"] *[Variable: NCP supply trend]*

SET A

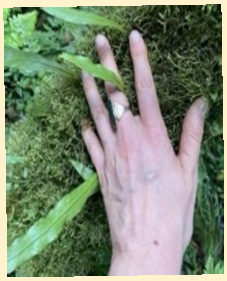
	NAME	EXAMPLES	EXEMPLARY PHOTOS	
A	**Habitat creation and maintenance**	• Habitat for animals • Habitat for people • Forest is home to animals and plants • Elephants as architects of the ecosystem		
B	**Pollination**	• Pollination by insects such as bees • Pollination by birds		
C	**Dispersal of seeds**	• Seed dispersal by animals, for example elephants and birds		
D	**Regulation of air quality**	• Fresh and clean air • Nature, e.g., plants, trees, provides oxygen		
E	**Regulation of climate**	• Carbon sink and sequestration • Shade for temperature or moisture control • Microclimate of Kilimanjaro • Pleasant and nice weather of Kilimanjaro		
F	**Regulation of freshwater quantity**	• Rainfall • Water flow in catchments, lakes, streams or rivers		
G	**Regulation of freshwater quality**	• Nature improves the quality of the water • Drinking, clean and safe water		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
H	**Regulation of soil fertility and protection of soils**	• Fertile and rich soil • Nutrients in the soil • Planting trees to prevent soil erosion		
I	**Regulation of hazards and extreme events**	• Trees help to prevent landslides • Trees as windbreakers • Without nature, there will be droughts [dry periods]		
J	**Regulation of detrimental species**	• Disease prevention • Less mosquitoes in higher elevation • Bees deter elephants • Plant used to catch the mole rat		
K	**Energy**	• Firewood • Charcoal • Hydropower		
L	**Food**	• Crops for eating such as fruit and vegetables • Coffee • Animal products such as milk, meat, honey etc. • Mbege [banana beer]		
M	**Feed**	• Fodder • Grass for livestock animals such as cows, goats etc. • Food scraps such as banana peels for livestock		
N	**Materials for building and construction**	• Raw materials to build infrastructure • Timber as building material for, e.g., sheds and houses • Rock as construction material		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
O	**Materials for domestic use**	• Timber to make furniture • Banana materials used for beds, roof of houses, baskets, umbrellas, seed base, etc. • Jewellery made from oyster nut shells • Lianas used as ropes		
P	**Medicine**	• Nature used for medicinal purposes • Medicinal honey from stingless bees • Traditional medicine		
Q	**Learning**	• Improved knowledge and understanding • Cultural exchange • Influence on life perspective • Personal or emotional growth		*Removed for consent purposes*
R	**Aesthetic enjoyment**	• Nature is beautiful • Visually pleasant scenery • Picturesque and incredible views • The beauty of the mountain		
S	**Recreation**	• Animal-watching • Camping • Swimming • Hiking, walking or exercising		
T	**Therapeutic and restorative benefits**	• Break from technology and modern life • Healing • Peace and solitude • Relaxation and stress-relief		*Removed for consent purposes*
U	**Social cohesion and bonding**	• Social relations with other people • Bonding and comradery • Community building • Friendship or family ties	*Removed for consent purposes*	

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
V	**Cultural heritage and identity**	• Ancestral ties • Cultural identity • Local, traditional and Indigenous heritage • Sacred places		*Removed for consent purposes*
W	**Connectedness with nature**	• Emotional, physical or spiritual connection with nature • Being 'one with' nature and/or feeling like part of it • Friendship, family ties or other relationship with nature, e.g., the trees are my best friends		
X	**Inter-generational benefits**	• Continued existence of biodiversity • Conservation of benefits for future generations • I want my children and grandchildren to see the beauty of nature • Preserve nature for future generations		
Y	**New and unique experiences**	• Nature's uniqueness • Diversity of ecosystems on one mountain • Snow and glaciers in the tropics • I have never experienced nature like this before		

SET B

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
Y	**New and unique experiences**	• Nature's uniqueness • Diversity of ecosystems on one mountain • Snow and glaciers in the tropics • I have never experienced nature like this before		
X	**Inter-generational benefits**	• Continued existence of biodiversity • Conservation of benefits for future generations • I want my children and grandchildren to see the beauty of nature • Preserve nature for future generations		
U	**Social cohesion and bonding in nature**	• Social relations with other people • Bonding and comradery • Community building • Friendship or family ties	*Removed for consent purposes*	
V	**Cultural heritage and identity through nature**	• Ancestral ties • Cultural identity • Local, traditional and Indigenous heritage • Sacred places		*Removed for consent purposes*
W	**Connectedness with nature**	• Emotional, physical or spiritual connection with nature • Being 'one with' nature and/or feeling like part of it • Friendship, family ties or other relationship with nature, e.g., the trees are my best friends		
S	**Recreation**	• Animal-watching • Camping • Swimming • Hiking, walking or exercising		

