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ORIGINAL ARTICLE

Interplays between nature's contributions to people, values of nature, and emotions expressed by smallholder farmers in Kilimanjaro, Tanzania: insights for inclusive conservation

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Abstract

Recent literature suggests considering plural ways people relate with nature to make conservation inclusive. Yet, there is little empirical evidence of the complex interplays between nature's contributions to people (NCP), values of nature, and emotions, which are three essential layers for understanding people's motivations to connect with nature. We applied the photovoice method to understand how smallholder farmers in Kilimanjaro benefit from, value, and emotionally connect with nature. Through content analysis and multiple correspondence analysis (MCA), we found three types of associations between NCP, values of nature, and emotions: (1) the association between unpleasant emotions, several materials and regulating NCP, intrinsic values, and the relational values of stewardship, responsibility, and aesthetics was expressed by smallholder farmers below the border of the national park; (2) the association between pleasant emotions, non-material NCP, and several relational values, such as sense of place and cultural heritage was expressed by smallholder farmers in their homegardens; and (3) the association between instrumental values, relational values, and NCP of social cohesion and social relations was expressed by all smallholder farmers from the lowland to the upland. These three types of associations suggest that, in the spirit of inclusive conservation, we need; (1) to consider the multiple ways smallholder farmers relate with nature, (2) to reduce access restrictions of local actors to protected areas to avoid eroding meaningful human-nature relations, and (3) to expand conservation-related benefit-sharing mechanisms beyond instrumental thinking and consider non-material NCP, relational values, and emotions.

Muhtasari

Machapisho ya hivi karibuni yanapendekeza kuzingatia njia anuwai ambazo watu wanahusiana na mazingira asili ili kufanya uhifadhi kuwa jumuishi. Hata hivyo, kuna ushahidi mdogo wa kimajaribio kuhusu mwingiliano changamani kati ya Michango ya Mazingira Asili kwa Watu (MMAW; *nature's contributions to people (NCP)* kwa kiingereza), thamani za asili, na hisia, ambazo ni tabaka tatu muhimu kwa kuelewa mambo yanayochangia watu kuunganika na asili. Tulitumia mbinu ya picha-sauti kuelewa namna wakulima wadogo mkoani Kilimanjaro wanavyonufaika, wanavyothamini, na wanavyounganishwa kihisia na mazingira asili. Kwa kutumia uchambuzi wa kimaudhui na wa kiulinganifu, tuligundua

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aina tatu za mahusiano kati ya MMAW, thamani za asili na hisia kulingana na mazingira asili; (1) uhusiano kati ya hisia hasi, faida kadhaa za vitu na za udhibiti za MMAW; thamani za asili za halisia, za mahusiano na za usimamizi, wajibu na muonekano ambao ulidhihirishwa na wakulima wadogo katika eneo chini ya mpaka wa hifadhi; (2) uhusiano kati ya hisia chanya, faida za vitu visivyoshikika za MMAW, na thamani kadhaa za uhusiano na mazingira asili za hisia za mahali husika, urithi wa kiutamaduni ambao ulidhihirishwa na wakulima wadogo katika mashamba ya nyumbani; na (3) uhusiano kati ya thamani za kutumika na faida za mshikamano na mahusiano ya jamii za MMAW ambao ulidhihirishwa na wakulima wadogo kutoka nyanda za chini hadi za juu. Aina hizi tatu za mahusiano zinapendekeza kuwa, katika ari ya uhifadhi jumuishi, tunatakiwa (1) kufikiria namna mbalimbali ambazo wakulima wadogo wanavyohusiana na mazingira asili, (2) kutathmini zuio kwa wadau wa ndani katika maeneo yaliyohifadhiwa ili kuepusha kumomonyoa uhusiano wa maana kati ya binadamu na mazingira asili, na (3) kuongeza mbinu mbalimbali za ugavi wa faida za uhifadhi zaidi ya fikra za thamani za vitu na kufikiria faida za MMAW za vitu visivyoshikika, thamani za mahusiano na mazingiza asili na hisia kutokana na mazingira asili.

Keywords Chagga farmers · Homegarden · Mountain ecosystem · Nature's contributions to people (NCP) · Photovoice · Plural values

Introduction

Conservation has historically neglected how local communities relate with nature, leading to negative consequences for local actors, such as displacement from ancestral land or restricted access to natural areas (Brockington 2002; West et al. 2006; Naidoo et al. 2019). Recent literature claims that conservation has partially failed because it mainly focuses on a narrow set of nature's contributions to people (NCP) and values of nature (Chaplin-Kramer et al. 2023; Raymond et al. 2023). The Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) has mirrored the calls of scholars to consider plural understandings of NCP and values (Díaz et al. 2015; Pascual et al. 2017, 2023) to enable inclusive and just conservation (Jacobs et al. 2020; Pascual et al. 2021; Carmenta et al. 2023a).

Nature's contributions to people are benefits that humans derive from nature and support their wellbeing (Díaz et al. 2018). These are classified into three groups: (1) regulating NCP: natural processes that mediate the environmental conditions, such as the regulation of water quantity and quality; (2) material NCP: natural elements that directly sustain people's physical survival and material assets, such as food and timber; and (3) non-material NCP: effects from nature on subjective or psychological aspects of people's wellbeing (Díaz et al. 2018). Values of nature are the importance, worth, or usefulness ascribed to nature, which are classified as intrinsic, instrumental, and relational (Díaz et al. 2015; Pascual et al. 2017, 2023). Intrinsic values are the inherent worth of nature regardless of human use and experience (Arias-Arévalo et al. 2017; Pascual et al. 2017). Instrumental values refer to the importance of nature in fulfilling human needs, such as providing food or supporting livelihoods (Arias-Arévalo et al. 2017). Relational values are the meaningful relationships between people and nature and among people mediated by nature, including also the responsibility and stewardship towards nature that originates from these relationships (Chan et al. 2016; Jax et al. 2018).

Both NCP and nature's values are interconnected, as people use and enjoy nature for various reasons. For example, Martín-López (2021) explained that the recreational experience of mushroom picking (NCP) can be associated with varying value categories. It can derive from the motivation to gather edible mushrooms for selling in local markets (instrumental) or from a motivation to enjoy an activity in nature with family members and friends (relational). Yet, there is a general assumption that non-material NCP is mostly associated with relational values (Ishihara 2018; Helseth et al. 2023), and only a few empirical studies have explored the interplay between NCP and values (Schmitt et al. 2022; Kachler et al. 2024). For instance, Kachler et al. (2024) found that tourists in protected areas in Germany associated regulating NCP with instrumental and relational values (i.e., care, stewardship, and social responsibility), while non-material NCP were only associated with relational values. In South Africa, Topp et al. (2021) found that smallholder farmers expressed the importance of diverse NCP, particularly when their farming decision-making relied on relational values. Leite et al. (2024) found that local communities in Guinea-Bissau associated NCP with the combination of intrinsic, instrumental, and relational values that reflect their subsistence needs. Yet, the importance of exploring the interplay between NCP and values to broaden our understanding of human-nature relationships in the context of conservation remains underexplored. However, understanding people's deeper motivations to connect with nature based on the interplay between the NCP preferences and nature's values has been recently recognized as essential for inclusive conservation since such interplay combines the knowledge of what aspects of nature contribute to people's

quality of life (i.e. NCP) and why nature is important for them (i.e. values) (Gross et al. 2025b).

An increasing body of knowledge indicates that people's emotional connection with nature is among the deeper motivations to value nature (Horcea-Milcu et al. 2019; Otamendi-Urroz et al. 2023; Gould et al. 2023). People connect with nature not only through material, experiential, or cognitive appreciation but also through emotions (Ives et al. 2018). In fact, emotions can shape human-nature relationships and people's dispositions toward conservation (Batavia et al. 2021; Arbieu et al. 2021). For example, emotions have been explored in conservation decisions that ban local communities from accessing natural resources (Mariki 2013) or aim to foster just conservation (Batavia et al. 2021; Brunet 2024). Despite the importance of understanding emotions that underpin how people relate with nature, to the best of our knowledge, there is no empirical research studying the associations between people's emotions, NCP, and values of nature, nor the implications of these associations for conservation.

To study the complexity of the associations between emotions, NCP, and nature's values, we applied photovoice, a methodological tool that has been widely applied to understand human-nature relationships (Beilin 2005; Stedman et al. 2014). Photovoice method is an art-based visual tool that engages research participants using photography (Wang and Burris 1997). It uses photographs as a medium to stimulate dialogue between participants and researchers (Wang and Burris 1994; Harper 2002; Masterson et al. 2018) and to foster participants' reflection on their realities (Freire 1970; Wang and Burris 1994). In doing so, photovoice can engage marginalized participants, such as farmers (Wang and Burris 1994), a specific social group that has been recognized in other studies because of their strong connection with nature (Vizuete et al. 2025). Although photovoice has been used to understand human-nature relations in recent years (e.g., Morton et al. 2020; Esteves-Dias and Armitage 2021), only a few studies have used photovoice to assess NCP (e.g., Berbés-Blázquez 2012; Masterson et al. 2018), and, to our best knowledge, there is no empirical study aiming to research human-nature relationships by analysing people's emotions, NCP and nature's values. In fact, despite the potential of photovoice to engage local communities when researching human-nature relationships, its application in conservation contexts still remains scarce (Berbés-Blázquez 2012).

The Kilimanjaro social-ecological system (hereafter referred to as Kilimanjaro) in Tanzania presents a promising avenue for applying the photovoice method to understand the human-nature relationships of local communities. Kilimanjaro comprises the Kilimanjaro National Park (KINAPA) in the upland and agroecosystems outside the National Park, where smallholder farmers develop agricultural practices (Durrant and Durrant 2008; Ichinose et al. 2020) and possibly hold a deep connection with nature through their life experiences (Pearson et al. 2025). Despite the dependency of smallholder farmers on nature (e.g., Masterson et al. 2019; Sanya et al. 2025), their needs and interests are often neglected in conservation decision-making (Mdee et al. 2019; Engström and Hajdu 2019; Othman et al. 2021; Carmenta et al. 2023b). Drawing on previous work on NCP and values of nature in Kilimanjaro (Gross et al. 2025b; Pearson et al. 2024), we applied the photovoice method to understand how smallholder farmers in Kilimanjaro benefit from, value, and emotionally connect with nature. We aim to answer three research questions related to uncovering NCP, values of nature, and emotions, respectively: (1) What aspects of nature contribute to people's quality of life (i.e. NCP)?, (2) Why does nature matter to people (i.e. nature's values)? and (3) How do people emotionally connect with nature (i.e. emotions)? (Fig. 1). Two specific objectives guide our research: (1) to uncover the NCP, values of nature, and emotions as expressed by smallholder farmers and (2) to understand the associations between NCP, values, and emotions (Fig. 1). Finally, we will discuss how this information can contribute with insights for inclusive conservation (Fig. 1).

