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Ethnic and locational differences in ecosystem service values: insights from the communities in forest islands in the desert

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Abstract

Understanding cultural preferences toward different ecosystem services is of great importance for conservation and development planning. While cultural preferences toward plant species have been long studied in the field of plant utilisation, the effects of ethnicity on ecosystem services identification and valuation has received little attention.

We assessed the effects of ethnicity toward different ecosystem services at three similar forest islands in northern Kenya inhabited by Samburu and Boran pastoralists. Twelve focus groups were organised in each mountain, to evaluate the ecosystem services provided by the forest, and assess which plant species are most important for provisioning different ecosystem services.

While water was always identified as the most important ecosystem service, the second most important differed; and some were only mentioned by one ethnic group or in one location. Preferred plant species for food, fodder, medicine resources, poles and firewood followed the same pattern.

Our results showed that ethnicity and location affect ecosystem services' identification and importance ranking. This should be taken into account by decision-makers, e.g. as restricted access and regulated extraction is likely to affect people differently. Conservation and development projects would be more effective if they were initiated with an understanding of how people already use and value their forests.

Keywords:
Northern Kenya
Plant use
Socio-cultural assessment
Biodiversity conservation
Remnant forests

1. Introduction

There has been an increasing interest in ecosystem services (ES), in the research, policy and practitioner communities (Costanza and Kubiszewski, 2012). Since the publication of the Millennium Ecosystem Assessment (MEA) by the United Nations in 2005, and the Economics of Ecosystems and Biodiversity (TEEB) report in 2010, the concept of ecosystem services not only gained broader attention, but it also entered the consciousness of mainstream media and business (Costanza et al., 2014). According to most researchers, the assessment of ES demands an integrative approach that considers ecological, economic and social evaluation criteria (Burkhard et al., 2010). However, most state-of-the art ES research has taken either an ecological or economic approach, or a combination of the two (Raymond et al., 2013), with limited studies using a social approach. Social approaches to ES assessment are those which apply research methods from the social sciences (e.g. interviews), value ES in non-monetary terms (e.g. perceptions) and explicitly make stakeholders the focal point of the research (Orenstein and Groner, 2014). These social ES assessment approaches can complement and increase the value of traditional economic and ecological approaches, as they have the advantages that they can help: (a) value cultural services, (b) understand complex socio-ecological systems, (c) assure social relevance of the ES assessment process and (d) strengthen the policy relevance of the assessment (see Orenstein and Groner 2014 and references therein). Moreover, they also help ensuring that subsequent management interventions are embedded and work with the local culture(s).

It has been argued that geographic, socio-economic and cultural factors, life experiences, and the use and non-use of particular areas of the landscape shape how individuals value ES (e.g. Allendorf and Yang, 2013; Alassaf et al., 2014; Muhamad et al., 2014). For instance, in several countries in Southeast Asia poor people, educated people and communities in close vicinity to forests tend to identify more ecosystem services (Sodhi et al., 2010). In southwest China, male, older age groups and people with higher level of education are more likely to identify more ES (Allendorf and Yang, 2013). Among the factors which affect ES identification and ranking, cultural factors such as ethnicity have received little attention. One recent study in the southern Arabah Valley including Jordanians and Israelis reported significant differences in ES ranking between different cultural groups (Orenstein and Groner, 2014). In southwest China and Hawaii ethnicity is also found to affect the identification of ES (Allendorf and Yang, 2013; Gould et al., 2014).

Interestingly, cultural preferences (related to ethnicity) toward plant species have been long studied in the field of wild plant utilisation (ethnobotany, ethnomedicine, wild edible fruits and vegetables) (e.g. Mnzava et al., 1999; Wickens and Lowe, 2008). For example, useful plant species and even plant parts of the same species are known to differ geographically and in relation to ethnic group (Assogbadjo et al., 2012; Sop et al., 2012). Plant use by local communities is also affected by the abundance of a species, the availability of alternative species and local taste preferences (e.g. Jusu and Cuni-Sanchez, 2014). These three factors are also likely to affect preferences towards ES.

Understanding cultural preferences toward ES is of great importance, especially for conservation purposes and for local development planning; including sustainable ES dependent livelihoods (Hartter et al., 2012). For instance, such information can be used to anticipate possible changes in the future, because typically there are trade-offs between different ecosystem services (Foley et al., 2005). For example, the enhancement of provisioning services (timber or firewood extraction) typically causes the decline in many other ecosystem services (water quality, soil conservation) (Foley et al., 2005).

The main objectives of this study were: (i) to determine if ethnicity and location (defined as spatially separated mountains) affect ES identification and ranking, and (ii) to assess if ethnicity and location affect the selection of most important plant species for different ecosystem services. As study area we selected three forest islands in the arid lands of northern Kenya. These forest islands are seasonal and dry-spell cattle grazing stations, and their conservation is a challenge. As already reported in 1961, 'the problem [of protecting northern Kenya forests] is not a small one; short of employing an army of forest guards, it would be impossible to protect these forests from damage or destruction by an unwilling population' (KNA, 1961). For example, in one of the forest studied, which is an important elephant habitat in northern Kenya (Ngene et al. 2009), ten plant species are red listed by IUCN and deforestation and forest degradation are major problems, mainly linked to firewood harvesting and increased demand for agricultural land for food production (Shibia, 2010; Githae et al., 2008). Through this case study in northern Kenya, we aim at highlighting gaps in current ES research and show how one could address these gaps, not only in northern Kenya, but elsewhere in the world.

2. Materials and methods

2.1. The case study area

This study focused on the communities living adjacent three forested mountains in northern Kenya: Mt Nyiro (2752m), Mt Kulal (2285m) and Mt Marsabit (1707m) (Fig. 1). Most of northern Kenya, which are lowlands, is classified as a very-arid area with annual rainfall between 150-350 mm (zone VII, Somboerk, 1982). However, the mountains we studied are much wetter and cooler, with annual rainfall between 800-1400 mm (semi-humid area, zone III Somboerk, 1982). Rainfall is concentrated in two wet seasons, from March to May and from October to December, but great inter-annual variation occurs, with some years having one or no rainy season.

In northern Kenya, closed forests are always restricted to mountain areas and hilltops, where mist condensation leads to more humid conditions (Bussmann, 2002). Although the three forests studied have similar forest types, there are some differences in observed plant communities and the altitudes where these are located (Table 1A, Appendix). The three mountains studied are part of the Eastern Afromontane Biodiversity Hotspot (Mittermeier et al., 2004). Mt Marsabit is a national park, Mt Nyiro is a forest reserve and Mt Kulal is a community forest. Access to Mt Marsabit forest is restricted and law reinforced by park guards (free access for non-timber forest products but grazing is restricted to dry seasons and firewood collection is illegal). Access to Mt Nyiro and Mt Kulal forests is not restricted. Note that Mt Marsabit is an important elephant habitat in northern Kenya (IUCN/UNEP, 1987; Ngene et al. 2009).