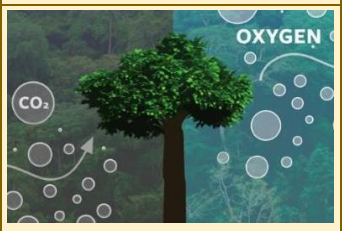
	NAME	EXAMPLES	EXEMPLARY PHOTOS	
R	**Aesthetic enjoyment**	• Nature is beautiful • Visually pleasant scenery • Picturesque and incredible views • The beauty of the mountain		
T	**Therapeutic and restorative benefits from / in nature**	• Break from technology and modern life • Healing • Peace and solitude • Relaxation and stress-relief		*Removed for consent purposes*
Q	**Learning**	• Improved knowledge and understanding • Cultural exchange • Influence on life perspective • Personal or emotional growth		*Removed for consent purposes*
P	**Medicine**	• Nature used for medicinal purposes • Medicinal honey from stingless bees • Traditional medicine		
M	**Feed**	• Fodder • Grass for livestock animals such as cows, goats etc. • Food scraps such as banana peels for livestock		
N	**Materials for building and construction**	• Raw materials to build infrastructure • Timber as building material for, e.g., sheds and houses • Rock as construction material		
O	**Materials for domestic use**	• Timber to make furniture • Banana materials used for beds, roof of houses, baskets, umbrellas, seed base, etc. • Jewelry made from oyster nut shells • Lianas used as ropes		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
L	**Food**	• Crops for eating such as fruit and vegetables • Coffee • Animal products such as milk, meat, honey etc. • Mbege [banana beer]		
K	**Energy**	• Firewood • Charcoal • Hydropower		
F	**Regulation of freshwater quantity**	• Rainfall • Water flow in catchments, lakes, streams or rivers		
H	**Regulation of soil fertility and protection of soils**	• Fertile and rich soil • Nutrients in the soil • Planting trees to prevent soil erosion		
G	**Regulation of freshwater quality**	• Nature improves the quality of the water • Drinking, clean and safe water		
A	**Habitat creation and maintenance**	• Habitat for animals • Habitat for people • Forest is home to animals and plants • Elephants as architects of the ecosystem		
J	**Regulation of detrimental species**	• Disease prevention • Less mosquitoes in higher elevation • Bees deter elephants • Plant used to catch the mole rat		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
I	**Regulation of hazards and extreme events**	• Trees help to prevent landslides • Trees as windbreakers • Without nature, there will be droughts [dry periods]		
B	**Pollination**	• Pollination by insects such as bees Pollination by birds		
E	**Regulation of climate**	• Carbon sink and sequestration • Shade for temperature or moisture control • Microclimate of Kilimanjaro • Pleasant and nice weather of Kilimanjaro		
D	**Regulation of air quality**	• Fresh and clean air Nature, e.g., plants, trees, provides oxygen		
C	**Dispersal of seeds**	• Seed dispersal by animals, for example elephants and birds		

SET C

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
N	**Materials for building and construction**	• Raw materials to build infrastructure • Timber as building material for, e.g., sheds and houses • Rock as construction material		
O	**Materials for domestic use**	• Timber to make furniture • Banana materials used for beds, roof of houses, baskets, umbrellas, seed base, etc. • Jewelry made from oyster nut shells • Lianas used as ropes		
P	**Medicine**	• Nature used for medicinal purposes • Medicinal honey from stingless bees • Traditional medicine		
L	**Food**	• Crops for eating such as fruit and vegetables • Coffee • Animal products such as milk, meat, honey etc. • Mbege [banana beer]		
M	**Feed**	• Fodder • Grass for livestock animals such as cows, goats etc. • Food scraps such as banana peels for livestock		
K	**Energy**	• Firewood • Charcoal • Hydropower		
J	**Regulation of detrimental species**	• Disease prevention • Less mosquitoes in higher elevation • Bees deter elephants • Plant used to catch the mole rat		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
I	**Regulation of hazards and extreme events**	• Trees help to prevent landslides • Trees as windbreakers • Without nature, there will be droughts [dry periods]		
E	**Regulation of climate**	• Carbon sink and sequestration • Shade for temperature or moisture control • Microclimate of Kilimanjaro • Pleasant and nice weather of Kilimanjaro		
G	**Regulation of freshwater quality**	• Nature improves the quality of the water • Drinking, clean and safe water		
H	**Regulation of soil fertility and protection of soils**	• Fertile and rich soil • Nutrients in the soil • Planting trees to prevent soil erosion		
D	**Regulation of air quality**	• Fresh and clean air • Nature, e.g., plants, trees, provides oxygen		
B	**Pollination**	• Pollination by insects such as bees • Pollination by birds		
C	**Dispersal of seeds**	• Seed dispersal by animals, for example elephants and birds		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
A	**Habitat creation and maintenance**	• Habitat for animals • Habitat for people • Forest is home to animals and plants • Elephants as architects of the ecosystem		
F	**Regulation of freshwater quantity**	• Rainfall • Water flow in catchments, lakes, streams, or rivers		
V	**Cultural heritage and identity through nature**	• Ancestral ties • Cultural identity • Local, traditional and Indigenous heritage • Sacred places		*Removed for consent purposes*
U	**Social cohesion and bonding in nature**	• Social relations with other people • Bonding and comradery • Community building • Friendship or family ties	*Removed for consent purposes*	
T	**Therapeutic and restorative benefits from / in nature**	• Break from technology and modern life • Healing • Peace and solitude • Relaxation and stress-relief		*Removed for consent purposes*
W	**Connectedness with nature**	• Emotional, physical or spiritual connection with nature • Being 'one with' nature and/or feeling like part of it • Friendship, family ties or other relationships with nature, e.g., the trees are my best friends		
S	**Recreation**	• Animal-watching • Camping • Swimming • Hiking, walking or exercising		

	NAME	EXAMPLES	EXEMPLARY PHOTOS	
X	**Inter-generational benefits**	• Continued existence of biodiversity • Conservation of benefits for future generations • I want my children and grandchildren to see the beauty of nature • Preserve nature for future generations		
Y	**New and unique experiences**	• Nature's uniqueness • Diversity of ecosystems on one mountain • Snow and glaciers in the tropics • I have never experienced nature like this before		
Q	**Learning**	• Improved knowledge and understanding • Cultural exchange • Influence on life perspective • Personal or emotional growth		*Removed for consent purposes*
R	**Aesthetic enjoyment**	• Nature is beautiful • Visually pleasant scenery • Picturesque and incredible views • The beauty of the mountain		

