


Disaggregating ecosystem services and disservices in the cultural landscapes of southwestern Ethiopia: a study of rural perceptions

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Abstract

Context Cultural landscapes provide essential ecosystem services to local communities, especially in poor rural settings. However, potentially negative impacts of ecosystems—or disservices—remain inadequately understood. Similarly, how benefit–cost outcomes differ within communities is unclear, but potentially important for cultural landscape management.

Objectives Here we investigated whether distinct forest ecosystem service–disservice outcomes emerge within local communities. We aimed to characterize groups of community members according to service–disservice outcomes, and assessed their attitudes towards the forest.

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Methods We interviewed 150 rural households in southwestern Ethiopia about locally relevant ecosystem services (provisioning services) and disservices (wildlife impacts). Households were grouped based on their ecosystem service–disservice profiles through hierarchical clustering. We used linear models to assess differences between groups in geographic and socioeconomic characteristics, as well as attitudes toward the forest.

Results We identified three groups with distinct ecosystem service–disservice profiles. Half of the households fell into a “lose–lose” profile (low benefits, high costs), while fewer had “lose–escape” (low benefits, low costs) and “win–lose” (high benefits, high costs) profiles. Location relative to forest and altitude explained differences between the “lose–escape” profile and other households. Socioeconomic factors were also important. “Win–lose” households appeared to be wealthier and had better forest use rights compared to “lose–lose” households. Attitudes towards the forest did not differ between profiles.

Conclusions Our study demonstrates the importance of disaggregating both ecosystem services and disservices, instead of assuming that communities receive benefits and costs homogenously. To manage cultural landscapes sustainably, such heterogeneity must be acknowledged and better understood.

Keywords Agriculture–forest mosaic · Benefit distribution · Ecosystem service–disservice framework · Human–wildlife conflict · Poverty

Introduction

Cultural landscapes are increasingly valued for their natural and cultural heritage (Altieri 2004). While many cultural landscapes (especially in Western Europe) are characterized by commercial, high-intensity agriculture, others (especially in poorer countries) are characterized by low-intensity semi-subsistence agriculture that is embedded within a mosaic of different land-uses (Plieninger et al. 2006). Cultural landscapes are gradually evolving, tightly linked social-ecological systems in which rural populations shape the natural environment according to their needs and adapt to the challenges posed by the environment (Bignal and McCracken 2000; Folke 2006). Such co-evolution creates dynamic landscapes with high levels of human-nature interaction (Plieninger et al. 2013; Horcea-Milcu et al. 2017). Although the intention of human interactions with nature is often to maximize human benefits, human-nature interactions can also result in non-beneficial outcomes. Both benefits and disadvantages of human-nature interactions thus need to be understood to appropriately manage cultural landscapes.

Human-nature interactions are often conceptualized via the concept of ecosystem services. Ecosystem services are the benefits people obtain from nature (Millennium Ecosystem Assessment 2005), and are increasingly linked to human well-being or poverty alleviation (Carpenter et al. 2009; Suich et al. 2015). Ecosystem service research has increased rapidly over the last decade (Abson et al. 2014), but at the same time has been criticized for being overly simplistic (Norgaard 2010; Schröter et al. 2014). One point of criticism has been that an aggregate understanding of how people benefit from ecosystem services is of limited value where community groups benefit differently from ecosystem services (e.g. Daw et al. 2011). Another criticism has been that ecosystems not only provide benefits to humans, but may also undermine or harm human well-being (Dunn 2010; Lele et al. 2013; Lyytimäki 2015; Saunders and Luck 2016). “Ecosystem disservices” stem from ecosystem-generated functions, processes and attributes that result in perceived or actual negative impacts on human well-being (Shackleton et al. 2016). Ecosystem disservices include diseases, crop pests, and crop-raiding or livestock-predating mammals, which can have far-reaching direct and indirect impacts on human well-

being (e.g. Mackenzie and Ahabyona 2012; Barua et al. 2013; Ango et al. 2016). However, ecosystem disservices are rarely analyzed in relation to ecosystem services explicitly (but see e.g. Ango et al. 2014; Rasmussen et al. 2016). Notwithstanding the limitations of the simple dichotomy of services versus disservices (Saunders and Luck 2016), thinking about the costs and benefits respects the everyday realities of local communities, and hence can be a useful framework to understand human-nature interactions (Ango et al. 2014).