In our study region there are different ethnic groups (Fig. 1). Mt Nyiro and Mt Kulal are only populated by Samburu pastoralists, while different ethnic groups inhabit Mt Marsabit, the northern part being dominated by Boran-speaking groups and the southern part by Samburu-speaking ones (Fig. 1, Table 1). Some differences with regard to main livelihoods and general development of the area can be observed between mountains (Table 1).

Traditional pastoralism for all the ethnic groups studied is typically a subsistence-level production system, with families relying more on milk than meat for nutrition, selling animals to get cash for other economic needs, and building herd sizes to accrue social status, wealth, and provide a buffer against risks such as severe droughts (Bussmann, 2006). In northern Kenya rural livelihoods are particularly prone to uncertainties, mainly related to vagaries of climate such as drought events and conflict like cattle rustling. Although development and emergency aid institutions have a relatively large presence here, and may provide some safety-net functions when shocks occur (e.g. food aid), they often take a long time to arrive (e.g. limited infrastructure in the area) and they do not address certain aspects such as reduction of herds (related to severe droughts or thefts).

2.2. Data collection

Focus-group (FG) discussions were organised in twelve permanent villages located around each of the three mountains (3 x 12 = 36, Fig. 1) in October – December 2014. This encompassed all major permanent villages in each mountain. These three mountains were selected because (i) they are isolated forest systems with similar a range of vegetation types and (ii) local communities have similar livelihood strategies which rely on these forest systems. Each FG involved 5-10 male elders including the village chief, as it is a custom in the area. After we explained the aim of the study to the village chief, he explained it to the elders and some decided to participate on a voluntary basis. There were no differences in the organization of the FG between villages. The FG were facilitated and translated by a person of the same ethnicity of the FG we were working on.

It could be argued that by only including male village elders in the FG discussions we might have obtained biased results. In the studied ethnic groups, females move to their husband's village when they marry (which might be in another mountain, or from lowlands to mountains) potentially reducing the number of species she might know from that site. Moreover, in the study area females do not talk openly in front of males due to cultural norms, and we had limited resources to organise two FG per village. Therefore, we decided that by including male elders in all sites we were more likely to have captured the whole range of important ES and species. Allendorf and Yang (2013) reported that male and older age groups are more likely to identify ES. However, we acknowledge that in other study areas it is recommendable to include female respondents.

First of all, participants were informed that the aim of the study was to better understand the importance of the forest for local communities. Secondly, informal discussions centred on assessing the importance of the forest by mentioning all ES (open question, no limit of ES to select). Thirdly, they were asked to select the two most important ES in each village stating the reasons behind. Afterwards, they were asked to select the three species they considered the most important for firewood, poles, medicine resources, food and fodder. All comments made in a single FG were considered to be a general opinion in the village if no clear disagreement between individuals was observed during the discussion.

All plant species mentioned in FG were collected for identification and verification of their local name at the Herbarium of University of Nairobi. Field observations were also made in each forest, to determine (i) if the plants mentioned in the FG were present, (ii) if they were relatively abundant (easy to find) and (iii) how they were being collected. Specimen samples of plants not mentioned in one mountain were shown to village elders in consecutive meetings in March 2015 (part of an ongoing research project), to verify if these plants not mentioned in the FG in that mountain could be found in that mountain.. Species presence in a mountain and their conservation status was also checked with the literature (e.g. Beentje, 1995). Unfortunately, as the samples of some plant species collected were sterile and they could not be identified, they are reported using their local name.

2.3. Data analysis

In order to determine the effects of ethnicity, the six Samburu-speaking villages and the six Boran-speaking villages in Mt Marsabit were pooled separately (hereafter named Mar-S and Mar-B respectively). However, the data from the 12 FG in Mt Kulal (all Samburu-speaking) was pooled together, and the data from the 12 FG in Mt Nyiro (all Samburu-speaking) was pooled together. Therefore, we had four combinations: (a) different ethnicity but same location (Mar-B and Mar-S), (b) same ethnicity but different location (Mar-S and Kulal or Nyiro), (c) same ethnicity and similar location (Kulal and Nyiro), and (d) different ethnicity and location (Mar-B and Kulal or Nyiro). We are aware that the number of FG in Mar-B and Mar-S is smaller than Kulal or Nyiro, but preliminary analysis using different combinations of six FG in Kulal or Nyiro gave similar results than using all 12 FG there, so we report our findings using all 12 FG in Kulal and Nyiro.

As we wanted to compare the similarity between the species mentioned in the different mountains and ethnic groups, we computed the Jaccard similarity coefficient (J), defined as the size of the intersection divided by the size of the union of the sample sets:

$$J(A,B) = \frac{A \cap B}{A \cup B}$$

where A and B are the binary descriptions of species presence/ absence in given age classes. A value of 1 indicates complete similarity, while 0 indicates complete dissimilarity.

For each species mentioned, we also calculated the number of times mentioned in a mountain and the number of important uses. The species mentioned more times for a given ES was considered the most important while the most important species overall was the species with more uses and mentioned more times.

Content analysis was used to capture the components of verbal discussion held. In this way the dialogue with respondents was broken down into smallest meaningful units of information or themes and tendencies. This helped researchers to ascertain values and attitudes of respondents.

3. Results

3.1. ES identification and valuing

In total, 11 ES were mentioned in Mar-B, 12 in Mar-S, 11 in Kulal, and 11 in Nyiro (Table 2). Seven ES were cited in all mountains and by all ethnic groups: water, micro-climate regulation, fodder during droughts, firewood, poles, honey/fruits and medicine resources (Table 2). While some ES were only reported by one ethnic group ('tools plough' by Boran, 'aesthetic values' and 'air purification' by Samburu); others were only mentioned at certain mountains ('wildlife' in Marsabit, 'shelter during conflict' in Kulal and Nyiro) (Table 2). Wildlife was linked to biodiversity rather than a source of food, as most pastoralists in the study area prefer to eat cow/goat/camel meat rather than bush meat.

Some variation in the definitions of specific ecosystem services was observed. In most FG in Nyiro participants did not separate food for humans and fodder. Also in Nyiro food for humans was mainly honey as opposed to other locations, where wild fruits were mentioned more often. 'Cultural value' linked to traditional ceremonies was only mentioned in Mar-S, but it should be noted that the same ceremonies are practiced by Samburu in Kulal and Nyiro, as elders confirmed when asked after the FG. Water availability was the most important ES in all mountains and for all ethnic groups (Table 2). The second most important ES differed between sites: in Mar-B it was firewood, in Mar-S fodder during droughts, in Kulal medicine resources, and in Nyiro it was more diverse (Table 2). Note that fodder was mentioned in all Samburu FG but only in 50% of the Boran FG (Table 2).