Nature's values

I would like to ask for your agreement on the following statements that I am reading about why you value nature in Kilimanjaro. *[Read set A/B/C (software randomly selects a set). An example of a set is provided below for the reader].* For each one, please indicate whether you "strongly disagree" (1), "disagree" (2), "agree" (3) or "strongly agree" (4). There are no right and wrong answers. We are interested in your personal opinion. *[Variable: Nature's values]*

Statements of nature's values	**Level of agreement (1-4)**
I value nature at Kilimanjaro because I/we feel part of it.	
I value nature at Kilimanjaro because it has its own right to exist and prosper.	
I value nature at Kilimanjaro because it connects me/us with who we are as a culture/ethnic group/community.	
I value nature at Kilimanjaro because I/we economically benefit from it.	
My/our care for nature at Kilimanjaro helps me/us to lead a good and fulfilling life.	
I value nature at Kilimanjaro because our/my relationship with it is an important part of my/our culture.	
I value each species at Kilimanjaro because it has its particular reason for its existence, and therefore, it is worthy of conservation.	
I value nature at Kilimanjaro because it connects me/us with my/ our traditions and the way of life of my/our ancestors [former family members].	
I value nature at Kilimanjaro because its uniqueness fulfills me/us.	
I value nature at Kilimanjaro because it is like family/friend/community to me/us.	
I value nature at Kilimanjaro because it is relevant to the heritage and history of myself/our people/the nation.	
I value nature at Kilimanjaro because it fulfills me/us with new/special experiences that I have not experienced elsewhere.	
I value nature at Kilimanjaro because I/we learn from and with it.	
I value nature at Kilimanjaro because it contributes to meeting my/our basic needs such as clean air and water.	
I value being responsible for nature at Kilimanjaro and taking care of it.	
I value nature at Kilimanjaro because I/we enjoy the beauty of its sights/sounds/smells.	
I value nature at Kilimanjaro because it inspires me with new ideas and creativity.	
I value nature at Kilimanjaro because it enables a sense of community.	
I value nature at Kilimanjaro because it is relevant for wisdom and knowledge of myself/our people.	
I value nature at Kilimanjaro because it gives me the opportunity to enjoy and deepen relationships with friends, family, and other people.	

General pro-environmental behavior and socio-demographic characteristics

- Have you ever been inside Kilimanjaro National Park? Yes/No *[Variable: Entered Kilimanjaro National Park]*
- In which year were you born? *[Variable: Age]*
- Were you born and raised in this village? Yes/No *[Variable: Born in the surveyed village]*
- Have your parents lived in Kilimanjaro? Yes/No *[Variable: Parents were born in Kilimanjaro]*
- What is your highest level of formal education? *[Variable: Education]*
- Within Kilimanjaro, do you engage in nature and/or environmental conservation? *[Variable: Active in conservation activities]*
- Are you a member of any association? Yes/no *[Variable: Member of any association]*
- Gender [It is inappropriate to ask locals for their gender ad to ask for diverse gender identity in the cultural context of the survey. Hence, the survey taker inserted the gender *[Female or Male]* of the survey respondent after the survey was finished]. *[Variable: Gender]*

Thank you!

This is the end of the questionnaire. Thank you so much for taking the time to answer this survey! I really appreciate your willingness to share your experience and perspective on nature at Mount Kilimanjaro. You have made a valuable contribution to this research project.
As a thank you we would like to compensate you [survey taker gives the compensation to the respondent]
Also, here is my card with contact information. You can find more information about our project here: https://kili-ses.senckenberg.de. If you would like to receive a signed consent/consent form to participate in our study, please send an email to [name of researcher]
You can withdraw your answers anytime for any reason and without penalty. If you want to do so, please email [name of researcher] and state your ID.

If you would like to receive a summary of the results, please email [name of researcher].

Appendix 2: Interview guides for farmers, nature conservationists, tour guides and tourists

Appendix 2.1: Farmers' interview guide

Introduction

Hello, my name is *(<names removed for peer-review process>)*. I am a researcher OR field assistant at Leuphana University, located in Germany.
First of all, thanks so much for taking the time to participate in this interview. You are making a valuable contribution to research by improving our understanding of nature´s contributions to people.
The interview is structured into two sections. I will start with a series of questions on how you experience, benefit from and value nature at Mt Kilimanjaro. We will finish off the interview with some standard socio-demographic questions about yourself and a few final wrap-up questions.
As stated in the consent form, your information will be treated confidentially. All answers given are anonymous and cannot be traced back to you.
We planned the interview for 30-45 minutes. However, please feel free to expand on the topic or talk about related ideas. I have sufficient time. Depending on how much you want to expand on the questions, our experiences proved: Our interview can take longer. I just want to know whether you have to 'leave' at some point or how much of your time you are willing to dedicate to our research project. (In case time is limited: If I sense that won't finish in the time available, is it okay, if I let you know)
Please note that there are no wrong answers to our questions. I am interested in your honest opinion and perspectives. Your answers do not need to be profound. It is ok to say ´I don´t know´ for questions that you are unable to answer. I don't want you to make up answers because you feel you have to.
If there is any question that you are not comfortable answering, please let me know and we can skip it. If *you* have any questions for me at any point during the interview, please don't hesitate to ask.
Let me know when you are ready and I will start the recording.