Especially in cultural landscapes of the Global South, livelihoods of rural communities often directly depend on provisioning ecosystem services (Millennium Ecosystem Assessment 2005; Tallis et al. 2008; Egoh et al. 2012). On the other hand, these communities may also be more exposed to disservices that could seriously impact on their livelihoods. Perhaps more importantly, within a given cultural landscape, it should be expected that the positive and negative effects of ecosystem services and disservices may not be equally distributed among different households, social groups, or across landscapes (Daw et al. 2011; Mackenzie 2012; Shackleton et al. 2016).

In this study, we focused on cultural landscapes in southwestern Ethiopia, which has a long history of gradually changing human-nature interactions (Ehret 1979, McCann 1995). We sought to disaggregate and quantify the positive effects of ecosystem services versus the negative effects of ecosystem disservices, as experienced by households in different landscape contexts and characterized by different social attributes. The study area is characterized by a mosaic of agricultural land, semi-managed coffee forest, and natural forest (Aerts et al. 2011; Hundera et al. 2013). The rural population depends heavily on provisioning forest ecosystem services for subsistence (e.g. fuelwood and construction material) as well as cash income (e.g. coffee and honey production) (Ango et al. 2014). Yet, the forest also harbors many wild mammals which generate major disservices to local people through crop-raiding and livestock predation (Lemessa et al. 2013; Ango et al. 2016). The resulting impacts can be both direct, such as crop and livestock loss, and indirect, such as undermining children’s school performance due to field guarding duties (Ango et al. 2016).

For ecosystem services, based on a pilot study, we focused on provisioning services. Provisioning

services—unlike others, such as cultural services—clearly emerged as being highly valued by locals during a pilot study. This could be because other services were actually valued less highly than provisioning services, for example because basic material needs may take precedence in relatively poor settings (Maslow 1954 and Koltko-Rivera 2006 in Wu 2013). Alternatively, more sophisticated, qualitative approaches may be required to elicit more indirect services, such as regulating or cultural services, and our pilot questions may have been unsuitable to elicit such indirect benefits. Either way, based on the pilot study, we decided to focus on provisioning services, which we could be certain were important to local people.

For disservices, again, pilot study results guided our design. Here we focused on the multiple dimensions of impacts from wild animals. Wild animals account for the most pertinent disservices in these landscapes according to local perceptions. We therefore decided to explore the multidimensional nature of disservices provided by wild animals rather than locally less important disservices identified elsewhere (e.g. Foli et al. 2014). Specifically, we aimed to: (i) generate disaggregated profiles of households with respect to the ecosystem services and disservices they experience; (ii) explain the resulting profiles via biophysical and socioeconomic characteristics of the households; and (iii) assess how the profiles relate to people's access to forest services, and their overall perception of whether the benefits generated by the forest outweigh the disadvantages.

Methods

Study area

We conducted our study in six *kebeles* spread across Gera, Setema, and Gumay districts (*woreda*) in Jimma zone in southwest Ethiopia (Fig. 1a, b). Kebeles represent the smallest administrative unit in Ethiopia and contain several villages. The kebeles were selected to cover gradients in altitude and forest cover. Altitudes ranged from approximately 1500 m to 2900 m above sea level, and forest cover ranged from approximately 10–80% within a kebele (Fig. 1c, d). The number of households ranged from 322 to 822 per kebele (for specific kebele characteristics see online

Appendix S1). The main ethnic group was Oromo, the largest minorities were Tigray, Amhara and Kaffa people. The dominant land cover types were semi-managed coffee forest, natural forest, and smallholder agricultural land comprised of mostly arable lands and pastures. The landscape has been shaped by human activities over many centuries (McCann 1995) and provides diverse ecosystem services to the rural communities (Ango et al. 2014; Moges et al. 2016). Coffee grows naturally in the region at altitudes between 1500 and 2100 m (Senbeta et al. 2007; Labouisse et al. 2008).