3.2.Preferred plant species for providing ES

In total, 23 species were mentioned in Mar-B, 22 in Mar-S, 36 in Kulal, and 27 in Nyiro (Table 2A, Appendix). Overall, the different Jaccard indexes of similarity (J) were quite low (<0.5, see Table 3), highlighting the low similarity on preferred species between groups studied. When considering all species mentioned, J was slightly higher between Mar-B/Mar-S and Kulal/Nyiro while when considering each providing ES, J was higher for fodder and food for Mar-B/Mar-S and for medicine resources between Kulal/Nyiro (Table 3). With regard to the most preferred species, Mar-B and Mar-S shared the most preferred species for food, poles and firewood, while Kulal and Nyiro shared it for fodder and poles (Table 4). While some species were only mentioned by Boran (*Bauhinia tomentosa*, *Chrysophyllum viridifolium*) or Samburu (*Rhamnus staddo*); others were only cited in Mt Marsabit (*Diospyros abyssinica*, *Drypetes gerrardii*, *Strychnos henningsii*) or in Mt Kulal and Mt Nyiro (*Dombeya torrida*, *Juniperus procera*, *Myrsine africana*, *Pavetta gardeniifolia*, *Rapanea melanophloeos*) (Table 2A, Appendix).

In Mt Marsabit the most important species was *Olea europaea*, and in Mt Kulal and Mt Nyiro it was *Olea capensis* (Table 4). In most cases a species was considered more important where it had more uses: *O. europaea* had five uses in Mar-B but two in Nyiro; *Coptosperma graveolens* had three uses in Mar-B but one in Kulal (Table 2A, Appendix).

It should be noted that in Mt Marsabit the species preferred for medicine resources and fodder were different between ethnic groups. While the preferred species by Boran for fodder was *O. europaea* and for medicine resources *Euphorbia tirucalli*, for Samburus they were *Rinorea convallarioides* and *Toddalia asiatica* respectively (Table 4). Interestingly, discussions revealed that Boran were unaware of the medicinal properties of *T. asiatica*, while Samburu knew those of *E. tirucalli* but preferred using something else. *E. tirucalli* is a species introduced from India, commonly cultivated for its use as a fence; but it can also be given to goats and camels as fodder, and it has medicinal properties (Beentje, 1995).

Both the literature review and field observations indicated that some species were not found in some sites. While *Rinorea convallarioides* is only found in Mt Marsabit, *Juniperus procera*, *Podocarpus* spp. and *Myrsine africana* which often grow >1800m are not found in Mt Marsabit (Beentje, 1995; Githae, 2007). However, in some cases a species can be found in a mountain but it was not mentioned in the FG: e.g. *Rhamnus prinoides* can be found in Mt Marsabit, *Prunus africana* and *Xymalos monospora* in Mt Kulal. When participants were asked about this observation, they either mentioned that the species was not abundant 'we need to go deep in the forest to find it' (participant comment for *Rhamnus prinoides* in

Marsabit) or that 'we prefer using something else' (participant comment for *Prunus africana* and *Xymalos monospora* in Kulal).

We found that most species mentioned for food (wild fruits) were not found inside the forest but at the edge of it (e.g. *Grewia* species, *Vangueria madagascariensis*). Moreover, in general, Boran mentioned more species (nine) which could not be found inside the forest compared with other FGs (five in Mar-S, six in Kulal, four in Nyiro).

4. Discussion

4.1. ES identification and valuing

In this study water availability was found to be the most important ES in all mountains and for all ethnic groups. Considering that the forests we studied are located in a drought-prone area, where water is difficult to find, this was not unexpected. Water is frequently the most important ES mentioned in drought-prone areas, such as southwest China (Allendorf and Yang, 2013) and in the desert in south Israel (Orenstein and Groner, 2014). Indeed, water is known to be the most important ES provided by the montane forests of Kenya, often known as Kenya's 'Water Towers' (UNEP, 2012). Deforestation of montane forests is known to negatively affect water yield, partially because of the loss in cloud water interception in these forests occurring at such high elevations (Bruijnzeel et al., 2011).

Despite the observed agreement on the most important ES, the second most important ES differed between sites: in Mar-B it was firewood, in Mar-S fodder during droughts, in Kulal and Nyiro medicine resources. This, together with the number of ES identified, and their definition, seems to be affected by both ethnicity and location. With regard to ethnicity, in Mt Marsabit the Boran stressed the important use of firewood, while Samburu mentioned fodder. Cattle holds high value in Samburu and Rendile cultures, so fodder for their cattle is more of a priority than for the Boran. In fact, in Mt Nyiro, the link between humans and cattle for Samburu was stressed even further when participants in FG said that food and fodder could not be separated from one another. This indicates that ethnicity influences not only the rating of ES but also their definition, as previously reported in Hawaii (Gould et al., 2014). 'Aesthetic values' and 'air purification' were only mentioned by Samburu, which are known to place high value on 'nature' (Bussmann, 2006).

Firewood, mentioned as the second most important ES by Boran, is known to be an important providing ES of forest ecosystems (e.g. Allendorf and Yang, 2013; Schaafsma et al., 2014). A recent study in the Eastern Arc Mountains in Tanzania also highlighted the importance of firewood for the local populations, especially for the poorest (Schaafsma et al., 2014). In this study, which combined over 2000 households, it was estimated that the total benefit flow of firewood, charcoal, poles and thatch from the Eastern Arc Mountains had an estimated value of USD 42 million per year. However, this study did not assess ES other than firewood, charcoal, poles and thatch.

With regard to location, as there is better access to western medicine around Mt Marsabit, medicinal plants were not mentioned as second most important ES in any FG there (contrary to Mt Kulal and Mt Nyiro). Wildlife was only mentioned in Mt Marsabit, as large mammals are scarce in steeper Mt Kulal or Mt Nyiro. Similarly, 'shelter during conflict' was only mentioned in Mt Kulal and Mt Nyiro. These two mountains are located at the border between the Samburu and Turkana ethnic groups, and cattle rustling is a common issue there.

Therefore, ‘shelter during conflict’ becomes crucial. Apart from differences related to ethnicity (importance of fodder) and local context (access to western medicine), local taste preferences also seem to be relevant. In Mt Nyiro, Samburu highlighted the importance of the honey they obtain from the forest as food, over wild fruits, despite all edible wild fruits mentioned in Mt Kulal FG being present there.