Materials and methods

Study area

The Kilimanjaro social-ecological system comprises the top of Mount Kilimanjaro (5,985 m asl) down to the foothill of the mountain in northeast Tanzania (Fig. 2). Kilimanjaro is located between 2°45′ and 3°25 S and 37°00′ and 37°43′ E and has a seasonally dry tropical climate, with rainfall and temperature (varying from 18 °C to 26 °C) depending on elevation and the dominant wind from the Indian Ocean (Hemp 2006; Lasway et al. 2022). The area is characterized by a bimodal rainfall pattern: the long rainy season from March to May and the short rainy season from November to December (Gebrechorkos et al. 2019). The ecosystems in the mountain range from dry and hot savannah (700–1000 m asl) to a nival zone bare of vegetation and with glaciers (4600–5895 m asl) (Hemp 2006), and is globally recognized as a biodiversity hotspot (Hrdina and Romportl 2017). The mountain supplies various NCP due to its fertile volcanic soils, climatic conditions, and dense network of streams and springs that feed the irrigation furrows *(mfongo* in Chagga) (Masao 1974; Fernandes et al. 1985).

Kilimanjaro is one of the most densely populated areas in Tanzania (URT 2022). The Chagga tribe is the main ethnic group inhabiting the southern slopes of Kilimanjaro

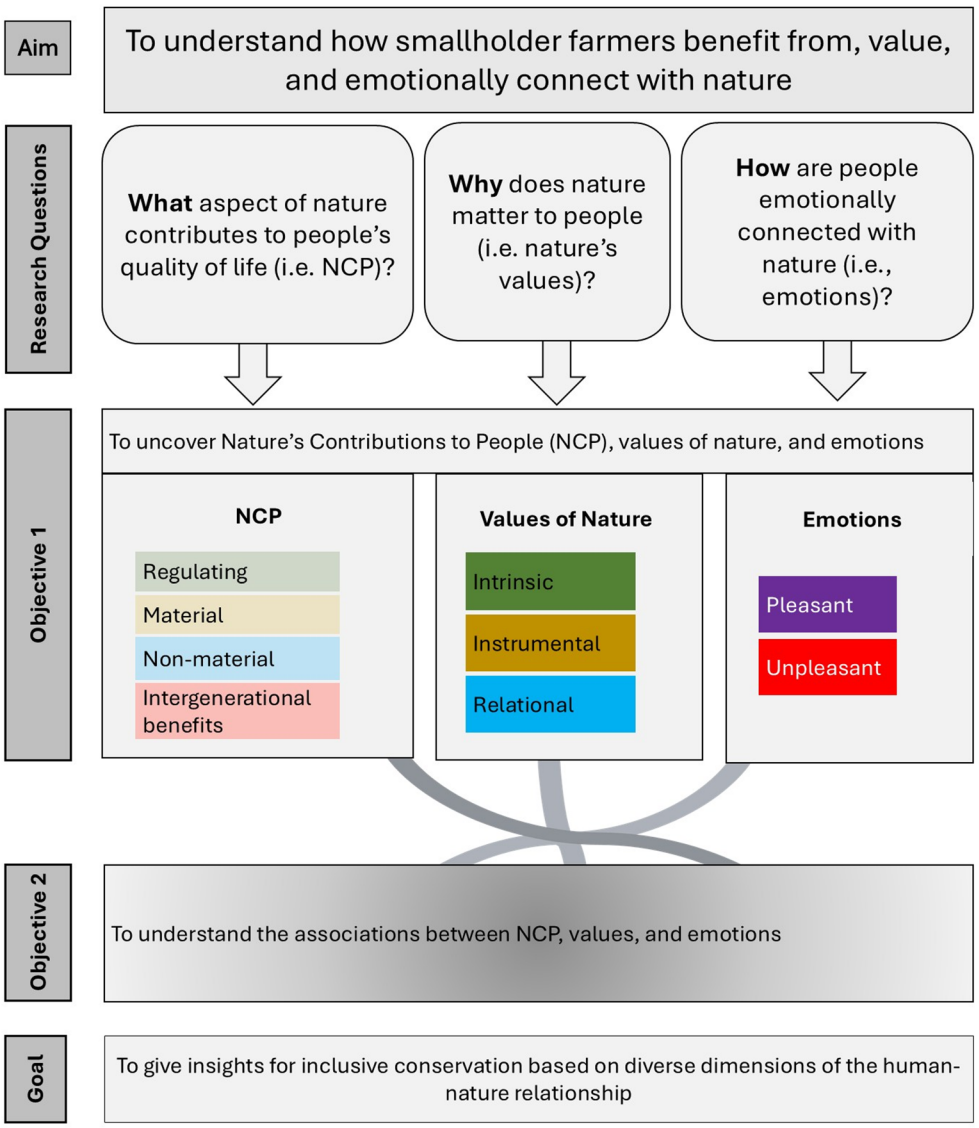


Fig. 1 Logical framework diagram connecting the research questions, specific objectives, and the overall goal of the research. Categories of Nature's Contributions to People (NCP) are based on the NCP framework proposed by Díaz et al. (2018), and values of nature are based on the three categories of specific values proposed by Díaz et al. (2015) and Pascual et al. (2023)

(Mtallo and Rubagumya 2015). Chagga are Bantu speakers who came from several African tribes to settle in the once-forested mountain foothills (Fernandes et al. 1985). Traditionally, Chagga livelihoods depend on their homegarden (*Kihamba* – a Chagga), a multilayered coffee-banana agroforestry system located between 1200 and 1800 m above sea level (m asl), bordering the KINAPA (Mdoe and Wiggins 1997; Mbwiga 2016). Below the Chagga homegarden zone (<1200 m asl), newcomers and tribes other than the Chagga engage in growing maize and beans along with a few coffee-banana patches and pastureland in intensive and mechanized agriculture (Soini 2005).

Although this research focuses on the areas below the KINAPA (Fig. 2), the conservation history of the National Park has affected local communities by limiting forest accessibility and resource use. During the colonial period, in 1904, all forests above 2700 m asl were designated as natural reserve areas – i.e., Mount Kilimanjaro Forest Reserve (Wood 1965; Schabel 1990; Newmark 1991). In 1941, the Chagga Council (a political body managed by Chagga chiefs) established the Half Mile Forest Strip (HMFS) – a social buffer zone and catchment forest that granted local communities access and user rights to the forest-related NCP, such as timber and firewood (Newmark 1991; William 2003). Soon after Tanganyika's (later Tanzania) independence, in 1962, the control over the HMFS was transferred to district councils, emphasizing commercial usage of forest products. The central government then controlled HMFS to preserve water and soil regulation (Newmark 1991). In 1973, the National Park of Kilimanjaro was established, and the HMFS was integrated into it later in 2005 (KINAPA 2006). At this time, local communities were banned from accessing HMFS to avoid overexploiting forest resources (Sébastien 2010)Between 2014 and 2019,

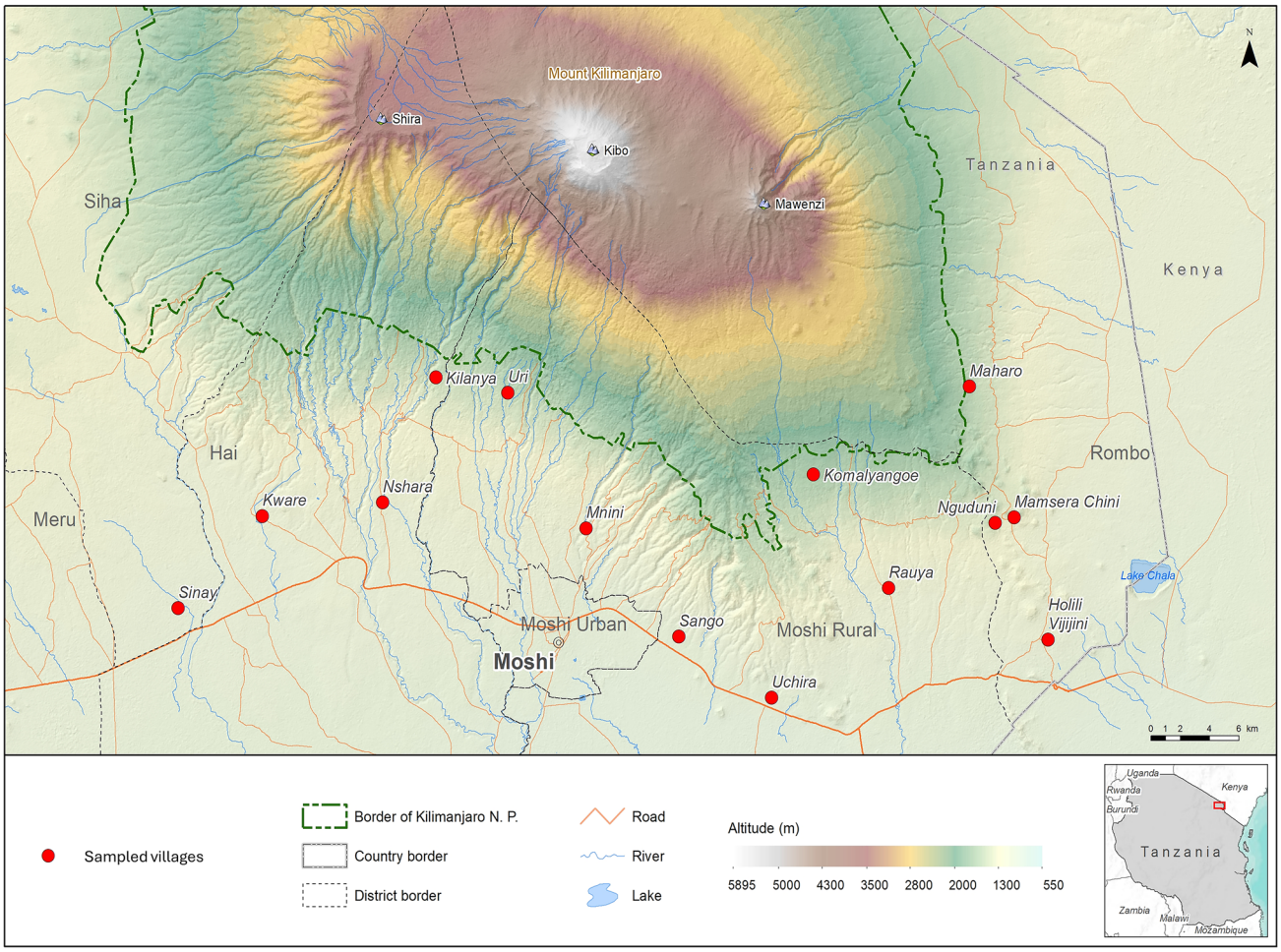


Fig. 2 Map of the study area showing the sampled villages on Kilimanjaro where the photovoice exercise took place. *N. P.* National Park

local communities' demands for reopening the HMFS were granted only to women. In 2021, the Kilimanjaro National Park Authority (KINAPA) reinstated an official ban on access to the HMFS, which remains in place. Consequently, a long legacy of to-and-fro negotiations over forest access is prevalent in Kilimanjaro, being the source of local communities' disgruntlement.