All land, including the forest, is officially owned by the government. However, relatively stable agreements (land certificates) exist that grant farmers access to specific plots of farmland and certain forest plots, although these are rare in the study area. Besides those, local people have traditional and customary rights across most forest land to manage certain plots for coffee or extract other non-timber forest products ('non-exclusive use rights'), and in some instances are also entitled to exclude other people from using particular plots places (here referred to as 'exclusive use rights', Stellmacher 2013). Presently, the government is trying to expand collaborative forest management schemes that divide forest management and responsibilities between the government and communities (Tadesse et al. 2016). Although cutting of natural trees is illegal, forest cover has decreased over the last 40 years from 54 to 40%, in an area covering most of our study kebeles, with higher rates at elevations above which coffee grows (Hylander et al. 2013). The forests are classified as moist evergreen Afromontane forest (Friis et al. 2010). Both forests and agricultural landscapes harbor a rich flora (Hylander and Nemomissa 2009) and fauna (Lemessa et al. 2015; Samnegård et al. 2015; Engelen et al. 2016), including a wide variety of forest mammals, which are officially protected by the government (Woldegeorgis and Wube 2012).

Study design

We first conducted an exploratory pilot study in July–September 2015 with the help of two translators. Using a structured questionnaire with open-ended questions, we asked 68 households (10–12 households per kebele) to name benefits and costs associated with the forest and wild mammals (specific questions asked

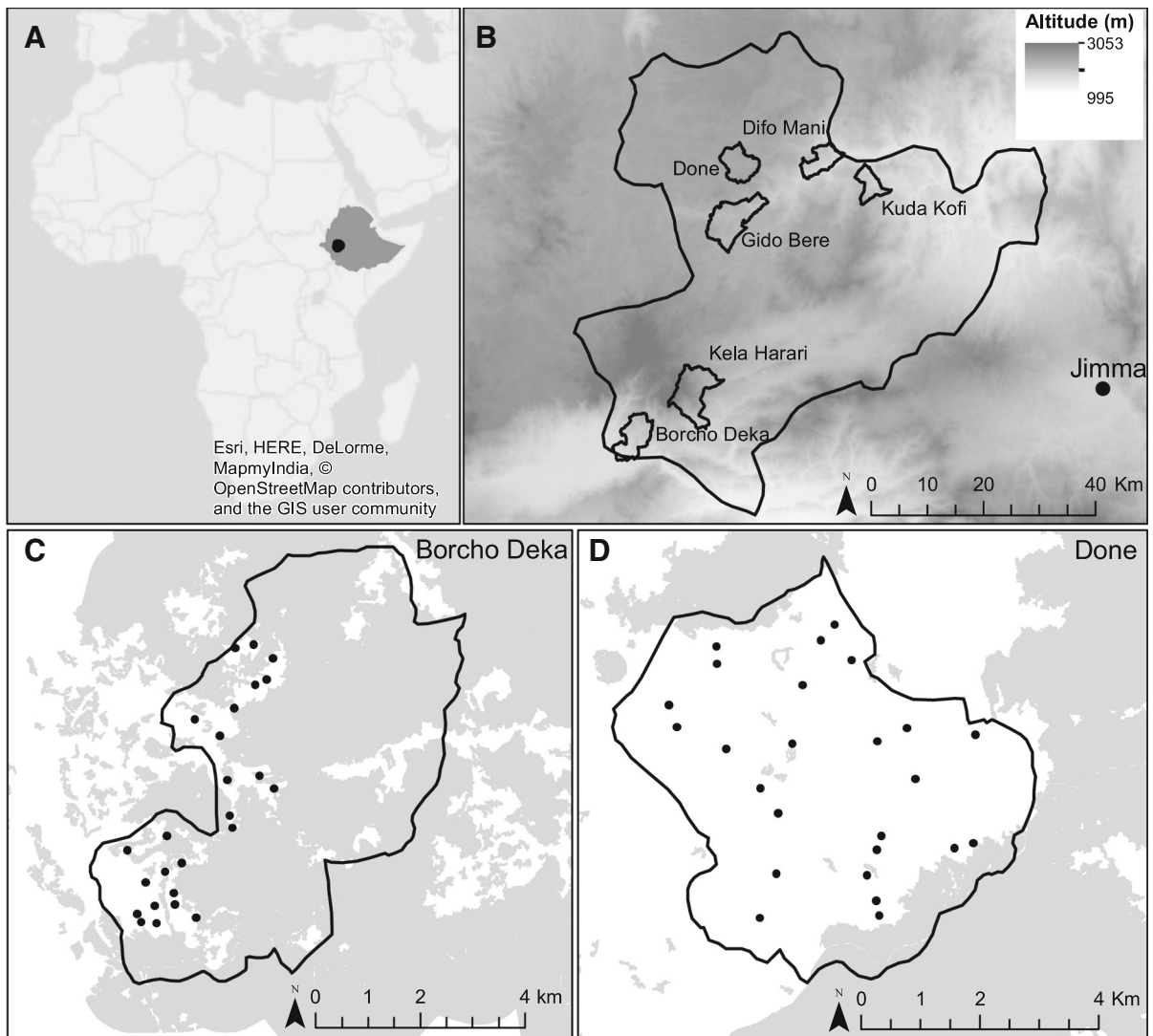


Fig. 1 Maps of the study location in Ethiopia, highlighted with a circle (a), the six study kebeles of Borcho Deka, Kela Harari, Gido Bere, Done, Difo Mani and Kuda Kofi (from west to east) within the outer boundary of the three study districts, against