It should be highlighted that the ES mentioned in this study included not only provisioning ES, but also regulating services (microclimate regulation) and cultural and supporting services. Rural people in south-east China and in several countries in south-east Asia also perceived many ecosystem services from nearby forests, including regulating, cultural, and supporting services (Sodhi et al., 2010; Allendorf and Yang, 2013). In Kibale National Park in Uganda most respondents also mentioned improved local rainfall and air quality as important benefits from the nearby forest (Hartter and Goldman, 2011). In Lake Naivasha in central Kenya, local residents also mentioned local climate regulation and aesthetic values (Morrison et al., 2013). A recent UNEP report on Kenyan montane forests (UNEP, 2012) highlighted the importance of regulating services such as local climate regulation, water regulation, erosion regulation, water purification and disease regulation (malaria), most of which were also mentioned by participants in this study.

We would like to emphasise how the approach used for ES assessment is likely to affect the results obtained. ‘Shelter during conflict’ is an ES not mentioned in other studies on ES (e.g. Sodhi et al., 2010 ; Hartter and Goldman, 2011; Allendorf and Yang, 2013; Morrison et al., 2013; Alassaf et al., 2014; Gould et al., 2014; Muhamad et al., 2014), and not considered in mainstream ES assessment. The identification of this ES by local communities was possible because of the methodology used (open questions). A recent study in Kakamega forest (western Kenya) using household surveys determined that the local economic benefits were considerably less than forgone returns from agricultural activities if the forest were to be converted to the best agricultural uses (Mukoto et al., 2015). However, by not including an open choice in their questionnaires, these researchers most likely missed ES, such as microclimate regulation and aesthetic values, which might be very important to local communities, as our study indicates. Also, by focusing on a small part of the Lake Victoria water catchment area, they might have underestimated the importance of water as an ES.

One interesting finding of our study is the fact that biodiversity was only mentioned in Mt Marsabit. Biodiversity is often considered one of the most important ES (e.g. in Lake Naivasha, Morrison et al., 2013). Often, high levels of particularly faunal species richness attract local holidaymakers, international tourists and researchers, which might bring an important economic return. Even in Mt Marsabit, where large mammals are present, the number of tourists visiting the National Park is relatively small, and the benefits the locals might get from that is insignificant (KWS manager comment). However, locals around Mt Marsabit still mentioned this ES most likely due to the cultural links with certain species (e.g. in the past young Samburu men used to kill a lion to become a ‘man’, participant comment).

Overall, it can be said that ethnicity affects ES valuing, but also local context (cattle rustling) and local taste preferences within one tribe (honey) affect it. However, in some cases, one ES is so vital that its value does not depend on these above-mentioned factors; this was the case for water.

4.2. Preferred plant species for providing ES

Similar to ES, ethnicity and location affect the selection of preferred species for providing ES. Boran and Samburu living around Mt Marsabit mentioned different species (low J index indicating low similarity) and their most preferred species for fodder and medicine resources also differed. Ethnicity is known to affect plant use and preferences among local communities (e.g. Assogbadjo et al., 2012). In our case it was rather surprising that Boran were not aware of the medicinal use of *Toddalia asiatica*, and that they mentioned more preferred species which could not be found inside the forest. This might be related to the relatively shorter time (compared with Rendile-Samburu) they have been residents around Mt Marsabit (Boran were re-settled there from Ethiopia during colonial times). Several studies have shown that a greater number of native species are used by long-time residents (e.g. Gould et al., 2014).

Apart from ethnicity, local context such as the abundance of the species and the availability of suitable alternatives affects plant use by local communities, as found in Jusu and Cuni-Sanchez (2014). In this study although *Rhamnus prinoides* can be found in Mt Marsabit, as it is 'difficult to find', locals use other species for the same medicinal purpose. Similarly, *Xymalos monospora* can be found in Mt Kulal (like in Mt Nyiro) but locals prefer using other plants for fodder. Local taste preferences are also relevant. For example, the Samburu of Mt Nyiro have a special preference for honey, so when we discussed species used as food, they mentioned several which do not provide wild fruits, but 'nice flowers for bees' (participant comment) such as *Dombeya torrida* or *Croton megalocarpus*.

Interestingly, our results suggest that cattle might have different taste preferences. *Olea capensis* (the preferred fodder species for Samburu in Mt Kulal and Mt Nyiro) is relatively abundant in the south-western part of Mt Marsabit, but 'the cows prefer Nteroni (*Rinorea convallarioides*) here' (Samburu participant comment). It should be noted that animals such as goats and cattle can be accustomed to eat certain plant species. *R. convallarioides* is a relatively small understory tree with a thin stem, easy to cut with a 'panga' (cutlass) while *O. capensis* is a canopy tree reaching >20m whose stem can be >40cm diameter. In Mt Kulal and Mt Nyiro herders climb *O. capensis* to cut a few branches for their cattle (Pers. Obs.). Where *R. convallarioides* is abundant, a herder prefers to cut this species and give it to his animals as it is easier than harvesting *O. capensis* (participant comment). Therefore, it is the herder (not the animals) who prefers this species and has accustomed his/her animals to it. This is an important point as it suggests that animals could be accustomed to other tree species, to reduce the pressure on *R. convallarioides*.

4.3. Implications for management

First of all, it should be highlighted that local people in northern Kenya, regardless of their ethnicity or location, place high value on their forests. There has been a growing trend towards assigning monetary value to biodiversity or ecosystem services through, for example, programs such as payments for ecosystem services, in order for people to value the benefits of forest ecosystems and protected areas in general. However, several studies have pointed out that it is not necessary to assign monetary value to biodiversity or ecosystem services for people to value these benefits (e.g. Allendorf and Yang, 2013). In fact, commodification may override existing value systems and diminish the rich set of values that that people already hold towards 'their' natural capital, e.g. protected areas (Kosoy et al., 2008). Instead, participatory approaches to protected areas' conservation, which allow communities to participate in valuation of biodiversity and ecosystem services, are important because they can recognize local context and values (Christie et al., 2012). Our study also supports this view.

We would like to stress the role local communities have already played towards the historical protection of these remnant forests in the desert. For example, when Kenya Forest Service (KFS) wanted to convert Mt Kulal forest into a Forest Reserve in the 1970s, local communities refused because they were afraid of illegal timber extraction by KFS elites, as it had happened in Mt Marsabit (FG participant comments' and KFS manager comments).