Photovoice method

Between August and October 2022, we applied a photovoice method in 14 villages below KINAPA and along the altitudinal gradient, according to the three agro-ecological zones (Soini 2005) of the southern slopes of Kilimanjaro (Fig. 2). The lowland zone (below 1000 m asl) comprises mechanized and intensive cultivation of crops such as maize, beans, sunflower, sorghum, and grazing land. Most of the area is natural savanna (Soini 2005). The midland zone (1000 to 1200 m) is dominated by monocrops of maize and beans, as well as open grazing land (Soini 2005). The midland zone is covered by natural dry forest vegetation, bushland, and grassland. The upland zone (1200 to 1700 m) borders KINAPA forests and hosts most Chagga homegardens (Soini 2005).

To apply the photovoice method, we followed three steps: (1) recruitment of participants, (2) introduction of participants to photovoice, and (3) the photovoice exercise itself that combined transect walks and in-depth interviews (Berbés-Blázquez 2012) (Photovoice interview guide in Text S1). First, we asked the Village Executive Officer to provide one contact who would be willing and interested in participating in the study. Then, we applied snowball sampling to recruit additional participants (Bryman 2016). We contacted smallholder farmers who have lived in the village as adults for at least 15 years, as we were interested in understanding how these farmers develop emotional connections to the study area over time.

Second, we introduced the research aim and verbally obtained participants' consent to record the conversations and store the data. All communication with participants was in Swahili, the official national language in Tanzania (Whiteley 1969). We trained participants in visual literacy

(Huilcapi-Collantes et al. 2020), explained the photovoice protocol and allowed them to familiarize themselves with the camera.

Third, we asked participants to choose any route that represents their daily interactions with nature. We specifically used the term 'nature' ('*Mazingira asili'* in Swahili) because of its potential to embrace different meanings and, therefore, different ways of relating with nature as a result of diverse worldviews (Díaz et al. 2015; Ducarme and Couvet 2020; Coscieme et al. 2020). We provided six prompts for participants to take photos that: (1) represent their relationship with nature, (2) contribute to their well-being, (3) contribute material goods, (4) contribute to their mental health, (5) contribute to nurturing social relationships, and (6) were pleasant or beautiful. While we recognize that these prompts could lead to expressing NCP inherently related to the prompt (e.g., aesthetic enjoyment derived from pleasant and beautiful places), we believe they helped participants consider a broad spectrum of NCP, including material, regulating, and non-material. Participants were allowed to take up to three photos per question during the transect walk. Moreover, we asked them to explain why they had selected a particular place or element of nature for each photo. A total of 26 participants were involved in the photovoice process (for the socio-demographic characteristics of the participants, see Text S2), capturing 117 photos. The route usually took between one to two hours to walk.

After the transect walk, we asked participants to select one photo for each theme, i.e., up to six photos, which led to 84 photos for in-depth interviews. Participants were asked to provide an explanation for their photo selection. Then, we asked six guiding questions per photo informed by the mnemonic PHOTEV: (1) What is the story behind your **P**hoto? (2) What benefits of nature are **H**appening in your photo? (3) Why did you take a photo **O**f this? (4) What are the **T**hreats to your life in this photo? (5) What are the **E**motions evoked by this photo? and (6) Why do you **V**alue the elements/places portrayed in this photo? (Photovoice interview guide in Text S1). We created PHOTEV as an adaptation of the mnemonic PHOTO (Hergenrather et al. 2009), which was previously used to explore NCP (Lim et al. 2021). The six questions provided by the mnemonic PHOTEV allowed the exploration of how participants conceived their relationship with different elements of nature at Kilimanjaro, how NCP perceived, how they valued nature, and what emotions emerged. Although selecting one photo per question can entail losing information on how farmers relate with nature, we decided against asking these six questions for all the photos because we intended to collect as much information as possible without demanding excessive extra time from participants, which could lead to their fatigue. The average length of these interviews was 50 min, with a range of 40 to 90 min. These conversations were audio-recorded. Before data collection, we obtained ethical clearance from the Ethics Committee of the Leuphana University of Lüneburg, and the necessary research permits from the Tanzania Commission for Science and Technology (COSTECH) and the Tanzania Wildlife Research Institute (TAWIRI).

Data analysis

Objective 1—content analysis

All interview transcripts were translated into English by the first author, who is fluent in both Swahili and English, imported into MAXQDA 2022 (VERBI Software 2022), and analyzed through content analysis (Vaismoradi et al. 2013). To uncover the expression of NCP, values of nature, and emotions (objective 1; Fig. 1), we applied deductive and inductive approaches to identify the verbatims representing smallholder farmers' expressions of NCP, values of nature, and emotions (Fig. 3). When different NCP, values, and emotions appeared together in the same interview segment, we coded all of them (see Pramova et al. 2021; López de la Lama et al. 2024; Vizuete et al. 2025). For example, the verbatim *"I feel happy when I see my farm (homegarden) is giving me what I need such as food, and fodder from it and this is a reason I am taking care of it"* includes expression of NCP (i.e. material NCP; food and fodder), values (i.e., relational value; taking care of homegarden) and emotions (pleasant emotion; happy, pride and gratitude) (Fig. 3). If the content of a verbatim remained ambiguous for coding NCP, values, or emotions, the first author consulted the co-authors until the research team reached an agreement on the coding scheme.

To uncover smallholder farmers' expressions of NCP, we first used a deductive coding approach, following the categories identified in a previous step of the research project, in which we conducted 130 semi-structured interviews with people living on, working at, and visiting Kilimanjaro (Pearson et al. 2024; Gross et al. 2025a; Sanya et al. 2025). During this first phase of the research project, we identified 25 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 (i.e., the capacity of nature to provide benefits to future generations). We supplemented this with an inductive approach to account for the local context and nuances provided by the participants' narratives. In this step, we found the NCP of 'economic opportunity for livelihoods', an NCP that was not part of the original list of 25 NCP but had been identified in previous NCP research in Kilimanjaro (Masao et al. 2022). The 'economic opportunity for livelihoods' NCP did not point to a particular NCP

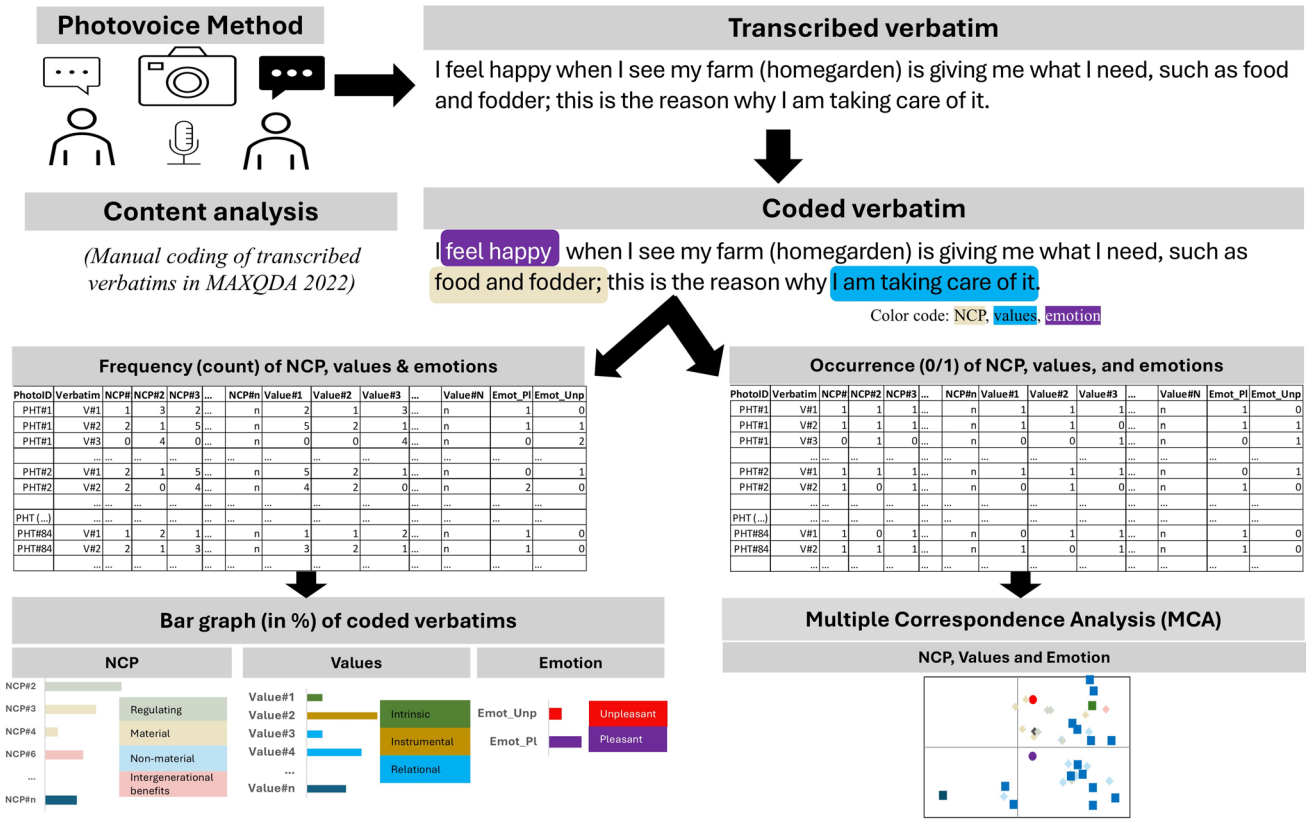


Fig. 3 Visual summary of the different data analysis steps. NCP: Nature's Contributions to People

category but referred to the economic benefits of selling crops (Masao et al. 2022). Hence, we separated this NCP under the 'Unclassified NCP' category. Finally, we applied the coding scheme of the final 26 NCP to all transcripts.