altitude (b), and examples of a kebele with high forest cover (light grey) and randomly selected households shown as circles (c), and a kebele with low forest cover (light grey) and households shown as circles (d)

are shown in Appendix S2). Costs were specified as events that damaged field crops, because crop yields are of central importance for local semi-subsistent livelihoods. In theory, causes of damage could include diverse factors including weather impacts or crop diseases, but in practice, respondents mentioned almost exclusively wild animals. All later questions therefore specified wild animals as the mediators of disservices. The questions in the pilot study were guided by existing literature on ecosystem benefits and costs in the study area (Ango et al. 2016) but also

included additional open-ended questions to ensure that we did not miss important services and disservices. We assessed ecosystem (dis)services on the basis of local people's perceptions. However, because the themes elicited are well understood by local people and quantitative in nature, we consider this approach to yield useful information.

Based on the pilot study, we devised a new questionnaire consisting primarily of closed questions to quantify households' ecosystem service–disservice profiles. The questionnaire was structured into four

main sections. The first two sections covered the forest provisioning ecosystem services and the impacts of ecosystem disservices specifically related to wild mammals. The third section included open questions regarding attitudes on access to forest ecosystem services and the perceived balance between costs and benefits. Here, people had the opportunity to explain their answers and highlight additional issues regarding forest services and disservices. The last section included general information about the interviewee and his/her household (for details, see Appendix S3).

We randomly selected 150 households—25 per kebele—for administering the questionnaire based on a grid design to ensure diversity in household location relative to forest proximity. First, we divided the area of each kebele into grid cells of 25 m × 25 m. Second, we randomly selected 25 grid cells and used the middle of each selected grid cell to locate the household used for the questionnaire. We only included households that obtained food from at least one type of field crop, either their own or sharecropped with another farmer. Respondents included household heads and/or other adult family members such as spouses. Before each interview, both in the pilot and the main study, we introduced the purpose and content of our study, informed respondents about procedural aspects such as privacy and confidentiality, and about the voluntary nature of their participation. We interviewed the households using these questionnaires with the help of a translator during September–December 2015.

Data

The dataset consisted of what we classify as provisioning ecosystem services and the negative impacts—i.e. the “disservices” delivered by wild mammals—that households receive from the forest landscapes. Provisioning services included fuel wood, trees for construction, ploughs used for farming, utensils for household living comforts (e.g. chairs or tables), lianas, medicinal plants, spices, coffee, and beehives. Disservices included livestock losses to predators and crop losses to crop-raiding mammals, and factors that were indirectly impacted by wild mammals: food security, cash income opportunities, farming opportunities, education, health, and social interactions (Table 1). For example, the impacts of wild animals on cash income opportunities, as a consequence of crop or livestock guarding, were

quantified via three separate questions: firstly, the number of days per month households missed out on cash crop activities (picking coffee and maintaining beehives); secondly, the number of days per month households missed out earning income through labor work; thirdly, the fraction of market days households missed for selling their own produce. All data on services and disservices were centered and scaled before analysis. Ethnicity was not included as a factor because too few respondents represented minorities. All analyses were conducted using the R computing environment (R Core Team 2016).

Clustering households by services and disservices

To generate clusters of households with respect to ecosystem services versus disservices, we considered each household’s individual ecosystem service/disservice profile. For this, we first calculated a Euclidean-based distance matrix from the centered and scaled data. We then performed hierarchical clustering of the distance matrix using Ward’s method. The resulting dendrogram, formatted and plotted using the ‘dendextend’ package in R (Galili 2015), was then classified into groups based on visual inspection. We used the dendrogram cluster group classifications to summarize the ecosystem services and disservices for each cluster type by plotting their means and 95% confidence intervals.