Secondly, our study demonstrates that ethnicity, location and local taste preferences, affect ES identification and valuing. Understanding cultural preferences toward ES is of key importance to decision-makers. Ethnic and site-specific preferences have been overlooked in the past, using 'one-size-fits-all' conservation solutions. Most of the scientific literature in natural resource management emphasizes that stakeholder integration and collaborative decision-making is crucial for assuring optimum ecological outcome in natural resource management (e.g. Clark, 2011). For example, one decision such as restricted access or regulated extraction might affect certain part of the population disproportionally. In the case of Mt Marsabit, restricted access to the forest is likely to affect Samburu-speaking people much more than Boran-speaking ones. For the Boran-speaking, the main ES of the forest (after water) is firewood, and several tree species found outside the forest (e.g. *Acacia* species) can be used for this purpose. However, for the Samburu-speaking, the main ES (after water) is fodder during drought events, and especially during those times, alternatives outside the forest are non-existing: thus, restricted access would imply massive cattle deaths and severe loss of livelihoods for these Samburu-speaking communities.

One issue we want to highlight, linked with ethnic and site-specific preferences, is the importance of the methodology used when identifying and ranking ES. We only identified the important ES of 'shelter during conflict' because of the open question used. Similarly, we thought food would also include mushrooms, as residents of other mountains in East Africa extensively collect mushrooms which are considered a delicacy (e.g. Newmark, 2002), but this was found not to be the case among the ethnic groups we studied (they never eat mushrooms).

Apart from ES identification and valuing, understanding cultural preferences toward preferred species for certain ES also helps decision-makers, as it allows assessing the ecological implications of the extraction. Going back to the same example in Mt Marsabit, the preferred species for firewood (also used for poles medicine resources, food and fodder) by Boran-speaking is *Olea europaea*, a canopy tree dominant in the *Croton-Olea* forest. If this tree is cut down, soil moisture is reduced not only because of greater understory exposure to sunlight, but also because its branches with numerous mosses and lichens no longer trap the mist (Muchura, 2005). Therefore, the use of this species for firewood has a considerable negative long-term effect on the forest. One the other hand, *Rinorea convallarioides*, the preferred fodder species by Samburu-speaking, is an understory tree; thus, the effects of its removal on the forest are less substantial. It should be noted that trees with greater number of uses, and used by more people (different ethnic groups) are generally considered to be at higher risk overexploitation (e.g. Jusu and Cuni-Sanchez, 2014).

Two more benefits of understanding cultural perceptions and preferences toward ES and species are (i) that it helps determine which species could be used in reforestation programs, and (ii) assess which alternative livelihoods could be promoted in an area. Given the number of uses and importance for the canopy, *Olea europaea* should be the targeted species in any reforestation program. At the same time, as the preferred species for food were not found inside the forest, indigenous fruit trees or bushes are not a good choice for reforestation programs in our study area. With regard to alternative livelihoods, for example, honey production could be promoted around Mt Nyiro, where communities have great knowledge on which tree species bees prefer and they place high value on honey.

We previously mentioned the isolated nature of our study area. However, it should be noted that this area is undergoing rapid transformation that is likely to increase over the coming years, with (i) the tarmacking of the major Nairobi-Ethiopian border road (passing Mt Marsabit), (ii) the construction of the largest wind power plant in Africa (located between Mt Kulal and Mt Nyiro), (iii) the development of a new deep-water port at Lamu and associated infrastructure (railway and pipeline) between South Sudan and the Kenyan coast and (iv) the plans for a large resort city in northern Kenya (GoK, 2011; Nyanjom, 2014). These large-scale infrastructural developments are likely to increase and diversify the population in these areas, with increased pressure on these already fragile ecosystems and the associated ES flows. This situation, one with strong parallels across East Africa, demand urgent development of appropriate management strategies that are based on the understanding of cultural preferences towards the ES provided by remnant forests.

5. Conclusions

Studies on ecosystem services should consider social evaluation criteria that reflect the place and space of the ecosystem services. This research details how the rural populations of northern Kenya appreciate and use their remnant forest islands and how ethnicity and location affects not only ES identification and valuing but also the choice of plant species for providing ES. Understanding cultural perceptions and preferences toward ES is vital for both conservation purposes and for local development planning. Understanding how people already value their forests, and then using this understanding as a starting point for collaborative dialogs about win–win scenarios and ways to maximize benefits for people and biodiversity, is vital to provide a solid foundation for conservation and development projects to maximise their potential of success.

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References

Alassaf, A., Alhunaiti D. Dick, J., Al-Adwan, T., 2014. Differences in perceptions, attitudes, and use of ecosystem services among diverse communities in an arid region: a case study from the south of Jordan. J. Hum. Ecol. 45, 157-165.

Allendorf, T.D., Yang J., 2013. The role of ecosystem services in park–people relationships: the case of Gaoligongshan Nature Reserve in southwest China. Biol. Conserv. 167, 187–193.

Assogbadjo, A.E., Glèlè Kakaï, R., Vodouhê, F.G., Djagoun, C.A.M.S., Codjia, J.T.C., Sinsin, B., 2012. Biodiversity and socioeconomic factors supporting farmers' choice of wild edible trees in the agroforestry systems of Benin (West Africa). Forest. Pol. Econ. 14, 41–49.

Beentje, H.J., 1995. Kenya Trees, Shrubs and Lianas. National Museums of Kenya, Nairobi.

Bruijnzeel, L.A., Mulligan, M., Scatena, F.N., 2011. Hydrometeorology of tropical montane cloud forests: emerging patterns. Hydrol. Process. 25, 465–498.

Burkhard, B., Petrosillo, I., Costanza, R., 2010. Ecosystem services – bridging ecology, economy and social sciences. Ecol. Complex. 7 (3), 257–259.

Bussmann, R.W., 2002. Islands in the desert-a synopsis of the forest vegetation of Kenya's northern, central and southern mountains and highlands. Journal of East African Natural History 91(1), 27-79.

Bussmann, R.W., 2006. Ethnobotany of the Samburu of Mt. Nyiru, South Turkana, Kenya. Journal of Ethnobiology and Ethnomedicine 2:35.

Christie, M., Fazey, I., Cooper, R., Hyde, T., Kenter, J.O., 2012. An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. Ecol. Econ. 83, 67–78.

Clark, S.G., 2011. The Policy Process: A Practical Guide for Natural Resource Professionals, New Haven. Yale University, USA.

Costanza, R., Kubiszewski, I., 2012. The authorship structure of ecosystem services as a transdisciplinary field of scholarship. Ecosyst. Serv. 1, 16–25.

Costanza, R., de Groot R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K, 2014. Changes in the global value of ecosystem services. Global Environ. Chag. 26, 152-158.

Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs, H.K., Helkowski, J.H., Holloway, T., Howard, E.A., Kucharik, C.J., Monfreda, C., Patz, J.A., Prentice, I.C., Ramankutty, N., Snyder, P.K., 2005. Global consequences of land use. Science 309, 570-574.

Githae, E.W., 2007. Assessment of plant diversity, community structure and impacts of human activities in Mt. Marsabit forest, Kenya. Master Thesis, University of Nairobi, Nairobi, Kenya.