To elicit the values of nature, we first used a deductive approach following the classification of intrinsic, instrumental, and relational values proposed by IPBES (Díaz et al. 2015; Pascual et al. 2017). For specific categories of relational values, we used relational values found in scientific reviews, such as Arias-Arévalo et al. (2018), Riechers et al. (2022) and Pratson et al. (2023). Then, we followed an iterative coding process to embrace the nuances of how farmers value nature as expressed in their narratives about the photos. This process led to the final coding scheme of values, which comprised 18 value (sub)categories, including intrinsic (n = 1), instrumental (n = 1), and relational (n = 16).

To uncover the emotions of smallholder farmers connected with nature, we employed a deductive approach and coded them into pleasant (e.g., happiness, joy, awe, or love) and unpleasant (e.g., sadness, fear, or anger) emotions (Larsen and McGraw 2011). We coded the diversity of emotions as pleasant and unpleasant because, in Swahili (the language used for data collection), general terms are used to describe the different facets of complex emotions (Tramutoli 2019). For example, Swahili uses the general term "*Mhemko /hisia"* to refer to excitement regardless of the context of use, whether anxiety, frustration, or anger. Nevertheless, this classification of emotions has been previously used in empirical research to understand human-nature relations (e.g., Otamendi-Urroz et al. 2023; Garau et al. 2024; López-Zayas et al. 2024).

We finally calculated the frequency of the different categories of NCP, nature's values, and emotions that appeared in the coded verbatims (Fig. 3).

Objective 2—multiple correspondence analysis

To detect associations between NCP, values, and emotions (objective 2; Fig. 1), we performed a Multiple Correspondence Analysis (MCA), an ordination technique to explore relationships between categorical data (Greenacre and Blasius 2006). Toward this end, we organized the data into 84 photos × 39 variables (NCP, values, and emotions) (Fig. 3). We used a dummy entry for the variables where '1' indicated that the specific NCP, value, or emotion were coded within a particular photo and '0' otherwise. As variables, we only considered those NCP and values accounting for more than 10% of total counts, resulting in 21 NCP and 16 values. We used XLSTAT Software Version 2020.3.1 (Addinsoft 2020) to conduct the MCA.

Translating between languages: methodological limitations

The most important methodological limitation was translation between languages. First, since most participants belong to the Chagga tribe, whose tribal language is Chagga, some Swahili terms in the interview were not fully understood. To overcome this challenge, we hired a Chagga research assistant to serve as a translator between Chagga and Swahili. Second, we encountered several translations between languages. The photovoice interview guide was designed in English (Text S1) and then translated into Swahili. In a few instances, while conducting the interview, some terms were translated from Swahili to Chagga. After the photovoice interview, we transcribed it using Swahili as the original language of the interview and then translated it into English. Through multiple translation stages to and from one language, nuances and the meaning behind the interview narratives may have been inadvertently lost in translation.

Results

Objective 1: uncovering NCP, values of nature, and emotions through content analysis

Expression of NCP

Participants identified eight regulating, six material, ten non-material NCP, intergenerational benefits, and 'economic opportunities for livelihood' (Table 1). Material and non-material NCP were more prominent than regulating, intergenerational benefits, and 'economic opportunity for livelihood'. The three most frequently mentioned NCP were food, regulation of freshwater quantity, and feed for livestock (Fig. 4).

Regarding material NCP, food was the most frequently mentioned NCP, appearing in 183 verbatims (13.6% of all coded verbatims on NCP), often when referring to agriculture: *"These are the areas where we grow crops, such as maize, banana, and beans. We are cultivating this in our small plot here in our surroundings"* (Farmer 7). Feed was the second most frequently mentioned material NCP (7.9%), often referring to leaves, grass, and planting trees for the sake of fodder: *"We are planting trees and herbs surrounding our homesteads for different purposes, such as fodder for our livestock"* (Farmer 21). Furthermore, participants residing in the upland pointed out the scarcity of feed sources, particularly as a result of the ban on entering the HMFS, and the need to plant fast-growing species: "*I can get water for drinking, firewood, and even grass for livestock. So, after the prohibition of not entering here, we decided to plant fast-growing tree species that can be used for our livestock"* (Farmer 5).

Regulation of freshwater quantity, the second most frequently mentioned NCP (8.0%; Fig. 4), was mainly referred to when expressing the importance of different sources of water, such as rain, rivers, and forest catchment: *"This forest water catchment is very important to our life because without water, there is no life, and here is the only place where you can get water without paying a coin"* (Farmer 2). Moreover, participants expressed the importance of water quantity in relation to irrigation furrows *(mfongo* in Chagga) and freshwater for domestic use. The connection to irrigation was specifically relevant to smallholder farmers in the upland, where the Chagga homegardens are maintained through the traditional irrigation system: *"This is one of the water reservoirs in our village… we are using collected water for irrigating our homegarden"* (Farmer 26). In the lowlands, participants mentioned water scarcity as a threat; unlike upland participants, they depend on rainwater and seasonal rivers flowing from Kilimanjaro.

In addition to material and regulating NCP, participants also mentioned non-material NCP. The two most frequently mentioned non-material NCP were aesthetic (5.8%) and social cohesion and bonding (5.1%; Fig. 4). Participants linked their aesthetic experience with nature by referring to the green appearance of their land, especially during the rainy season: *"The view of this place attracts me the most, especially during the rainy season. You'll find that the place is very colorful"* (Farmer 10). Participants also expressed social cohesion and bonding, referring to the different activities fostered by working together, such as cleaning canals for irrigation; "*We typically meet to clean by removing grass from the water reservoir. We are doing this activity collectively. So, we meet to clean this reservoir and other water sources, usually some days before the rain starts"* (Farmer 26). In addition, participants expressed that nature at Kilimanjaro provides a place for village gatherings that contribute to living as a community: *"Being here is different from town. Here, we have our meeting schedule, which reminds us of being close to each other and living as a community, which is difficult to find in town"* (Farmer 4).

Furthermore, participants recognized the intergenerational benefits (2.9%; Fig. 4) by recognizing the importance of nature as a means for providing benefits for current and future generations: *"[…] having this hill in our village is beneficial because there are some of the resources that are not found in our home but are found in those hills, such as medicinal plant species that we use as a remedy for humans and livestock, so for them being here is very beneficial. Therefore, we must protect this hill for our use and future generations*" (Farmer 3). Moreover, the fifth most frequently mentioned NCP was economic opportunities for

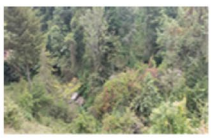
Table 1 Nature's contributions to people (NCP) expressed by farmers (n = 26) during the photovoice narratives

NCP	Themes	Exemplary verbatim	Exemplary photo	N of photos (%)
Regulating NCP				
Habitat creation and maintenance	"hill", "plant species", "Wild area", "home garden"	"It is the area where you can still find wild animals. […] This area is still wild and not destroyed much by people, […] there are also wild animals, such as antelopes" (Farmer 22)		20.2%
Dispersal of seeds	"seeds", "dispersion"	"It is believed that the seed of this tree cannot grow here but rather can be dispersed by birds. But the seed of this tree cannot grow here. We don't know what is happening here.." (Farmer 18)		1.2%
Reg. of air quality	"air", "forest", "trees", "shade"	"I feel happy that environment here is very green. Also, when you sit here and breathe that air, you realize you are inhaling very nice air compared to other places with no vegetation" (Farmer 21)		26.2%
Reg. of climate	"temperature", "vegetation", "shade"	"You know we are very lucky to be here in this village. As you know, there is no rain currently, but in our area, we have plenty of water, different from other places in the lowlands" (Farmer 24)		29.8%
Reg. of freshwater quantity	"water" "forest catchment" "rainwater" "irrigation"	"The benefit of this forest water catchment is not only for the villagers here but also for people from other villages to fetch water here. This is like the source of our life here" (Farmer 2)		39.3%
Reg. of freshwater quality	"water" "forest" "catchment" "rain" "mountain"	"This was the only place in our village that provided us fresh water for our households. […] It means people can benefit from having water to use in their homes" (Farmer 5)		38.1%
Reg. of soil fertility and protection of soils	"soil fertility" "cultivation" "farmland"	"This area has good soil supporting the cultivation of the crops I mentioned that we depend on for food" (Farmer 9)		25.0%
Reg. of hazards and extreme events	"heavy rain" "drought" "land sliding"	"During the rainy season, we face many challenges such as mud and land sliding, thus why we are insisting that people plant more trees" (Farmer 26)		6.0%
Reg. of detrimental species	"pests" "wild animals"	"The eruption of pests happened some years back, but we have not seen them. It might be the elevation where we are located" (Farmer 25)		8.3%
Material NCP				
Energy	"firewood" "trees" "dead wood" "charcoal"	"We can get fodder for our livestock, even firewood from dead wood because this area is at the border of the national park and village land" (Farmer 17)		33.3%

Table 1 (continued)

NCP	Themes	Exemplary verbatim	Exemplary photo	N of photos (%)
Food	"crops" "banana" "maize" "beans"	"[…] our area in the upland is very different from the areas in the lowland. So here you can harvest some crops twice a year, which is different from the lowland. So, we can get more food and other materials here in the upland" (Farmer 16)		57.1%
Feed	"grazing area" "grass" "fodder" "trees" "tree leaves"	"Apart from basic needs for my family, such as bananas and beans, […]we are keeping livestock under the stall. From my farm, I can get the fodder for them" (Farmer 3)		63.1%
Building materials	"timber" "poles" "stone"	"This is where we used to get construction materials; […] we can get poles from the tree you see here for the construction of our houses" (Farmer 5)		34.5%
Materials for domestic use	"timber" "poles" "stone"	"The most important element here is the trees because they are the ones that give us all the necessary needs, such as poles for house construction (Farmer 25)		7.1%
Medicine	"remedy" "plant species" "medicinal plants"	"[…] having this kind of resource in our village is beneficial because there are some of the resources that are not found in our home, but they are found in those hills, such as medicinal plant species that we use as a remedy for humans and livestock, so for them, being here is very beneficial" (Farmer 13)		8.3%
Non-material NCP				
Learning	"knowledge sharing" "conservation education"	"Being close as communities and sharing knowledge for conserving our homegarden" (Farmer 3)		22.6%
Aesthetic enjoyment	"green environment" "home garden" "aesthetic view"	"It attracts me with the vegetation and greening of the environment, and I feel happy that nature is in a good place. Also, when you sit there and breathe that air, you realize you are inhaling very nice air compared to other places with no vegetation" (Farmer 1)		34.5%
Therapeutic and restorative benefits	"home garden" "shade" "forest" "trees"	"[…] relaxation under the shade of the trees found here. Also, I can feel more connected to the environment here on my farmland (Farmer 4)		33.3%
Recreation	"playground" "recreation activities"	"It is the area where I can get other benefits. This is also the place that improves the activities, it is the place for the kids to play football and other activities for their minds and bodies (Farmer 8)		1.2%