Introductory questions about interviewee

a) What is your current job (confirm job title if already pre-discussed with interviewee)?
   i) Are you self-employed, or do you work for a farming organization?
   ii) In how many farms are you working? And where are they?
   iii) Do you own the farm/s? Or is it shared?
   iv) When did you start working as a <insert profession name>?
   v) What motivated you to start working as a <insert profession name>?
   vi) What does your job entail on a daily basis?
   vii) What do you enjoy most about your job? Why?

Questions related to Nature's Contributions to People (NCP)

1. (I. Appreciation) *What do you appreciate about nature at Mount Kilimanjaro (We consider the entire mountain area, i.e., from the foothills of the mountain with its agricultural fields and settlements to its top including the National Park?*
   a. *What do you think other people (who live on, work at and come as tourists to Mount Kilimanjaro) appreciate about nature at Mount Kilimanjaro?*
2. (II. Benefits) *Do you think that nature at Mount Kilimanjaro provides benefits to humans? If yes, what are the benefits of nature at Kilimanjaro?*
   a. *For you?*
   b. *For your family?*
   c. *For local communities and society as a whole?*
3. (III. Well-being) *What does nature at Mount Kilimanjaro contribute to*
   a. *your well-being? Feel free to think about 'well-being' in the broadest sense of the word including any type or dimension of 'well-being'. This can be related to mental and physical well-being or beyond.*
   b. *other people (who live on, work at and come as tourists to Mount Kilimanjaro)'s well-being?*

4. (II. Benefits) *Are there any other contributions and/or benefits of nature at Mount Kilimanjaro to you and other people (who live on, work at and come as tourists to Mount Kilimanjaro) that you can think of?*
    a. *for example, in environmental, economic, social or terms?*
5. (IV. Importance) *Do you think nature at Mount Kilimanjaro is important? Why?*
    a. *Optional, if not addressed before: For you personally? Why?*
    b. *Optional, if not addressed before: in the role of <insert profession name>? Why?*
    c. *Optional, if not addressed before: For other people (who live on, work at and come as tourists to Mount Kilimanjaro)? Why?*
6. Do you think that nature at Mount Kilimanjaro provides any threats and/or negative impacts to humans? If yes, what are these?
    a. How do you manage these threats and/or negative impacts?
7. Do you think your living at Mount Kilimanjaro affects nature? How and why?

Socio-demographic information

1. What is your age?
    i) What is your gender?
    ii) What is your highest level of formal education?
    iii) Where do you currently live?
        i. How many years of your life did you live / have you been living in the Mount Kilimanjaro area?
        ii. Where did you grow up (age: 0-12 years)?

Final questions

1. That's all the questions I have for you. Is there anything else you would like to add to the interview? Do you have any questions for me?
2. Optional, if we still need interviewees: Is there anyone else you know who might be able to participate in this interview?

Thanks so much for your time and for sharing your experience with nature at Mount Kilimanjaro and its surroundings. You will also be in touch with information about the results of this work.

Appendix 2.2: Nature conservationist and tour guide

Introduction

Hello, my name is (<names removed for peer-review process>). I am a researcher OR field assistant at Leuphana University, located in Germany.
First of all, thanks so much for taking the time to participate in this interview. You are making a valuable contribution to research by improving our understanding of nature´s contributions to people.
The interview is structured into two sections. I will start with a series of questions on how you experience, benefit from and value nature at Mt Kilimanjaro. We will finish off the interview with some standard socio-demographic questions about yourself and a few final wrap-up questions.
As stated in the consent form, your information will be treated fully confidential. All answers given are anonymous and cannot be traced back to you.
We planned the interview for 30-45 min. However, please feel free to expand on the topic or talk about related ideas. I have sufficient time. Depending on how much you want to expand on the questions, our experiences proved: Our interview can take longer. I just want to know whether you have to 'leave' at some point or how much of your time you are willing to dedicate to our research project. (In case time is limited: If I sense that won't finish in the time available, is it okay, if I let you know)
Please note that there are no wrong answers to our questions. I am interested in your honest opinion and perspectives. Your answers do not need to be profound. It is ok to say ´I don´t know´ for questions that you are unable to answer. I don't want you to make up answers because you feel you have to.
If there is any question that you are not comfortable answering, please let me know and we can skip it. If *you* have any questions for me at any point during the interview, please don't hesitate to ask.
Let me know when you are ready and I will start the recording.

Introductory questions about interviewee

A. What is your current job title?

Questions related to Nature's Contributions to People (NCP)

8. (I. Appreciation) *What do you appreciate about nature at Mount Kilimanjaro (We consider the entire mountain area, i.e., from the foothills of the mountain with its agricultural fields and settlements to its top including the National Park?*
   a. *What do you think other people (who live on, work at and come as tourists to Mount Kilimanjaro) appreciate about nature at Mount Kilimanjaro?*

9. (II. Benefits) *Do you think that nature at Mount Kilimanjaro provides benefits to humans? If yes, what are the benefits of nature at Kilimanjaro?*
   a. *For you?*
   b. *For your family?*
   c. *For local communities and society as a whole?*

10. (III. Well-being) *What does nature at Mount Kilimanjaro contribute to*
   a. *your well-being? Feel free to think about 'well-being' in the broadest sense of the word including any type or dimension of 'well-being'. This can be related to mental and physical well-being or beyond.*
   b. *other people (who live on, work at and come as tourists to Mount Kilimanjaro)'s well-being?*

11. (II. Benefits) *Are there any other contributions and/or benefits of nature at Mount Kilimanjaro to you and other people (who live on, work at and come as tourists to Mount Kilimanjaro) that you can think of?*
   a. *for example, in environmental, economic, social or terms?*

12. (IV. Importance) *Do you think nature at Mount Kilimanjaro is important? Why?*
13. Optional, if not addressed before: For you personally? Why?
14. Optional, if not addressed before: in the role of <insert profession name>? Why?
15. Optional, if not addressed before: For other people (who live on, work at and come as tourists to Mount Kilimanjaro)? Why?