Characterizing clusters

We first obtained general information on the cluster groups (gender and age) and the type of household (male or female headed, average age, average education level, household size), and compared this across the different kebeles. Second, we used one-way ANOVAs and generalized linear models (GLM) with a binomial error distribution to characterize the cluster groups by certain geographic, biophysical and socioeconomic variables. These included the households’ specific locations (forest cover in a 500 m radius and altitude), and the size of land and the number of livestock they owned. Forest cover was calculated as the proportion of woody vegetation cover in patches larger than one hectare, based on supervised classifications of RapidEye satellite data from 2014. Further, we used the household’s roof material as an indicator of their economic status, because corrugated metal roofs are usually preferred to grass roofs but need economic investment. We also

Table 1 Overview of the studied services and disservices, their importance from a human perspective, and their calculation in this study

Variable	Type	Importance	Description/calculation
Services	Fuelwood	Satisfies basic human need, is used for heating and cooking	Number of fuelwood bundles a household collected from the forest per week
	Trees for construction	Satisfies basic human need, is used to build shelter and fences	Number of trees cut from the forest for building construction in the past
	Ploughs	Satisfies basic human need, is used for preparation of cropping field	Number of ploughs constructed from forest trees per household during the past year
	Household utensils	Improves living comfort in form of furniture and storage space	Number of larger utensils constructed from wood that were present in a household, such as chairs, tables, benches, boxes
	Lianas	Satisfies basic human need, is used for constructing fences and shelter	Number of liana bundles a household collected from the forest during the past year
	Medicine	Satisfies basic human need, has traditional and current value in addition to the local health infrastructure. Also used for livestock	Number of times a household collected wild medicinal plants from the forest during the past year
	Spices	Valued ingredients of local cuisine	Number of times a household collected wild spice plants from the forest during the past year
	Coffee	Traditional and cultural values, but also a major cash crop	Amount of coffee (kg) a household harvested from the forest during the past year
	Beehives	Honey is valued for health benefits and dietary diversity, but also a cash crop	Number of beehives a household had suspended in the forest at time of interview
Disservices	Stock loss	Impacts basic needs (nutrition, economic status)	Total score of livestock loss during the past 5 years, of cattle and horses (score = 10), sheep and goats (score = 5) and chickens (score = 1)
	Crop loss	Impacts basic needs (nutrition, economic status)	Total loss of crop loss during the past year in 'oxen', a local land size unit
	Food insecurity	Impacts basic human need	Total score on meal size reductions, meal skipping, and going to bed hungry because of wild animals. Each question was scored as 0 (none), 1 (<10 days/month) or 2 (>10 days/month)
	Cash income loss	Impacts economic opportunities	Total score on missing coffee/honey income opportunities, labor work opportunities, and market sale opportunities. Former two questions were scored as 0 (none), 1 (<10 days/month) or 2 (>10 days/month), latter question as 0 (none), 1 (<1/3 market days) or 2 (>1/3 market days)
	Farming impacts	Impacts opportunities to satisfy basic human need	Total score on being unable to use own land, being unable to use modern farming methods, and being unable to keep poultry/livestock. Former two questions were scored as 0 (none), 1 (<1/3 of total land) or 2 (>1/3 of total land), latter question as 0 (none), 1 (<1/3 of poultry lost) or 2 (>1/3 of poultry lost)
Education impacts	Impacts personal development and skills, and future economic opportunities	Total score on school dropouts of children, children skipping school, and adults missing education or training opportunities. First questions was scored as 0 (none) or 2 (yes), second question as 0 (none), 1 (<10 days/month) or 2 (>10 days/month), third question as 0 (none), 1 (<1/3 of such events) or 2 (>1/3 of such events)	

Table 1 continued

Variable	Type	Importance	Description/calculation
	Health impacts	Impacts basic human need.	Total score on injuries inflicted by wild animals, loss of sleep, and the suffering of illnesses. The former question was scored as 0 (none), 1 (lasted <10 days), or 2 (lasted >10 days), the latter questions as 0 (none), 1 (<10 days/month) or 2 (>10 days/month)
	Social impacts	Impacts traditionally and culturally valued exchange with others	Total score on missing visits to sick people/mourning events/funerals, missing visits to friends/family/community work, and having conflict with relatives/neighbors. The former question was scored as 0 (none), 1 (<1/3 events), or 2 (>1/3 events), the latter questions as 0 (none), 1 (<10 days/month) or 2 (>10 days/month)

included whether the households had non-exclusive or exclusive rights to the forest plots from which they received their benefits. Where GLMs were used, we calculated p values and explained deviance (D) by comparing them against the null model.