Table 1 (continued)

NCP	Themes	Exemplary verbatim	Exemplary photo	N of photos (%)
Social cohesion and bonding	"village meeting" "social development" "irrigation"	"The significant benefit I can get from this place is connecting with other community members [...] we have our meeting schedule, which reminds us of being close to each other and living as a community" (Farmer 24)		32.1%
Cultural heritage and identity	"culture" "tradition" "preservation"	"[…] I am feeling happy for being here and being a Chagga because of continuing what I am doing and what my parents were doing such as agroforestry her in my home garden" (Farmer 17)		38.1%
Connectedness with nature	"connectedness" "environment"	"I can feel more connected to the environment by staying here on my farmland because it the place where I can get all my basic needs such as food from the crops that we grow here" (Farmer 14)		22.6%
Sense of place	"home" "ancestors" "homeland" "home garden"	"[…]we have small plots inherited from our parents, so it is difficult for some people to move to another place for agricultural activities rather than utilizing the small plots available at your home" (Farmer 24)		28.6%
Spiritual experiences	"rituals" "spiritual" "beliefs" "forest"	"We also had an opportunity to conduct rituals there in the forest, but currently, we have to undergo the process to enter the forest where our rituals are practiced" (Farmer 7)		15.5%
Intergenerational benefits NCP				
Intergenerational benefits	"conservation" "future generation" "forefathers" "protection"	"I like this area most because it portrays and presents our conservation and protection efforts […] I see the results of our protection of the environment for others. […] every person in this village is responsible for conserving and preserving this place for future generations. Conserving this place helps other creatures, such as wild animals, to exist" (Farmer 4)		19.0%
Unclassified NCP				
Economic opportunities for livelihoods	"Coffee" "banana" "selling crops" "cash crops"	"We used to grow coffee as one of the cash crops here. Due to the unstable coffee market and increased running costs, many people thought it was better to take care of other crops, such as bananas and maize, instead of growing coffee, which has no benefits. Bananas have also become one of the cash crops compared to previously when it was only for food" (Farmer 5)		40.5%

Each context-specific NCP is illustrated with corresponding themes, exemplary verbatim, exemplary photos, and the percentage share of NCP that appeared in all photos.

Reg. Regulation, N of photos refers to the number of photos through which participants expressed each NCP

livelihoods (6.4%), an NCP referring to the opportunities of selling material goods from nature, such as crops and timber, for income generation: *"From this piece of land that you see on this photo, I can earn money through selling crops such as coffee and bananas"* (Farmer 4).

Expression of values of nature

Participants articulated intrinsic, instrumental, and relational values, each exhibiting different expression levels. Relational values (49.8% of all coded verbatims) were the

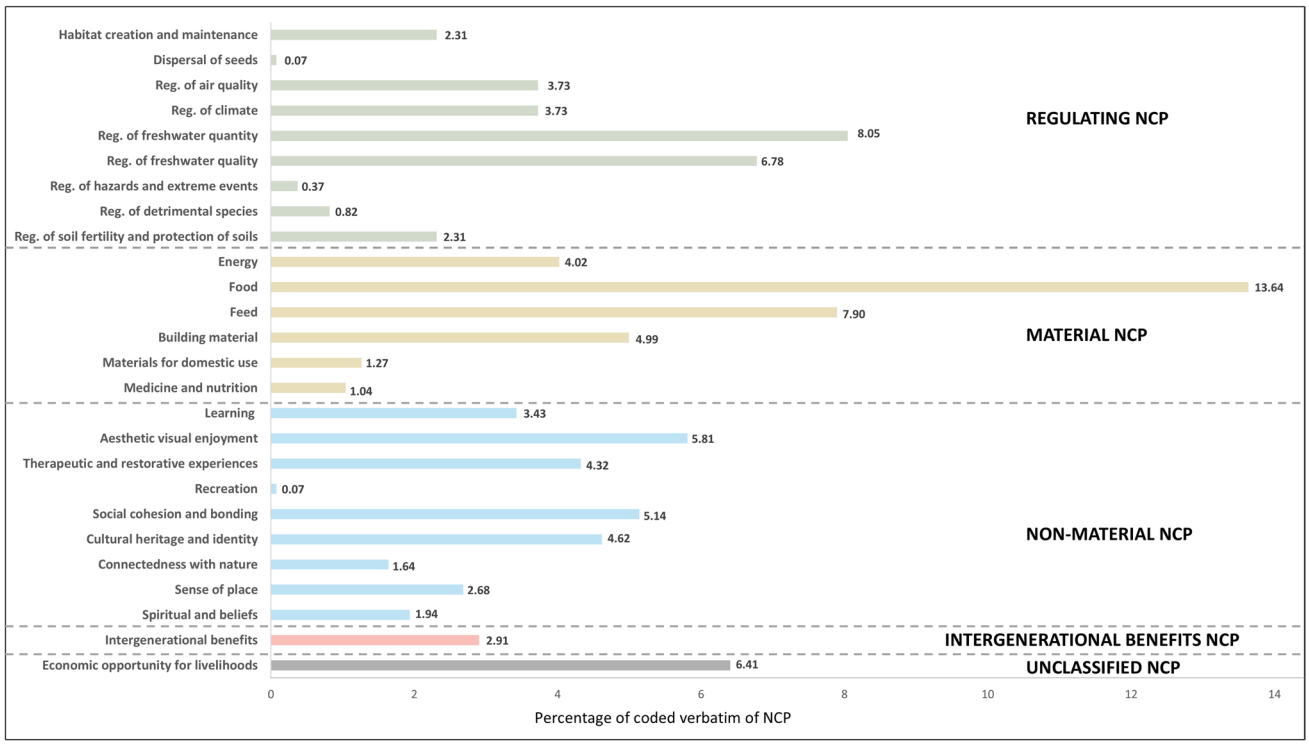


Fig. 4 Percentage of coded verbatims representing each distinct Nature's Contributions to People (NCP) as mentioned by the participants during the narratives provided through the PHOTEV guiding questions. *Reg.* Regulation, *NCP* Nature's Contributions to People

most mentioned category, followed by instrumental values (47.9%), and intrinsic values (2.3%; Fig. 5). Specifically, participants categorized 16 sub-categories of relational values (Fig. 5; Table 2).

Participants expressed intrinsic values by acknowledging the importance of conserving species: "*I like this area most because it portrays our conservation and protection efforts. Being here, I feel more comfortable because I see the results of our protection of the environment for others. Conserving this place helps other creatures, such as wild animals, to exist"* (Farmer 2). In addition, participants mentioned intrinsic values by explaining the importance of conserving the environment: *"People in this village understand the importance of having this place and being green, and thus, when they hear someone cutting down trees in this area, they will call the leaders immediately. We are conserving the area by collaborating with the National Park"* (Farmer 17). Other participants expressed intrinsic values by explaining the importance of intact ecosystems to protect Indigenous species: *"This area [hill] is important to me because it is the area which is still intact, so finding Indigenous or wild species is possible, and there are also wild animals, such as antelopes"* (Farmer 10).

Instrumental values refer to the importance of material benefits provided by nature for basic needs: *"Nature at Kilimanjaro is very important to me because I can get food, timber, and even grass to feed my cow at home. […] I can say that farmland is the area which contributes to our well-being"* (Farmer 3). Participants also expressed the instrumental values of nature as an economic opportunity for their livelihoods: "*The most important elements from this photo are coffee and bananas because both can benefit me through earning when I sell them"* (Farmer 4).

In addition to intrinsic and instrumental values, participants expressed 16 sub-categories of relational values, whereby the three most articulated were aesthetic values (8.%), psychological and therapeutic values (5.6%), and responsibility (4.9%) (Fig. 5). The expression of aesthetic values was related to the appearance of nature, which depended on where smallholder farmers lived. Participants who lived in the uplands appreciated the aesthetic appearance of the lowlands: *"[…] the aesthetic view of the lowland is very attractive*" (Farmer 3) and the green area in the upland: *"For me, this place is very beautiful because of the vegetation available here and the appearance of this place"* (Farmer 5). Moreover, participants expressed their relationship with nature by providing opportunities to relax and relieve stress after work, either within their homegardens or in nature: *"I've chosen this place in my homegarden because I see it's one of the very calm places in the village. After finishing my farmwork, I can relax here because it is very quiet, […] So, for me, being in this homegarden. It is crucial because it helps me stay calm"* (Farmer 13).

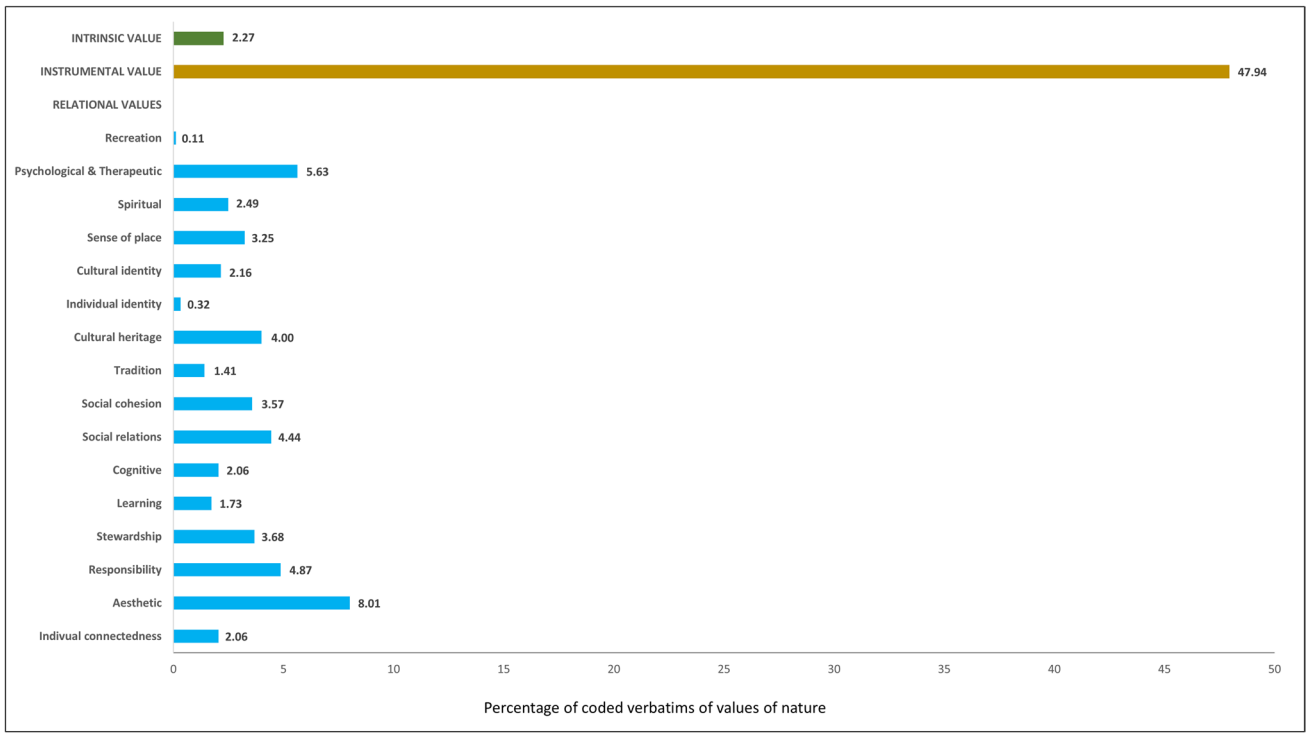


Fig. 5 The percentage of coded verbatims representing each distinct value of nature mentioned by the participants during the narratives provided through the PHOTEV guiding questions