Socio-demographic information

iv) What is your age?

v) What is your gender?
vi) What is your highest level of formal education?
vii) Where do you currently live?
    i. How many years of your life did you live / have you been living in the Mount Kilimanjaro area?

Final questions

16. That's all the questions I have got for you. Is there anything else you would like to add to the interview? Do you have any questions for me?
17. Optional, if we still need interviewees: Is there anyone else you know who might be able to participate in this interview?

Thanks so much for your time and for sharing your experience with nature at Mount Kilimanjaro with me. I'll also be in touch with information about the results of this work.

Text A2.3 Tourists' interview guides

Introduction

Hello, my name is (<names removed for peer-review process>) and I am a researcher at Leuphana University, located in Germany.
First of all, thanks so much for taking the time to participate in this interview. You are making a valuable contribution to research by improving our understanding of nature´s contributions to people.
The interview is structured into three sections. I will start with some general questions about your experience at Mount Kilimanjaro followed by a series of questions on how you have benefited from and value nature at Mt Kilimanjaro. We will finish off the interview with some standard socio-demographic questions about yourself and a few final wrap-up questions.
As stated in the consent form, your information will be treated fully confidential. All answers given are anonymous and cannot be traced back to you.
We planned the interview for 30-45 min. However, please feel free to expand on the topic or talk about related ideas. I have sufficient time. Depending on how much you want to expand on the questions, our experiences proved: Our interview can take longer. I just want to know whether you have to 'leave' at some point or how much of your time you are willing to dedicate to our research project. (In case time is limited: If I sense that won't finish in the time available, is it okay, if I let you know)
Please note that there are no wrong answers to our questions. I am interested in your honest opinion and perspectives. Your answers do not need to be profound. It is ok to say ´I don´t know´ for questions that you are unable to answer. I don´t want you to make up answers because you feel you have to.
If there is any question that you are not comfortable answering, please let me know and we can skip it. If *you* have any questions for me at any point during the interview, please don't hesitate to ask.
Let me know when you´re ready and I will start the recording.

General experience of Mount Kilimanjaro

A. When did you visit Mount Kilimanjaro (month and year)?
    a. Is that the only time you have been?
    b. How long was your visit/s? (number of days) (record for all visits)
B. Did you enter the National Park? (record for all visits)
    a. If they climbed, did you climb to the top? (record for all visits)

Questions related to Nature's Contributions to People (NCP)

3. <u>(I. Appreciation)</u> a. What did you appreciate about nature at Mount Kilimanjaro? (*Our questions refer to when you visited Mount Kilimanjaro and your perception afterwards).*
    b. What do other people appreciate? *These examples can be either things you've witnessed personally or that you've heard from other people.*
4. <u>(III. Well-being)</u> What did nature at Mount Kilimanjaro contribute to
    a. your well-being? *Feel free to think about 'well-being' in the broadest sense of the word including any type or dimension of 'well-being'. This can be related to mental and physical well-being or beyond.*
    b. other people's well-being?
5. <u>(II. Benefits)</u> What are some other contributions and/or benefits of nature at Mount Kilimanjaro to you and other people that you can think of?

a. for example, in environmental, economic, social or cultural terms?

6. (IV. Importance) Do you think nature at Mount Kilimanjaro is important? Why?
    a. Optional, if not addressed before: For you personally? Why?
    b. Optional, if not addressed before: For others? Why?

Socio-demographic information

i) What is your age?
ii) What is your gender?
iii) What is your highest level of formal education?
iv) Where do you currently live?

Final questions

7. That's all the questions I have got for you. Is there anything else you would like to add to the interview? Do you have any questions for me?
8. Optional, if we still need interviewees: Is there anyone else you know who might be able to participate in this interview?

Thanks so much for your time and for sharing your experience with nature at Mount Kilimanjaro with me. I'll also be in touch with information about the results of this work.

Text A2.4 Definition of nature and our study area

We did not define the term nature and the scope of the geographical area of Kilimanjaro for our interviewees. Language and cultural background can impact the conceptual understanding of nature, and hence, we asked interviewees to draw on their conceptualisation of nature (Coscieme et al. 2020, Masao et al. 2022).

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Appendix 3: Qualitative content analysis protocol

We created the interview guide that entailed open-ended questions (interview guides in A2.1-A2.3) to facilitate face-to-face semi-structured interviews. The focus of the interview questions was on the interviewee's experience with nature at Mount Kilimanjaro, why nature at Kilimanjaro is important to them and questions on socio-demographics (interview guides in A2.1-A2.3).We conducted 130 interviews between May 2021 and March 2022, after ethical permission from the first authors' university and research permits from Tanzanian institutions at the national, regional, district, and local levels, as well as tour guides and agents. Additionally, we got oral or written consent from respondents before each interview. We targeted representatives of four social group actors over 18 years of age: smallholder farmers (n=44), nature conservationists (n=28 interviewees), tour guides (n=20), and tourists (n=38). We conducted online interviews with all the tourists and a few tour guides while interviews with other tour guides, all smallholder farmers and nature conservationists were conducted face-to-face at the study area. The interviews were in Swahili with smallholder farmers and in English with representatives from other social groups. The interviews last between 30 minutes and 60 minutes.