Attitudes towards access to services and the “cost–benefit” balance

In addition to the information whether households had non-exclusive or exclusive rights to the forest plots, we assessed how many respondents were dissatisfied with their current access to forest services, and why. To understand respondents’ attitudes towards the balance between services and disservices we first tested whether respondents in the different cluster groups perceived the balance between services and disservices differently using generalized linear models with a binomial error distribution. Second, we assessed whether other ecosystem services besides provisioning services were important in shaping respondents’ attitudes towards the perceived balance by coding the respondents’ answers to the open question regarding their perception towards this balance.

Results

Household characteristics

Out of the 150 randomly sampled respondents, 68 were female, 78 male, and in 7 cases both spouses

contributed answers. Most households were male-headed, with only 17 (11.3%) being female-headed households. Mean household size was 6.2 household members, and respondents had received on average 1.7 years of schooling. Households cultivated between one and seven fields, and on average received crops from three fields with a cumulative size of seven oxen (~0.875 ha). Sharecropping, where farming tasks and yields for a given field are divided among two or more households, were common, with only 24 (16%) households reporting to have no sharecropped fields. The major crops were maize, *teff*, sorghum, wheat, barley, and different types of pulses.

Ecosystem services and disservices

Households regularly used the forest for provisioning ecosystem services. Only four households reported to not use a single service from the forest, but obtained all their needs from their farmland or markets. Most forest products were used for subsistence only, except for coffee and honey which also provided cash income. Only seven households sold spices from the forest. Besides the use of different timber and non-timber forest products, 85 (56.7%) households used the forest daily for livestock grazing during the dry season.

Crop raiding and livestock predation were commonly experienced by households. Crop raiding was especially high on maize, sorghum and *teff*, and the main crop raiding mammals were olive baboons (*Papio anubis*), vervet monkeys (*Cercopithecus aethiops*), bush pigs (*Potamochoerus larvatus*), and

warthogs (*Phacochoerus africanus*). Where crop-raiding was considered a problem, different members from the households continuously guarded the crops. Self-reported yield loss ranged from 0 to 100%, with an average of 36.4% across all fields and 43.8% across fields that suffered crop-raiding. Lions (*Panthera leo*), leopards (*Panthera pardus*), and hyenas (*Crocuta crocuta*) preyed on larger livestock such as oxen, cows, and horses. Baboons, but also leopards, were the main predators on sheep and goats, and chickens were often eaten by baboons, civet cats (*Civettictis civetta*), and genets (*Genetta genetta*).

Disaggregating ecosystem services and disservices

Based on their responses regarding provisioning ecosystem services and disservices, three groups of households were identified. The three groups corresponded to distinctly different profiles of services and disservices (Fig. 2; Appendix S4).

Group A—Win_{ES}-lose_{EDS}: This group represented a major gain (“win”) from ecosystem services, but also substantial losses (“lose”) from ecosystem disservices (Fig. 2). Of the three groups, this group received the largest quantities of services, especially coffee, lianas, and wood for ploughs and fuel. However, wild mammals heavily impacted this group. This group was more heavily impacted by the direct costs of crop loss and livestock predation than the other groups, and also missed out more than average on farming and educational opportunities (see Table 1).

Group B—Lose_{ES}-lose_{EDS}: The second group represented households whose benefits from ecosystem services were substantially lower than those of the previous group (“lose”) (Fig. 2). However, similar to the first group, this group also incurred a range of impacts from disservices (“lose”). Although the direct costs (i.e. crop loss and livestock predation) were lower than for the first group, the second group incurred higher indirect costs. Households in this group missed out on cash income and farming opportunities, were affected in their health and social relationships, and the impact of mammals made them more food insecure than households in the first group (Fig. 2).

Group C—Lose_{ES}-escape_{EDS}: The third group obtained relatively little benefit from ecosystem services (“lose”), but also experienced low levels of disservices (“escape”) (Fig. 2). Except for spices and

fuel wood, this group of households received lower than average ecosystem services. However, this group had very low levels of disservices.