Githae, E.W., Chuah-Petiot, M., Mworia, J.K., Odee, D.W., 2008. A botanical inventory and diversity assessment of Mt. Marsabit forest, a sub-humid montane forest in the arid lands of northern Kenya. Afr. J. Ecol. 46, 39–45.

Gould, R.K., Ardoin, N.M., Woodside, Y., Satterfield, T., Hannahs, N., Daily, C.G., 2014. The forest has a story: cultural ecosystem services in Kona, Hawai‘i. Ecol. Soc. 19(3), 55.

Government of Kenya, 2011. Vision 2030 Development Strategy for Northern Kenya and other Arid Lands, final report. See www.vision2030.go.ke

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O., Townshend. J.R.G., 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342, 850–53.

Hartter, J., Goldman, A., 2011. Local responses to a forest park in western Uganda: alternate narratives on fortress conservation. Oryx 45, 60–68.

Hartter, J., Stampone, M.D., Ryan, S.J., Kirner, K., Chapman, C.A., Goldman, A., 2012. Patterns and perceptions of climate change in a biodiversity conservation hotspot. PLoS One 7, e32408.

IUCN/UNEP, 1987. International Union of Conservation of Nature and Natural Resources/UNEP. Ecologically Sensitive Site in Africa. Washington, DC: World Bank.

Jusu A., Cuni Sanchez A., 2014. Medicinal Plant Trade in Sierra Leone: Threats and Opportunities for Conservation. Econ. Bot. 68, 16-29.

Kenya National Assembly, 1961. Legislative Council debates (12th Council), Kenya National Assembly Official Record (Hansard), 11th May 1961. Nairobi, Kenya.

Kosoy, N., Corbera, E., Brown, K., 2008. Participation in payments for ecosystem services: case studies from the Lacandon rainforest, Mexico. Geoforum 39, 2073–2083.

Mittermeier, R. A., Robles G.P., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J., da Fonseca G.A.B., 2004. Hotspots Revisited. Garza Garcia N.L. Mexico: CEMEX

Mnzava, N.M., Dearing, J.A., Guarino, L., Chweya, J.A., Koeijer, H., 1999. Bibliography of the genetic resources of traditional Afrcian vegetables. Neglected leafy green vegetable crops in Africa, vol. 2. International Plant Genetic Resources Institute, Rome, Italy.

Morrison, E.H.J., Upton, C., Pacini, N., Odhiambo-K’oyooh, K., Harper, D.M., 2013. Public perceptions of papyrus: community appraisal of wetland ecosystem services at Lake Naivasha, Kenya. Ecohydrology and Hydrobiology 13, 135–147.

Muchura, H.M., 2005. Bryodiversity of Mount Marsabit forest and Bryophytes mist trapping ability assessment. Master Thesis, University of Nairobi, Nairobi, Kenya.

Muhamad, D., Okubo, S., Harashina, K., Parikesit Gunawan, B., Takeuchi, K., 2014. Living close to forests enhances people's perception of ecosystem services in a forest–agricultural landscape of West Java, Indonesia. Ecosyst. Serv. 8, 197–206.

Mutoko, M., Hrin, L., Shisanya, C.A., 2015. Tropical forest conservation versus conversion trade-offs: Insights from analysis of ecosystem services provided by Kakamega rainforest in Kenya. Ecosyst. Serv. 14, 1–11.

Newmark, W.D., 2002, Conserving Biodiversity in East African Forests, Springer-Verlag Berlin Heidelberg, Germany.

Ngene, S.M., Van Gils, H., Van Wieren, S.E., Rasmussen, H., Skidmore, A.K., Prins, H.H.T., Toxopeus, A.G., Omondi, P., Douglas-Hamilton, I., 2009. The ranging patterns of elephants in Marsabit protected area, Kenya: the use of satellite-linked GPS collars. Afr. J. Ecol. 48, 386–400.

Nyanjom, O., 2014. Remarginalising Kenyan pastoralists: the hidden curse of national growth and development. African Study Monographs 50, 43-72.

Orenstein, D.E., Groner, E., 2014. In the eye of the stakeholder: Changes in perceptions of ecosystem services across an international border. Ecosyst. Serv. 8, 185–196.

Raymond, C.M., Singh, G.G., Benessaiah, K., Bernhardt, J.R., Levine, J., Nelson, H., Turner, N.J., Norton, B., Tam, J., Chan, K.M.A., 2013. Ecosystem Services and beyond: using multiple metaphors to understand human–environment relationships. BioScience 63 (7), 536–546

Schaafsma, M., Morse-Jones, S., Posen, P., R.D. Swetnam, R.D., Balmford, A., Bateman, I.J., Burgess, N.D., Chamshama, S.A.O., Fisher, B., Freeman, T., Geofrey, V., Green, R.E., Hepelwa, A.S., Hernandez-Sirventm,, A., Hess, S., Kajembe, G.C., Kayharara, G., Kilonzo, M., Kulindwa, K., Lund, J.F., Madoffe, S.S., Mbwambo, L., Meilby, H., Ngaga Y.M., Theilade, I., T. Treue, T., van Beukering, P., Vyamana, V.G., Turner, R.K., 2014. The importance of local forest benefits: economic valuation of Non-Timber Forest Products in the Eastern Arc Mountains in Tanzania. Global Environ. Chang. 24, 295–305.

Shibia, M.G., 2010. Determinants of attitudes and perceptions on resource use and management of Marsabit National Reserve, Kenya. J. Hum. Ecol. 30(1), 55-62.

Schultka, W., Hilger, H.H., 1983. Epizoochore Verbreitung in der Krautschicht beweideter BergwaIder des Mt. Kulal (Nordkenia). Beitraege zur Biologie der Pflanzen 58, 333-356.

Sodhi, N.S., Lee, T.M., Sekercioglu, C.H., Webb, E.L., Prawiradilaga, D.M., Lohman, D.J., Pierce, N.E., Diesmos, A.C., Rao, M., Ehrlich, P.R., 2010. Local people value environmental services provided by forested parks. Biodivers. Conserv. 19, 1175–1188.

Sop, T.K., Oldeland, J., Bognounou, F., Schmiedel, U., Thiombiano, A., 2012. Ethnobotanical knowledge and valuation of woody plants species: a comparative analysis of three ethnic groups from the sub-Sahel of Burkina Faso. Environ. Dev. Sustain. 14, 627–649.

Sombroek, W.G., Braun, H.M.H., van der Pouw, B.J.A., 1982.Exploratory Soil Map and AgroClimatic Zone Map of Kenya, 1980. Scale: 1:1'000'000. Exploratory Soil Survey Report No. E1. Kenya Soil Survey Ministry of Agriculture - National Agricultural Laboratories, Nairobi, Kenya.