Furthermore, we transcribed all audio-recorded interviews. Then, all Swahili recorded transcripts were translated into English with the assistance of the first author and two local research assistants who are native Swahili speakers. We imported the English transcripts and the notes of one interview – one interviewee did not consent to record the interview – into MAXQDA 2022 (VERBI Software 2022), a software program to analyze qualitative data (Kuckartz and Rädiker 2022). To code Nature's Contribution to People (NCP), and the values of nature, we applied deductive and inductive approaches (Bryman 2016). We started by identifying context-specific NCP from a subset of interviews to formulate a preliminary coding framework. Then, this framework was iteratively refined to apply to the remaining interviews while considering adding context-specific NCP that emerged (e.g., Pearson et al. 2024). Additionally, we supplemented this with an inductive approach to account for the local context and nuances conveyed by the respondents' narratives. We established a comprehensive coding framework comprising 25 context-specific NCP that were classified following Díaz et al. (2018) into regulating (n=10 NCP), material (n=6), and non-material (n=8) NCP, as well as the cross-cutting category of intergenerational benefits NCP. Furthermore, to link context-specific NCP with NCP of the generalizing perspective, we employed an interwoven approach (Hill et al. 2021). Most of the identified context-specific NCP correlated with the generalizing perspective, except for the NCP "new and unique experiences" and we separated this NCP from other generalizing categories.

We followed a similar approach to code for values of nature. First, we used a deductive approach following the classification of three domains of values of nature; intrinsic, instrumental, and relational values proposed by the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) (Díaz et al. 2015, Pascual et al. 2017). To code categories of values of nature, applied approach found in scientific reviews for the specific categories, such as Arias-Arévalo et al. (2018) and Pratson et al. (2023). Then, we followed an iterative coding process to embrace the nuances of how farmers value nature as expressed in interviews. Finally, we established a coding scheme of values of nature comprising a total of 20 value categories, including intrinsic (n=2), instrumental (n=2), and relational (n=16) (see Table A4). Coding was a collaborative endeavour involving the first co-author, multiple co-authors, and research assistants who trained together to identify NCP and the values of nature.

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Appendix 4: Value statements used during data collection based on literature review and context-specific values (Kinship, Individual connectedness, and Uniqueness 1&2). *NC* = Nature conservationists; *TG* = Tour guides

Value categories	Exemplary verbatims
Intrinsic values	
Intrinsic 1	"I appreciate most if we continue planting trees, to continue conserving and making the mountain looks good so that the mountain should not disappear." (Farmer1)
Intrinsic 2	"All those species are, for some reason, important in the environment. They have a particular reason for their existence, so they need to be conserved" (NC23)
Instrumental values	
Instrumental 1	"I value the mountain because we get food and rainfall and good weather conditions." (Farner2)
Instrumental 2	"My understanding is no nature, no life. So, my company without nature, I am finished"(TG15)
Relational values	
Cultural identity	"So globally, politically, Kilimanjaro is iconic for the region. It stands out. In the Declaration of Independence, the flags of the nationals light up in the light of this country's independence in 1961. So, Kilimanjaro is just one of us, a centerpiece for – I will not say only for Tanzania. But the mountain is for the whole continent of Africa" (TG12)
Individual identity	"For all people living under this mountain, it is important to them, we grow up seeing this mountain and it is important to us as Chagga people [...]" (Farmer29)
Cultural heritage	"[...] For us, as Chagga people, if water decreases from rivers, we will not be able to conserve the home gardens that our parents left." (Farmer42)
Tradition	"We have different flora and fauna found here in Kilimanjaro. But for me, it was admiring these trees and shrubs which are found here, which our forefathers, our ancestors were using as a, shall I say medicine - as a traditional medicine." (NC52)
Social cohesion	"So having this opportunity to get seven days of uninterrupted full day conversations while - that are emotionally and socially hard and challenging and eye-opening, while also doing something physically that was really hard and challenging and eye-opening that gave us that space to talk. Absolutely. I would say before that trip, we were still in kind of an awkward place. And after that trip, we were bonded and connected". (Tourist42)
Social relations	"[…] I feel like nature brings me closer to people. I feel like it's a bonding experience for me, going hiking. It's something I pick to do when I want to hang out with somebody. I'm like, let's go for a hike. So it's a way that it brings us together. That's a picture of my brother, and myself". (Tourist3)
Cognitive	"The nature of Mount Kilimanjaro is important because this is the environment that we have already used and experienced to live. We know weather conditions and how to adapt to it." (Farmer32)
Learning	"Yeah, as I explained, I learned, I learned a lot. And of course, I learned also in other areas, […] And here you can, you can find new species. […] So you can - this, this is the exciting thing here in Africa, you can really find so many new things in every respect" (NC60)
Stewardship	"[…] I have never seen even a single day that this mountain has any negative impact on humans, thus why when we hear that there is a wildfire up there, we go very quickly to stop the fire not to spreading because we want to conserve and protect the mountain." (Farmer4)
Social responsibility	"From this nature, we get good weather conditions. So, if people conserve the environment by planting more trees then it makes them live a good standard of living." (Farmer11)
Aesthetic	"[...] I can say that the nature and beauty of this mountain can make people enjoy when they see it even from far." (Farmer27)
Inspiration	"In fact, I developed the slogan as a result of the climb, which is every top is within reach if you just keep climbing" (Tourist37)

Value categories	Exemplary verbatims
Kinship	"So there is this great sort of tribal sense of we are one tribe, those who climbed to Kilimanjaro and funnily enough, that lasts even off the mountain, I think the experience is so powerful. […] And there was this feeling of kinship, of fellowship, for having had that experience of the mountain. […] The mountain makes you feel small in a good way. (Tourist38)
Individual connectedness	A connection to the landscape. From a personal level, I don't want to look at screens anymore. I'm tired of this last year. I don't want to look at any more screens. And back then, I felt the same way. It was about connecting with a landscape in an intimate and personal way (Tourist23)
Uniqueness 1	It is important because of its uniqueness. Because of the vegetation types. And the forest surrounding the mountain. It is very important because if the forest is not conserved, the environment downward the mountain, it's not conserved, obvious that uniqueness will be, will not - uniqueness would not be there. (NC66)
Uniqueness 2	And then I was experiencing something that I had never seen or done before, and I was able to be wholly in the moment. And it's rare, I think, that we get the opportunity to do that (Tourist01)

Appendix 5: Summary and description of variables used in the Redundancy Analyses (RDAs). KINAPA: Kilimanjaro National Park.