Characterization of ecosystem service–disservice profiles

Most respondents were clustered within the lose–lose profile, whereas the least number of respondents were clustered within the win–lose profile (Table 2). There was little difference in the gender between the profiles (Table 2). Respondents in the lose–escape profile were younger and had smaller households, and respondents in win–lose profiles had received slightly more schooling compared to respondents in the other groups (Table 2). The lose–lose group formed the majority of households in all kebeles (Fig. 3). The win–lose group was particularly prevalent in Borcha Deka, whereas the lose–escape group was especially prevalent in Done (Fig. 3).

Households from the three profiles differed in the amount of forest cover in the surrounding landscape (ANOVA, $F_{2,147} = 19.15$, $p < 0.001$; Fig. 4a) and in altitude (ANOVA, $F_{2,147} = 9.98$, $p < 0.001$; Fig. 4b). Households in the win–lose profile were surrounded by the highest amount of forest cover at the lowest altitude, whereas households in the lose–escape profile were surrounded by the lowest amount of forest cover at higher altitudes (Fig. 4a, b). Households from the three different profiles also differed in the average size of land cultivated (ANOVA, $F_{2,147} = 3.09$; $p = 0.049$; Fig. 4c) but not in the number of livestock owned (ANOVA, $F_{2,147} = 1.46$; $p = 0.24$; Fig. 4d). Households in the win–lose profile had larger land holdings compared to households in the other two groups (Fig. 4c). The proportion of households with metal roofs was also larger for households in the win–lose profile (GLM, $D = 4.02$, $p = 0.05$; Fig. 4e), and they also received their services more from their own forest plots than from other types of forest (GLM, $D = 14.69$, $p < 0.001$; Fig. 4f). Thus, households in the win–lose profile appeared to be wealthier than households in the other two profiles.

Attitudes towards access to services and the “cost–benefit” balance

Although most people did not obtain their forest products from their own forest plots, most respondents

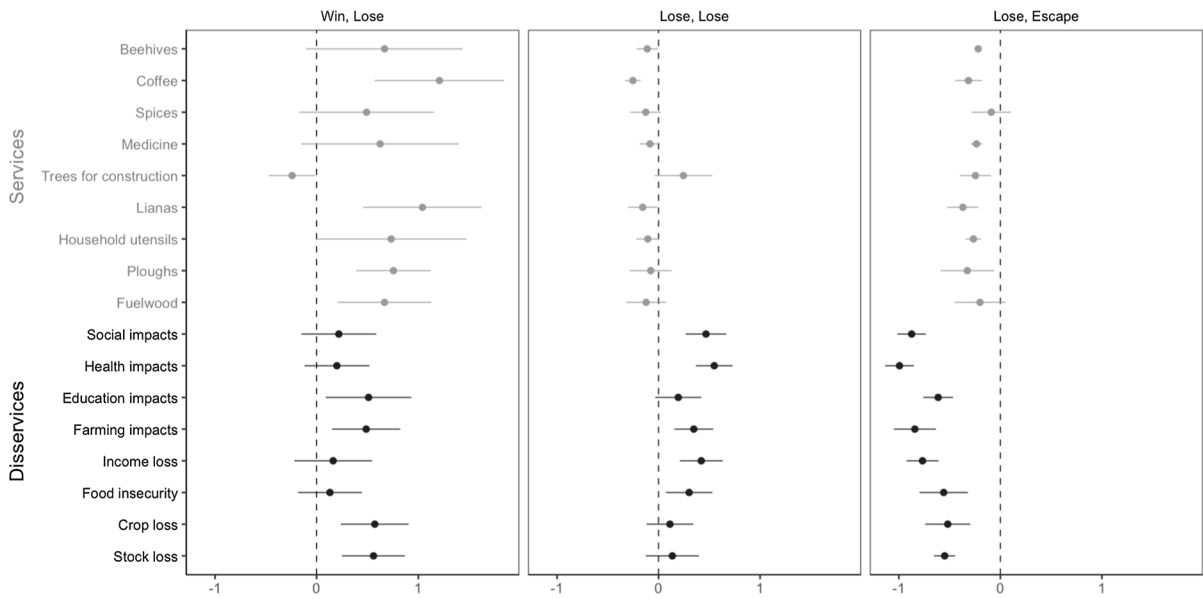


Fig. 2 Service–disservice profiles of the three household profile groups: win–lose, lose–lose and lose–escape. Services are shown in the upper eight rows, disservices in the lower eight

rows. Group means and 95% confidence intervals are presented. The dashed 0-line is the overall mean

Table 2 General characterization of the three household profile groups identified through hierarchical clustering