Expression of emotions

The verbatims referring to the emotions expressed through the photos by smallholder farmers were classified into pleasant emotions (76.3% of coded verbatims) and unpleasant (23.7%) (see Table 3). Pleasant emotions were associated with the material benefits they get from nature and support their livelihood: *"I feel happy when I see my farm (homegarden) is giving me what I need such as food and fodder from it, and this is a reason I am taking care of it"* (Farmer 3). Furthermore, farmers associated pleasant emotions with regulating NCP, particularly with the regulation of air quality: *"I feel pleasure being in this area, you know, apart from the nice view that you see here, we are getting good air quality compared to those in the lowlands"* (Farmer 17). Finally, we found the expression of pleasant emotions when referring to non-material NCP and particular relational values. Participants expressed pleasant emotions when referring to the value of sense of place and the pride of being Chagga: *"The feeling of being at home and the place where I was born, I see, is one of the benefits I am getting from this place. […] I am feeling happy for being here and being a Chagga because of continuing to do what my parents were doing "* (Farmer 7).

Unpleasant emotions were expressed in relation to resource scarcity, such as water shortage or drought: *"I feel sad because this area has a water shortage. It isn't easy to fulfill other needs that we want in our lives"* (Farmer 9). Smallholder farmers in the upland expressed unpleasant emotions due to prohibited access to KINAPA to collect material NCP: *"I feel sad because what we were getting from this area, we are no longer getting, such as feed, poles, firewood"* (Farmer 5). In addition, when participants thought about future generations, they expressed unpleasant emotions because they perceived a decreasing trend in this NCP: *"I feel frustrated because my future with my family is uncertain. The land is decreasing and does not fulfill all my basic needs"* (Farmer 3).

Objective 2: Multiple Correspondence Analysis (MCA) to unravel the associations between NCP, values of nature, and emotions

The first two axes of the MCA accounted for 67.5% of the inertia (Fig. 6; Table S3). The first axis (44.5% of inertia) separated two associations between NCP, values, and emotions. The first axis (F1) positive scores represented the association between both pleasant and unpleasant emotions and a mix of regulating (habitat creation and maintenance, regulation of air quality and regulation of climate), material (medicine), non-material NCP (learning, aesthetic, enjoyment, therapeutic and restorative benefits, connectedness with nature, sense of the place, spiritual experience), intergenerational benefits, intrinsic values and most

Table 2 Values of nature articulated by farmers (n = 26) during the photovoice narratives

Values of nature	Themes	Exemplary verbatim	Exemplary photo	N of photos (%)
Intrinsic value	"conservation" "right to exist" "intact"	"We are ensuring this area is not destroyed through our by-laws. Hamlet's leader mandate is to ensure the area remains intact" (Farmer 2)		2.9%
Instrumental value	"farmland" homegarden" "water" "crops"	"This is the place that shows my relationship with nature because this is the only place where I can grow crops, and get other needs for my livestock at home" (Farmer 16)		22.3%
Relational value				
Recreation	"recreation" "physique"	"This place is very important because it is the place for the kids to play football and do other activities that develop their minds and physique, so when we come here, we enjoy seeing our kids use this ground" (Farmer 8)"		0.3%
Psychological & Therapeutic	"homegarden" "relax" "calm place" stress-free"	"I like to be here in my homegarden because I see it's one of the very calm places in the village. After finishing my farmwork, I can relax here, and I can think about my life" (Farmer 25)		7.8%
Spiritual and belief	"rituals" "belief" "origin"	"I like this area because of the myth and belief that exist here; it is believed that the seed of this tree cannot grow here but rather can be dispersed by birds. We don't know why the seeds cannot grow here is happening here, but that's the reality" (Farmer 18)		2.6%
Sense of place	"home place" "homegarden" "place"	"The place that I inherited from my parents, […] I was born here, and I still stay here […] and I will be buried here. For me, here is more important than another place" (Farmer 7)		5.8%
Cultural identity	"agro-pastoralist" "local food" "culture"	"This area is very important to me because it brings me close to my environment and represents my culture, the agro-pastoralist community. I can grow crops as you see here such as banana and keep livestock" (Farmer 20)		4.6%
Individual identity	"tribe" "individual identity" "agro-forestry"	"I like this place because it is the land that I inherited from my parents, so it is difficult for me people to move to another place for farming or starting new settlement rather than utilizing the small plots available at your home" (Farmer 9)		0.9%
Cultural heritage	"culture" "heritage" "ancestors"	"I grew up seeing traditional leaders come here and perform rituals, so this tree has been preserved as one of the cultural property in our community" (Farmer 1)		7.0%
Tradition	"tradition" "irrigation" "local beer"	"This place reminds me of my tradition that we are still performing here at our community such as taking local brew made from banana (*Mbege in Chagga)*" (Farmer 26)		3.2%

Table 2 (continued)

Values of nature	Themes	Exemplary verbatim	Exemplary photo	N of photos (%)
Social cohesion	"gather" "meeting" "family"	"Here is the place we gather and has made us a family because when we meet here, we discuss issues relating to our development, such as conserving our environment or other development projects" (Farmer 17)		6.6%
Social relations	"relationship" "neighborhood" "villagers"	"The benefit of this forest water catchment is not only for the villagers here but also for people from other villages to fetch water here. This is like the source of our life here" (Farmer 2)		7.5%
Cognitive	"preservation" "erosion" "irrigation"	"It may happen if no one is here to check if it is full of water; water may flow out of its channel to other places and can cause soil erosion" (Farmer 26)		4.6%
Learning	"education" "learning"	"we are getting environmental education from NGOs and national park authority that helped me continue conserving the environment while benefiting from the area I conserve. (Farmer 4)		2.9%
Stewardship	"conservation" "forest" "water catchment"	"In the past, this area was under the management of the village council. So, we were conserving this area, conducting all necessary efforts to conserve it, even now we are still conserving the area in collaboration with the park" (Farmer 23)		3.8%
Responsibility	"responsibility" "planting trees"	"This area is very important to me and my family because we are getting many benefits from it. […] so keeping this area intact with natural vegetation is very useful to my community and me" (Farmer 2)		5.8%
Aesthetic	"aesthetic" "trees" "green"	"This area is very important for its view of the lowland. You see a nice view of the lowland here like I am at the top of the hill. From this side, you can enjoy the view of the lowlands " (Farmer 7)		6.7%
Individual connectedness	"forest" "connectedness" "dependency"	"This place is very important to my community and me because it reminds me how I depend on the environment because I have been getting all my basic needs…for instance, the contribution of people's well-being through different activities that communities engage with here. This is an area with a source of water, so people are engaging in gardening" (Farmer 6)		4.6%

Each value of nature is illustrated with corresponding themes, exemplary verbatim, exemplary photos, and the percentage share of the value of nature that appeared in all photos. N of photos refers to the number of photos through which participants expressed each value of nature

relational values (except social cohesion and bonding). On the negative scores, F1 represented the association between the non-material NCP of social cohesion and bonding and instrumental values. The second axis (23.0% of inertia) represented the distinct associations with unpleasant emotions in its positive scores and pleasant emotions in its negative scores. Unpleasant emotions were associated with a mix of regulating (regulation of freshwater quantity and quality, regulation of soil fertility, and habitat creation and maintenance) and material NCP (energy, medicine, food, and building materials), intergenerational benefits, economic opportunities for livelihoods, as well as intrinsic and some relational values, such as learning, aesthetics, responsibility, and stewardship. Pleasant emotions in the F2 negative scores were associated with several non-material NCP (except aesthetic enjoyment and learning experiences) and relational values, such as cultural identity, cultural heritage, tradition, spiritual values, and sense of place.

Table 3 Emotional connectedness with nature expressed by farmers (n = 26) during the photovoice narratives

Emotions	Themes	Exemplary verbatim	Exemplary photo	N of photos (%)
Pleasant emotion	"happy" "joy" "content"	"I feel happy when I see my farm is giving me what I need from it and the way I am conserving it" (Farmer 3) "I am feeling happy for being here and being a Chagga because of continuing to do what my parents were doing" (Farmer 7)		76.3%
Unpleasant emotion	"sad" "disgusted" "anger"	"I feel sad because what we were getting from this area, we are no longer getting such as feed, poles, firewood" (Farmer 5) "I feel sad because this area has a water shortage. It isn't easy to fulfill other needs that we want in our lives" (Farmer 9)		23.7%

Each emotion is illustrated with corresponding themes, exemplary verbatim, exemplary photos, and the percentage share of emotion that appeared in all photos. N of photos refers to the number of photos through which participants expressed each emotion