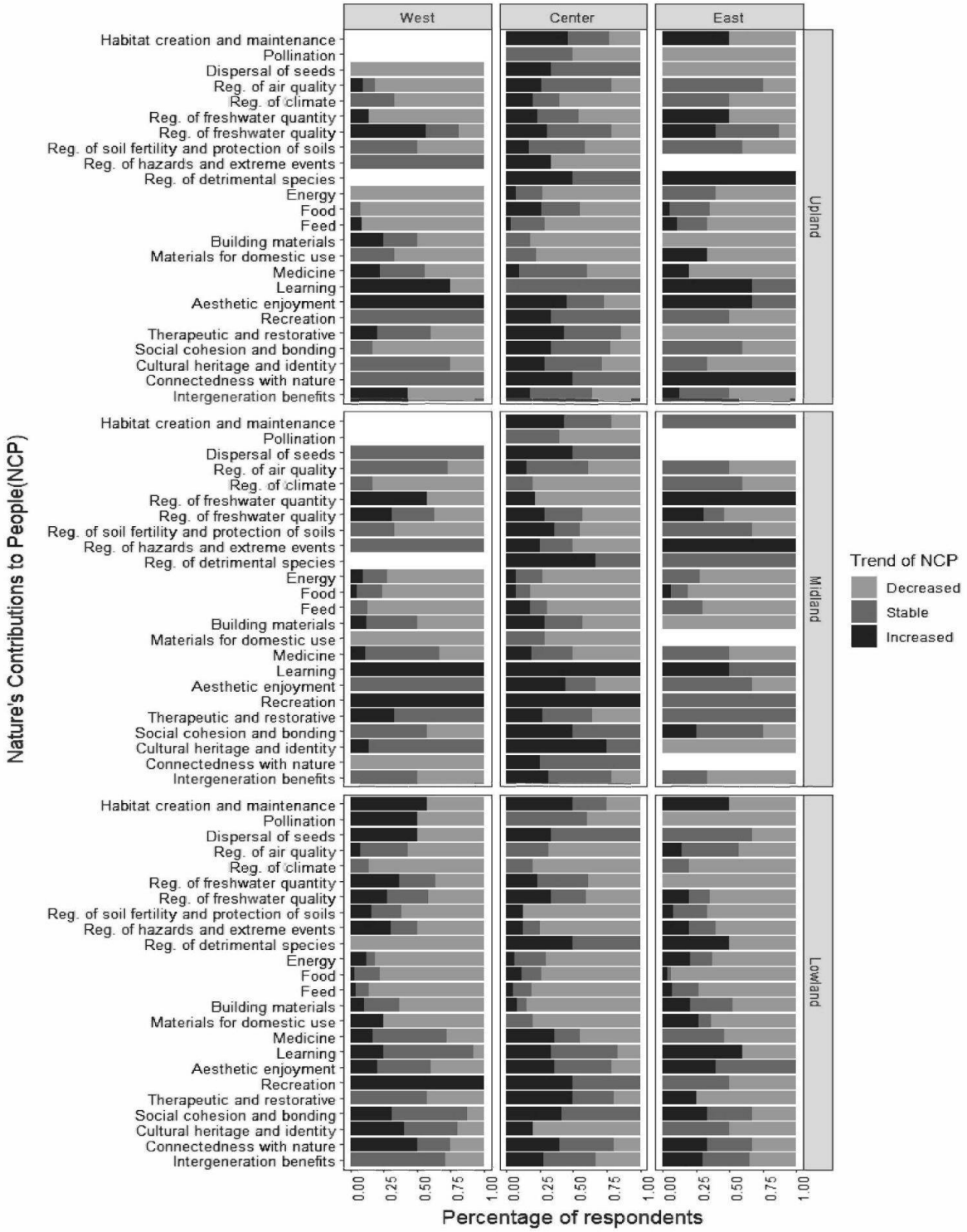
Name of variable	Description of variable	Attributes
Response variables		
Nature's Contributions to People (NCP)		
Regulation of air quality	If the respondent selected the NCP regulation of air quality	1: Yes; 0: No
Regulation of climate	If the respondent selected the NCP regulation of climate	1: Yes; 0: No
Regulation of freshwater quantity	If the respondent selected the NCP regulation of freshwater quantity	1: Yes; 0: No
Regulation of freshwater quality	If the respondent selected the NCP regulation of freshwater quality	1: Yes; 0: No
Regulation of soil fertility and protection of soils	If the respondent selected the NCP regulation of soil fertility and protection of soils	1: Yes; 0: No
Regulation of hazards and extreme events	If the respondent selected the NCP regulation of hazards and extreme events	1: Yes; 0: No
Energy	If the respondent selected the NCP energy	1: Yes; 0: No
Food	If the respondent selected the NCP food	1: Yes; 0: No
Feed	If the respondent selected the NCP feed	1: Yes; 0: No
Building materials	If the respondent selected the NCP building materials	1: Yes; 0: No
Medicine	If the respondent selected the NCP medicine	1: Yes; 0: No
Learning	If the respondent selected the NCP learning	1: Yes; 0: No
Social cohesion and bonding	If the respondent selected the NCP social cohesion and bonding	1: Yes; 0: No
Cultural heritage and identity	If the respondent selected the NCP cultural heritage and identity	1: Yes; 0: No
Intergenerational benefits	If the respondent selected the NCP intergenerational benefits	1: Yes; 0: No
Nature's values		
Intrinsic 1	I value each species at Kilimanjaro because it has its reason for its existence and is, therefore, worthy of conservation.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Intrinsic 2	I value nature at Kilimanjaro because it has its own right to exist and prosper.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Instrumental 1	I value nature at Kilimanjaro because it contributes to meeting my/our basic needs, such as clean air and water.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Instrumental 2	I value nature at Kilimanjaro because I/we economically benefit from it.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Cultural identity	I value nature at Kilimanjaro because it connects me/us with who we are as a culture/ethnic group/community.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Individual identity	I value nature at Kilimanjaro because our/my relationship with it is an important part of my/our culture.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Cultural heritage	I value nature at Kilimanjaro because it is relevant to the heritage and history of myself/our people/the nation.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Tradition	I value nature at Kilimanjaro because it connects me/us with my/ our traditions and the way of life of my/our ancestors [former family members].	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Social cohesion	I value nature at Kilimanjaro because it enables a sense of community.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Social relations	I value nature at Kilimanjaro because being in nature at Kilimanjaro gives me the opportunity to enjoy and deepen relationships with friends, family, and other people.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Cognitive	I value nature at Kilimanjaro because it is relevant for wisdom and knowledge of myself/our people.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Learning	I value nature at Kilimanjaro because I/we learn from and with it.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree

Name of variable	Description of variable	Attributes
Stewardship	My/our care for nature at Kilimanjaro helps me/us to lead a good and fulfilling life.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Responsibility	I value being responsible for nature at Kilimanjaro and caring for it.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Aesthetic	I value nature at Kilimanjaro because I/we enjoy the beauty of its sights/sounds/smells.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Inspiration	I value nature at Kilimanjaro because it inspires me/us with new ideas and creativity.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Kinship	I value nature at Kilimanjaro because it is like family/friend/community to me/us.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Individual connectedness	I value nature at Kilimanjaro because I/we feel part of it.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Uniqueness 1	I value nature at Kilimanjaro because its uniqueness fulfills me/us.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Uniqueness 2	I value nature at Kilimanjaro because it fulfills me/us with new/special experiences that I have not experienced elsewhere.	0: Strongly Disagree and Disagree 1: Agree and Strongly Agree
Explanatory variables		
Socio-demographic characteristics		
Age	Respondents' age in years	Ln (Age+1)
Gender	Respondent's gender - Female	1: Yes; 0: No
	Respondent's gender - Male	1: Yes; 0: No
Religion	Respondents' religion - Christian	1: Yes; 0: No
	Respondents' religion - Muslim	1: Yes; 0: No
Education	Respondents' level of education	0: Informal; 1: Primary; 2: Secondary education; 3: Tertiary education 4: Undergraduate degree or Vocational training
Born in the surveyed village	If the respondent was born in that village	1: Yes; 0: No
Parents were born in Kilimanjaro	If the respondent's parents are from Kilimanjaro	1: Yes; 0: No
Member of any association	If a respondent is a member of any association	1: Yes; 0: No
Entered KINAPA	If the respondent has visited other protected areas from Kilimanjaro National Park	1: Yes; 0: No
Pro-environmental behavior		
Active in conservation activities	If the respondent has been engaging in nature/environmental conservation in Kilimanjaro	1: Yes; 0: No
Geographical location		
Village location	Location of respondent's village	East; Center; West, Lowland; Midland; Upland

Appendix 6: Characteristics of the sampled population across altitudinal and latitudinal gradients at Mount Kilimanjaro.

Variable	Level of variable	Number (*n*)	Percentage of respondents (%)
Socio-demographic characteristics			
Gender	Female	213	58.5
	Male	143	39.3
	Missing	2	2.2
Level of formal education	No formal education	67	18.4
	Primary school	216	59.3
	Secondary school	51	14
	Undergraduate degree or Vocational training	25	6.8
	Missing	5	1.4
Religion	Christian	325	89.3
	Muslim	36	9.9
	Others	3	0.8
Born in the surveyed village	Yes	228	62.6
	No	136	37.4
The respondent's parents were born in Kilimanjaro region	Yes	320	87.9
	No	44	12.1
Member of any association	Yes	90	24.7
	No	274	75.3
Entered Kilimanjaro National Park	Yes	79	21.4
	No	285	78.6
Pro-environmental behavior			
Active in conservation activities	Yes	78	24.7
	No	286	75.3
Geographical location			
Altitudinal gradients	Upland	101	27.7
	Midland	104	28.6
	Lowland	159	43.7
Latitudinal gradients	West	114	31.3
	Center	160	44
	East	90	24.7

Appendix 7: Relative share of all respondents on the perceived supply trend of Nature's Contributions to People (NCP) in the last ten years, shown for the altitudinal and latitudinal zones. *Reg.* Regulation.



Appendix 8: Relative share of respondents of the agreement level with a 4-point Lickert scale with nature's value statement, shown for the zones of the latitudinal and altitudinal gradients. (A+SA represents the relative share of agreement *A* Agree and *SA* Strongly agree)