United Nations Environment Programme (UNEP), 2012. The role and contribution of montane forests and related ecosystem services to the Kenyan economy. UNON/Publishing Services Section/Nairobi, Kenya.

Wickens, G.E., Lowe, P., 2008. The Baobabs, Pachycauls of Africa, Madagascar and Australia. Dordrecht, The Netherlands: Kluwer Academic Publishers Group.

Tables and figures

Fig. 1. Selected mountains in northern Kenya and villages where focus-group discussions were organised with regard to main ethnic groups in the area. Black lines refer to major roads, dark grey areas to forests and red dots to villages studied.

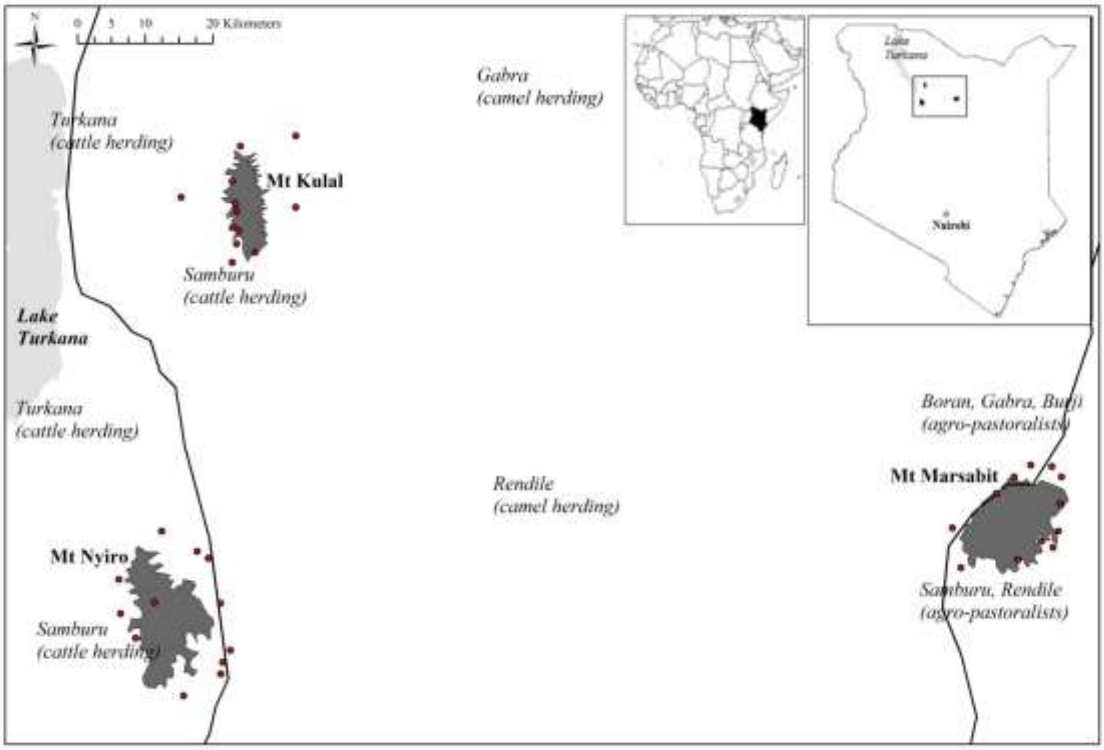

Table 1 General information about the three mountains studied with regard to existing ethnic groups, languages, main livelihood strategy and general development of the area.

Location	**Ethnic group**	**Main language**	**Main livelihood**	**Observations**
Mt Marsabit northern part	Boran, Gabra, and few Burgi	Boran	agro-pastoralism	better access to healthcare, education, and markets
Mt Marsabit southern part	Samburu, Rendile	Samburu	agro-pastoralism	better access to healthcare, education, and markets
Mt Nyiro	Samburu	Samburu	pastoralists with cattle, some still nomadic	little access to healthcare, education, and markets
Mt Kulal	Samburu	Samburu	pastoralists with cattle, some still nomadic	little access to healthcare, education, and markets

Table 2
The two most important ecosystem services (ES) and all the other ES mentioned in the focus-group discussions in Mt Marsabit Boran-speaking (MarB), Marsabit Samburu-speaking (MarS), Mt Kulal (Samburu) and Mt Nyiro (Samburu). Values for first, second and other ES refer to percentage of FG reporting a given ES (n=12 in Mt Kulal and Mt Nyiro but n=6 for MarB and MarS), but values for number ES mentioned in each location are absolute values.

		Mar-B	**Mar-S**	**Mt Kulal**	**Mt Nyiro**
First ES	water	100	100	83	83
	micro-climate regulation			17	8
	food				8
Second ES	firewood	83			
	micro-climate regulation	17	33	17	
	fodder during droughts		50		33
	wildlife		17		
	medicine resources			58	33
	air purification			17	
	water			8	8
	food				8
	shelter during conflict				25
Other ES	food	100	100	100	50
	medicine resources	100	100	42	67
	poles	100	100	100	100
	wildlife	100	30		
	micro-climate regulation	67	30	58	42
	shade	67	33		67
	fodder during droughts	50	50	92	58
	soil formation	33		17	
	tools (plough)	33			
	firewood		100	100	100
	air purification		33	58	17
	aesthetic values		16	25	8
	cultural value		16		
	shelter during conflict			42	58
	water			8	8
Number ES mentioned		*11*	*12*	*11*	*11*

Table 3 The Jaccard index of similarity between preffered plant species for provisioning ecosystem services mentioned at different study sites. Marsabit Boran-speaking (MarB), Marsabit Samburu-speaking (MarS). Note that Mt Kulal and Mt Nyiro are Samburu-speaking.

	All species	**Fodder**	**Medicine resources**	**Food**	**Poles**	**Firewood**
MarB-MarS	0.29	0.27	0.19	0.33	0.21	0.33
MarB- Kulal or Nyiro	0.18	0.12	0.18	0.14	0.05	0.20
MarS- Kulal or Nyiro	0.20	0.08	0.18	0.14	0.10	0.20
Kulal -Nyiro	0.29	0.18	0.30	0.20	0.14	0.31

Table 4 The most preferred species and the total number of species (spp.) reported for different provisioning ecosystem services, and the most important species overall and its number of uses, with regard to ethnicity and location. Marsabit Boran-speaking (MarB), Marsabit Samburu-speaking (MarS). Note that Mt Kulal and Mt Nyiro are Samburu-speaking.