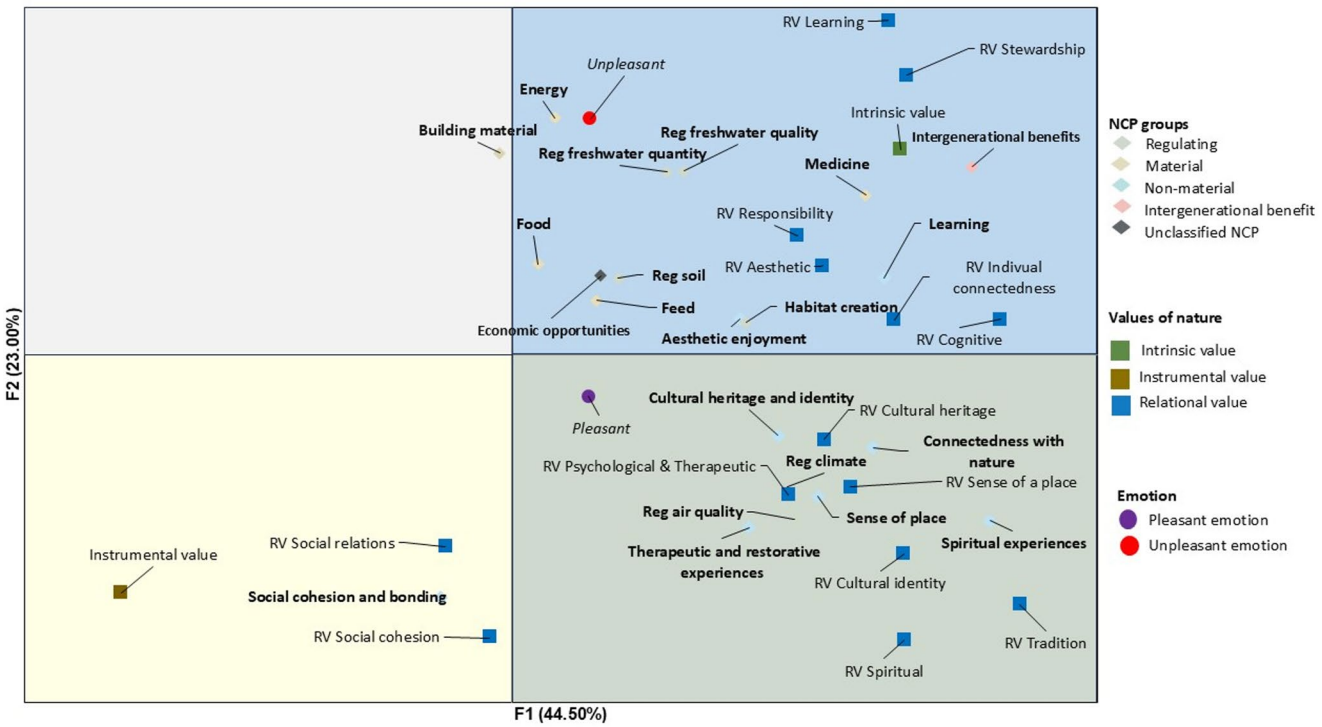


Fig. 6 Multiple correspondence analysis (MCA) for the association between Nature's Contributions to People (NCP), values of nature, and emotions connected with nature expressed by farmers at Kilimanjaro. Diamond shapes (◊) and bold words represent Nature's contributions to people (NCP); square shapes (□) represent values of nature; circle shapes (◯) and italic words represent emotions connected with nature. Reg = Regulation, RV = relational value. The background color of the biplot quadrants represents different patterns of associations between NCP, values of nature, and emotions. For the specific interpretation of the background colors and their representation of the associations, the reader is referred to the main text of this section

The MCA factors represented a different pattern of associations between NCP, values, and emotions as expressed by smallholder farmers through the narratives derived from the photos. The biplot with the first two MCA factors (Fig. 6) portrayed three different patterns of associations. First, in the quadrant represented by the positive scores of F1 and F2, we found an association among unpleasant emotions, several materials and regulating NCP, intrinsic values, and the relational values of stewardship, responsibility, and aesthetics (light blue colored in Fig. 6). This association of NCP and values with unpleasant emotions represented a nostalgic reaction towards what it was enjoyed in the past. This can be explained by a combination of two reasons. First, the prohibition from collecting fodder, firewood, and other forest resources imposed through the HMFS ban, as expressed by the quote: *"I have chosen this picture to show*

you how we have conserved the environment ever since we had access to the Half-Mile Forest Strip there, where we used to conserve the forest. We used to have access to the forest (in the Half-Mile Forest Strip) to collect non-timber forest products, firewood, and feed for our livestock. But after that, we tried to grow trees at home to get some of the benefits from the forest. When we had access to the forest, we also had a chance to clean the surroundings of the water catchments. We also had an opportunity to conduct rituals there in the forest" (Farmer 7). Second, smallholder farmers perceived that the supply of most material and regulating NCP has decreased over the last 15 years: *"We used to get fresh water from this water source. This was the only place in our village that provided us with fresh water for our household. […] We used to get water throughout the year, but now, as you can see, there is no water at all due to the destruction and climate change"* (Farmer 5). Moreover, we found that unpleasant feelings were also associated with the sense of loss of identity as stewards of the forest and the opportunities for spiritual rituals and diversifying their livelihoods.

At the same time, smallholder farmers recognized the importance of the forest in KINAPA in regulating freshwater quality and quantity and providing habitat for species, expressing intrinsic values. The recognition of these NCP and intrinsic values is also expressed through the emotion of concern for nature within the National Park due to the impact of fires: "*People in my village understand the importance of having this place and being green, and thus, when they hear someone cutting down trees in this area, they will call the leaders immediately. Here, we are conserving the area by collaborating with the National Park because we want animals in the National Park to continue to exist. For instance, once the area catches fire, we understand the cost of leaving the area unprotected will affect the park and us as villagers […] You know we are very lucky to be here in this village. As you see, it is not the rainy season, but we have plenty of water in our area, which is different from other places in the lowlands where they are suffering from water scarcity (Farmer 17).* The narratives presenting this association are derived from photos taken by smallholder farmers in the uplands below the border with the KINAPA (Fig. 7a).

The second pattern portrayed by the bottom right quadrant of the biplot represented the association between pleasant emotions, non-material NCP, and several relational values (light green colored in Fig. 6). This association of non-material NCP and relational values with pleasant emotions was found in photos representing the Chagga homegarden, which was framed as a cultural space for practicing Chagga traditions and preserving their heritage: "*I chose this photo because it portrays the inheritance from my family. Traditionally, we are getting this piece of land from our parents, so viewing this photo reminds me of what I inherited from my parents. So, in that case, I also have to pass on the land to my son"* (Farmer 4). The pleasant feelings were also associated with embracing intangible assets associated with the homegarden and with emotions of pride and belonging to the Chagga community. Moreover, agroforestry practices in the homegardens are portrayed to embrace the culture of the Chagga's ancestors, which strongly inspires residents to continue farming and activates emotions of happiness and pride in continuing the Chagga agroforestry practices: "*I am feeling happy for being here and being a Chagga because of continuing what I am doing and what my parents were doing (agroforestry)"* (Farmer 7). This narrative was mainly derived from photos portraying agroforestry systems (Fig. 7b).

The third pattern of associations was represented by the negative scores of F1 and F2 (yellow colored in Fig. 6), which portrayed the association between instrumental values, relational values of social cohesion and social relations, and the NCP of social cohesion and bonding, representing the daily lifestyle of the Chagga and other smallholder farmers. For instance, participants articulate that nature provides the space for them to meet and discuss issues relating to their social development at the village level, making them feel united as one family: *"We meet here as villagers to discuss issues related to the development of our village. If there is anything that we want to do as villagers, we must meet here first to discuss it. Community development activities include contributing to the construction of our school. So, I see this place as valuable because we have no place in the village to accommodate all villagers"* (Farmer 6). In addition, participants articulated the instrumental values attached to the farmland: *"This is the place [farmland] I like the most because it is where I get what I want, such as food"* (Farmer 4). This narrative was primarily derived from photos illustrating home gardens in the uplands and maize fields in the lowlands (Fig. 7c).

Discussion

Methodological implications

An approach to assess multiple NCP, values of nature, and emotions

Former research applying photovoice has demonstrated associations between NCP and people's quality of life (e.g.,

Fig. 7 Photos collected during the photovoice exercise related to the MCA results presented in Fig. 6 above. **a** Photos taken by farmers in the uplands at the border with the Kilimanjaro National Park that relate with the narratives presented in the top-right corner of the MCA. **b** Photos were taken by farmers in the uplands within the traditional Chagga homegardens that relate to the narratives presented in the bottom-right corner of the MCA. **c** Photos of farmers showing agricultural activities from the lowland to the upland that relate to the narratives presented in the bottom-left corner of the MCA

Berbés-Blázquez 2012; Masterson et al. 2018). With this study, we take a step further by demonstrating that combining photovoice and MCA facilitates the revelation of associations between NCP, values of nature, and pleasant and unpleasant emotions. By combining content analysis and MCA, we not only identified the associations between NCP, values, and emotions but also the places where these associations are contained. For example, smallholder farmers living in the upland areas bordering the National Park expressed unpleasant emotions, such as nostalgia, fear, and disapproval, associated with losing access to material NCP due to the HMFS ban and a decreased supply of most material and regulating NCP. Moreover, smallholder farmers who live in homegardens in upland areas expressed pleasant emotions, such as pride and gratitude, connected to several non-material NCP associated with the cultural heritage of homegardens.

An approach to elicit an understanding of human-nature relations

By taking photos and discussing them with researchers, photovoice encourages local communities to reflect on the benefits of nature (Berbés-Blázquez 2012; Stedman et al. 2014; Tengö et al. 2017; Masterson et al. 2018). In doing so, photovoice can activate multiple knowledge systems. First, we mobilized the local knowledge system of Chagga farmers and discovered that their homegardens matter not only for their material contributions but also for the regulating and non-material NCP. Second, we brought together the experiential knowledge of smallholder farmers and photography (art-based knowledge) to uncover the associations between NCP, values, and emotions. Therefore, photovoice leveraged multiple knowledge systems, enabling us to understand how Chagga farmers manage homegardens as

holistic systems in accordance with their relational worldviews. Moreover, photovoice enabled participants to gain a deeper understanding of their relationship with nature by combining images and narratives, which, in turn, provided an emotional account of why the photo was taken (Coffey 2023). With this study, we elicit emotions through the narratives of the photos that allow us to understand NCP and values of nature as embodied in emotions.

Empirical implications

The pluriverse realities of Chagga farmers

Drawing on Arturo Escobar's notion of the pluriverse (Escobar 2020) or *'a world where many worlds fit'* (an evocative expression from the Fourth Declaration of the Lacandón Jungle, in (De la Cadena and Blaser 2018). We argue that there are many worlds that align with the reality of smallholder farmers. Through this study, we contribute to demonstrating the multiple ways in which a single social actor relates to nature, influenced by their daily life experiences. Within the social actor of smallholder farmers, we found three different ways of relating with nature that result from the associations between NCP, values of nature, and emotions (Fig. 8): (1) the association of unpleasant emotions with several material and regulating NCP, intrinsic values, and relational values of stewardship, responsibility, or aesthetics, (2) the association between pleasant emotions, non-material NCP, and several relational values, and (3) the association between instrumental values and the relational values and NCP of social cohesion and social relations, and bonding.