	MarB	**MarS**	**Mt Kulal**	**Mt Nyiro**
Fodder	*Olea europaea*	*Rinorea convallarioides*	*Olea capensis*	*Olea capensis*
	10 spp.	*5 spp.*	*11 spp.*	*7 spp.*
Medicine resources	*Euphorbia tirucalli*	*Toddalia asiatica*	*Rhamnus prinoides*	*Myrsine africana*
	8 spp.	*8 spp.*	*9 spp.*	*11 spp.*
Food	*Dovyalis abyssinica*	*Dovyalis abyssinica*	*Dovyalis abyssinica*	*Faurea saligna*
	7 spp.	*6 spp.*	*8 spp.*	*7 spp.*
Poles	*Olea europaea*	*Olea europaea*	*Juniperus procera*	*Juniperus procera*
	6 spp.	*7 spp.*	*15 spp.*	*7 spp.*
Firewood	*Olea europaea*	*Olea europaea*	*Olea capensis*	*Olea europaea*
	7 spp.	*8 spp.*	*7 spp.*	*6 spp.*
Overall	*Olea europaea*	*Olea europaea*	*Olea capensis*	*Olea capensis*
	5 uses	4 uses	3 uses	2 uses

Appendix A

Table 1A Vegetation types in Mt Marsabit, Mt Kulal and Mt Nyiro following an altitude gradient. Note that vegetation types and altitude at which plant associations change differ between sites. a: following Githae (2007), b: following Schultka and Hilger (1983); c: following Bussmann (2002).

	Mt Marsabit (1707m) a	**Mt Kulal (2285m) b**	**Mt Nyiro (2752m) c**
lower altitudes	dense thorny bushland (*Commiphora, Grewia* and partly *Acacia)*	dense thorny bushland (*Commiphora, Grewia* and partly *Acacia)*	dense thorny bushland (*Commiphora, Grewia* and partly *Acacia)*
	Croton megalocarpus-Olea europaea subsp. *africana* forest association	*O. europaea-Juniperus procera* forest association	*O. europaea-Juniperus procera* forest association
	evergreen-broadleafed *Cassipourea malosana* forest association		
	mixed species forest with *Ficus* and *Cordia africana* emergents	*Olea capensis-C. malosana* forest association	*Olea capensis-C. malosana* forest association
			evergreen bamboo forests (*Sinarundinarietea alpinae*)
			elfin-like type of Kosso-forests (*Gnidietum glaucae*)
higher altitudes		large grassy clearings	large grassy clearings

Table 2A
Preferred plant species for different provisioning ecosystem services with regard to ethnicity and location. Marsabit Boran-speaking (MarB), Marsabit Samburu-speaking (MarS). Note that Mt Kulal (K) and Mt Nyiro (N) are Samburu-speaking. The last ten plant names which could not be identified are reported in local language Samburu ([s]) or Boran ([b])

Scientific name	Firewood	Poles	Food	Medicine resources	Fodder
Albizia grandibracteata					N
Apodytes dimidiata	K	K			
Bauhinia tomentosa	Mar-B				
Brucea antidysenterica		K	K		K
Cadia purpurea		K			
Carissa spinarum			Mar-B, Mar-S, K, N	Mar-B, Mar-S, K, N	
Cassipourea malosana				K	
Chrysophyllum viridifolium				Mar-B	
Coptosperma graveolens	Mar-B, Mar-S, K	Mar-B, Mar-S			Mar-B
Croton megalocarpus	Mar-B, Mar-S		N	Mar-B, Mar-S, N	
Diospyros abyssinica	Mar-S	Mar-B			
Dombeya torrida	K	K, N	N		N
Dovyalis abyssinica	Mar-S	Mar-S	Mar-B, Mar-S, K, N		
Drypetes gerrardii	Mar-B	Mar-B			Mar-B, Mar-S
Ehretia cymosa		K			
Euclea racemosa		Mar-B		Mar-S, K, N	
Euphorbia tirucalli				Mar-B	
Faurea saligna	N	N	N		
Ficus sp.			K		
Flueggea virosa			Mar-S		
Grewia arborea			Mar-B		
Grewia damine		K, N			
Grewia similis			K		
Grewia trichocarpa					Mar-B
Grewia villosa			Mar-B		
Gymnosporia heterophylla					K
Harrisonia abyssinica				Mar-S	
Heinsenia diervilleoides					K
Juniperus procera	K, N	K, N			
Margaritaria discoidea		K			K
Myrsine africana				K, N	
Olea capensis	K, N	K			Mar-B, Mar-S, K, N
Olea europaea	Mar-B, Mar-S, K, N	Mar-B, Mar-S, K	Mar-B, Mar-S, K	Mar-B, Mar-S	Mar-B, K, N
Pavetta gardeniifolia					K, N
Pavonia urens					Mar-B
Peponium vogelii			K		
Podocarpus latifolius		N			

Prunus africana	N				N
Rapanea melanophloeos				K, N	
Rhamnus prinoides		N		Mar-B, K, N	Mar-B
Rhamnus staddo				Mar-S, K, N	
Rinorea convallarioides					Mar-S
Rotheca myricoides			Mar-S	Mar-B, K, N	
Rubus apetalus			K, N		
Rytigynia neglecta		K			
Schrebera alata					K
Searsia natalensis			K		
Shirakiopsis elliptica				N	
Strychnos henningsii	Mar-B, Mar-S	Mar-B, Mar-S			Mar-B, Mar-S
Strychnos usambarensis		K			K
Toddalia asiatica				Mar-S	
Trema orientalis					Mar-B
Trichilia dregeana	Mar-S				
Vangueria madagascariensis			Mar-B, Mar-S	N	
Vepris nobilis	Mar-B, Mar-S, K, N	Mar-S, K			Mar-B, Mar-S
Xymalos monospora		N			N
Zanthoxylum chalybeum				N	
Ereteti [s]			N		
Gambariti [s]		Mar-S			
Gerenuk [s]		K			
Genikeri [s]		Mar-S			
Gerianthus [s]				Mar-S	
Gitalasua [s]				N	
Lasan [s]				K	
Lgagunik [s]					K
Lkaulei [s]		K			
Mululash [b]			Mar-B	Mar-B	

Appendix B. Focus-group discussions guiding questionnaire:

Part 1. The forest

1. Is the forest important for your community?
2. Why is it important? (List the benefits)
3. What other benefits does the forest provide to you?
4. Which of all these benefits that have been mentioned is the most important for your community and why?
5. Which of all these benefits that have been mentioned is the second most important for your community and why?

Part 2. Preferred plant species

6. Which three plant species from the forest are the most important for your community for firewood?
7. Which three plant species from the forest are the most important for your community for poles?
8. Which three plant species from the forest are the most important for your community for food? (mention that mushrooms can also be included)
9. Which three plant species from the forest are the most important for your community for medicine?
10. Which three plant species from the forest are the most important for your community for fodder?
11. Are some plant species outside the forest more important for firewood, poles, food, medicine or fodder than the ones you mentioned?
12. Is there anything else you would like to add with regard to the importance of your forest and the plant species found inside?