Chagga farmers expressed unpleasant emotions, such as sadness or fear, which are associated with the loss of access to forest and the opportunities that this ecosystem offers in terms of material NCP and "economic opportunities for livelihood", as well as the loss of the farmers' capacity to be stewards of the land (relational values). The findings are similar to those of previous studies, which have assessed emotions associated with restrictions on access and use of the land. For instance, González-Hidalgo and Zografos (2017) found that Indigenous Mapuche communities expressed anger and sorrow due to the conflict over tree plantations in Southern Chile. Moreover, the restriction on forest access might have disrupted Chagga farmers' sense of place, leading to unpleasant emotions. For instance, Cundill et al. (2017) found that local communities displaced from their land in South Africa strongly demanded their cultural identity as connected with nature.

In contrast, Chagga farmers expressed pleasant emotions, such as pride and gratitude related to the opportunities offered by their homegardens for enjoying non-material NCP and relational values, such as sense of place, spiritual values, cultural heritage, and traditions. The fact that smallholder farmers connect pleasant emotions with non-material NCP and relational values in their homegardens could be explained by different reasons. First, the emotion of happiness might indicate a sense of contentment with the livelihood security, sense of place and their work in the homegarden. Second, the emotion of pride might be explained by a deep emotional connection to the Chagga culture and heritage, which is transmitted to younger generations. Chagga people have practiced agroforestry in their homegardens for many years, making it part of their cultural identity and traditions (Fernandes et al. 1985; Mbeyale and Mcharo 2022). Managing Chagga homegardens requires communal work, such as maintaining irrigation furrows, which creates a sense of community and stewardship (Kimaro and Bogner 2019). In fact, some Chagga farmers expressed pride blended with environmental stewardship because they conserve large native trees by maintaining the traditional and economic uses of the oyster nut (*Telfairia pedata*) or *kweme* in Swahili (Shayo 2023).

These two realities – i.e., unpleasant emotions associated with prohibited access to the forest and pleasant emotions derived from the meaning of their homegardens co-exist in the same place (Fig. 8), within the same local Chagga community, and within the same Chagga farmer, demonstrating the pluriverse contained in Chagga farmers.

A tapestry of values of nature in Chagga homegardens

By combining photovoice and MCA (Fig. 6), we could identify the co-occurrence of instrumental values with relational values, such as social cohesion and bonding, which emerged from the narratives of photos depicting farming practices. These results challenge the idea that farming practices not only target meeting basic needs but also are based on Chagga farmers' meaningful relations with their homegardens. This aligns with recent research confirming that agricultural activities are not only for production but also for fostering relational values (Chapman and Deplazes-Zemp 2023; Ortiz-Przychodzka et al. 2023; Vizuete et al. 2025). For example, (Chapman and Deplazes-Zemp (2024) argued that in those human-nature relationships where reciprocity exists, such as when farmers also act as environmental stewards, the categories of intrinsic, relational, and instrumental values are interwoven and difficult to extract from each other. Similarly, Vizuete et al. (2025) found that assemblages of instrumental and relational values mostly sustain the agroecological practices led by women in Spain, and that we cannot separate the instrumental aspect from the relational one. Together with our results, these studies demonstrate the relationality of farming practices. Pearson

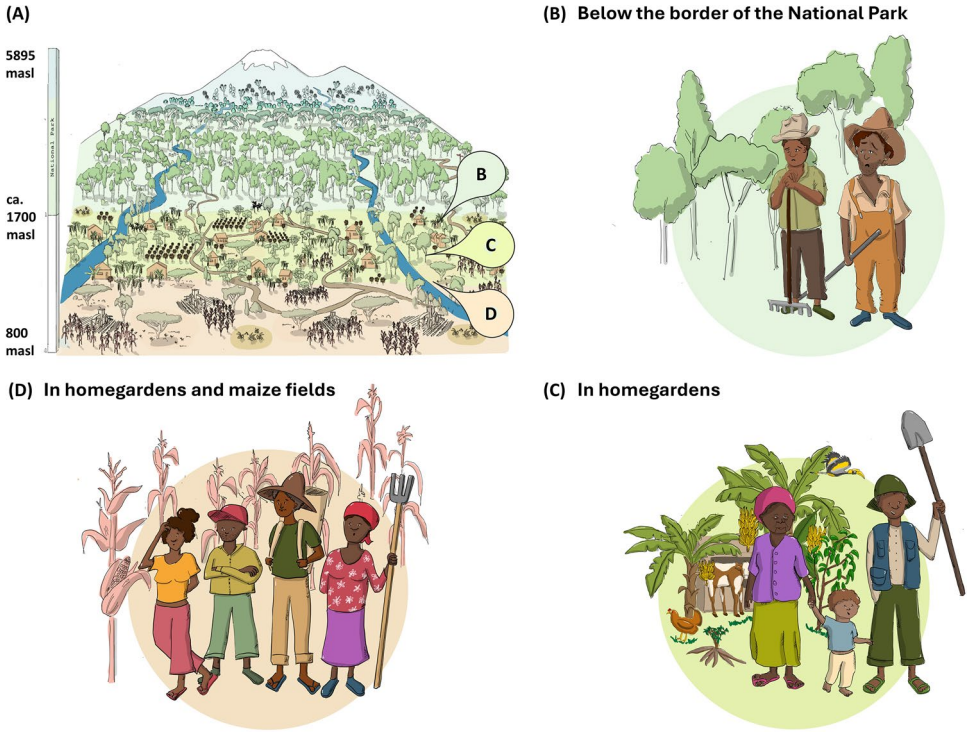


Fig. 8 Illustration of the pluriverse realities of smallholder farmers in Kilimanjaro reflecting the interplays of NCP, values of nature, and emotions. **A** It represents the sketch of Mt. Kilimanjaro, which reaches its summit (5895 masl) and places where the interactions between NCP, values of nature, and emotions occur (top-left). **B** Illustration representing the association of unpleasant emotions with several material and regulating NCP, intrinsic values, and a few relational values below the border of the National Park (top-right). **C** Illustration representing the association between pleasant emotions, non-material NCP, and several relational values in homegardens (down-right). **D** Illustration representing the association between instrumental values and the relational values and NCP of social cohesion and relations in homegardens and maize fields (down-left). The quadrant representation is based on the results of the Multiple Correspondence Analysis (MCA) presented in Fig. 6

et al. (2025) found that agricultural and culinary practices are the platform by which Chagga women emotionally connect with nature and, in doing so, express an assemblage of instrumental and relational values of aesthetics, cultural identity, and stewardship.

Implications for inclusive conservation

Rethinking the access restriction to protected areas: the need to foster meaningful human-nature relationships

Although creating borders around protected areas (e.g., those of national parks) can achieve biodiversity conservation objectives (Su et al. 2022), it can hinder the maintenance of meaningful relationships between people and nature (Xu and Huntsinger 2022). Borders restrict local communities' access and rights to resources (Adams and Hutton 2007; Cumming 2016), affecting material-based and non-material benefits, as well as emotional connections with nature (Ives et al. 2018). In the context of Kilimanjaro, our results show that the HMFS ban (KINAPA 2006) might have disrupted farmers' access to feed, energy, and the spiritual experience of nature, rupturing human-nature connections for the Chagga and their identity as stewards of Kilimanjaro. Smallholder farmers often expressed this point, suggesting that the HMFS ban on KINAPA entry may demoralize people's interest and support for biodiversity conservation. Similarly, Cundill et al. (2017) found that restricting access to protected areas in South Africa undermined the sense of responsibility that displaced communities felt towards nature. In our study, smallholder farmers felt this most strongly in upland areas (Fig. 8), where they tended to express unpleasant emotions associated with restricted access to material NCP and limited opportunities for relational experiences with nature. Our findings suggest the need to rethink access restrictions, which are eroding meaningful relations between people and nature and fostering unpleasant emotions towards nature and its management.

Conservation-related benefit sharing mechanisms: the need for multiple purposes

Most protected areas in Tanzania were established by displacing people and denying them access to their communal

lands (Songorwa 1999). National parks in Tanzania implement benefit-sharing programs with local communities called "*Ujirani mwema*" (in Swahili), meaning good neighborliness. The program mostly consists of providing monetary and material benefits to the surrounding villages. This is aimed at offsetting the conservation costs borne by villagers residing below the border of the protected areas (Kideghesho et al. 2007). A review conducted by Kegamba et al. (2022) on conservation-related benefit-sharing mechanisms in Tanzania, three forms of benefit-sharing were found: social services provision, livelihood provision, and local employment. However, these conservation-related benefit-sharing mechanisms mostly address livelihood security Mariki (2013) and overlook non-material NCP, relational values, and emotions. We suggest reconsidering the benefits-sharing program beyond basic needs and livelihood security to include relational dimensions, such as a sense of place, identity, cultural practice, and emotions.

Conclusion

The connections between NCP, values of nature, and emotions provide valuable insights into understanding the multiple ways by which people relate to nature. The photovoice method provided a unique opportunity to understand smallholder farmers' connections with nature through their daily experiences. The three forms of associations between NCP, values of nature, and emotions that we identified were (1) the association between unpleasant emotions, several material and regulating NCP, intrinsic values, and the relational values of stewardship, responsibility, and aesthetics that was expressed by smallholder farmers below the border of the national park, (2) the association between pleasant emotions, non-material NCP, and several relational values, such as sense of place and cultural heritage that smallholder farmers expressed in their homegardens, and (3) the association between instrumental values, relational values, and NCP of social cohesion and social relations that was expressed by all smallholder farmers from the lowland to the upland. Based on these results, we suggest three main measures to foster inclusive conservation: (1) to consider the pluriverses of human-nature relations that occur within one social actor (here the smallholder farmers); (2) to reduce access restrictions of local actors to protected areas to sustain meaningful human-nature relations and minimize unpleasant emotions towards nature and its management, and (3) to expand conservation-related benefit-sharing mechanisms beyond instrumental thinking to consider non-material NCP, relational values, and emotions.

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Author Contribution JS, JP and BML conceived the idea and designed the methodology; JS conducted data collection through photovoice interviews; JS transcribed and translated the interviews; JS, JP and BML developed the coding scheme and analyzed the data; JS and BML developed the first draft of this manuscript. THM and JKS contributed to the discussion section. All authors commented on previous versions of the manuscript and gave final approval for publication.

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Data availability Due to the sensitive nature of the information provided by participants and in accordance with the ethical approval granted by Leuphana University of Lüneburg, the interview transcripts are not publicly available. The quantitative dataset, however, is openly accessible via a Digital Object Identifier (DOI) in the university's data repository: https://doi.org/10.48548/pubdata-2410

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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