	Win _{ES} -lose _{EDS}	Lose _{ES} -lose _{EDS}	Lose _{ES} -escape _{EDS}
Respondents	<i>n</i> = 28	<i>n</i> = 75	<i>n</i> = 47
Gender	<i>f</i> = 11, <i>m</i> = 16, <i>b</i> = 1	<i>f</i> = 24, <i>m</i> = 45, <i>b</i> = 6	<i>f</i> = 30, <i>m</i> = 17, <i>b</i> = 0
Household head	<i>f</i> = 2, <i>m</i> = 26	<i>f</i> = 8, <i>m</i> = 67	<i>f</i> = 7, <i>m</i> = 40
Age (years)	42.1 ± 8.0	42.6 ± 4.9	32.4 ± 4.7
Education (years)	2.5 ± 0.5	1.6 ± 0.2	1.4 ± 0.2
Household size (members)	7.1 ± 1.3	6.2 ± 0.7	5.5 ± 0.8

Regarding gender of respondents, “f” indicates female, “m” indicates male, and “b” indicates both, where spouses were present during the interview. Most respondents did not receive any formal education, explaining the very low figures in this context. Where applicable, means with standard errors are provided

were satisfied with their access to forest services. Only nine respondents expressed that they were unhappy with their access to the forest; they felt their access to forest plots for cultivation was too constrained, or they could not access forest products due to a lack of energy at old age.

Despite the high impact of wild mammals and the negative perception thereof, most respondents still thought that the benefits obtained from the forests outweighed the costs from wild mammals in the forest. Only 23 (15%) respondents found the costs higher than the benefits, with no difference between the different groups of service–disservice profiles (GLM, $D = -0.13, p = 0.72$). Interestingly, the provisioning

services were not the only reason why people thought benefits outweighed the cost. Fifty-nine (46%) respondents who perceived the benefits to outweigh the costs also mentioned the importance of forest regulating services, such as local climate regulation, pure air, shade, and soil erosion prevention; and five (4%) respondents also mentioned the importance of cultural services, such as a place to relax.

Discussion

Cultural landscapes are increasingly appreciated for their ecosystem services (Plieninger et al. 2014).

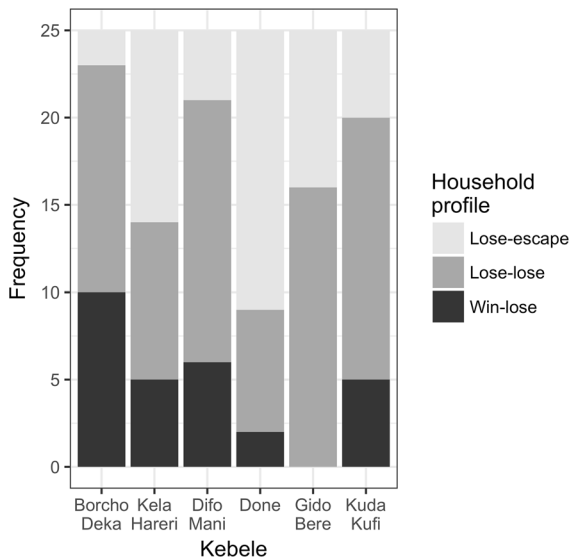


Fig. 3 Distribution of the frequency of the three household profile groups (win–lose, lose–lose and lose–escape) across the different kebeles

However, much of the existing literature stems from settings in the Global North, while much less is known about cultural landscapes of the Global South (Seppelt et al. 2011; Wangai et al. 2016). Here, we show that cultural landscapes in a Global South context provide a range of ecosystem services that are appreciated by rural communities, including provisioning and regulating services. Importantly, however, we also demonstrate that these positive features of cultural landscapes cannot be isolated from negative effects originating from the very same ecosystem. Rural communities thus experience ecosystem services and ecosystem disservices at the same time and hence, both should be considered in the management and governance of cultural landscapes in the Global South.

Recent work has shown that disaggregation of ecosystem services is important to generate a better understanding of the winners and losers in specific contexts, especially in poor rural settings (e.g. Daw et al. 2011; Willemen et al. 2013; Dawson and Martin 2015; Horcea-Milcu et al. 2016). Our work suggests that such disaggregation may be even more important when disservices are considered next to services. Both affect human well-being in multiple ways (as discussed in Ango et al. 2014, 2016), and only disaggregated views allow an assessment of how different community groups may be impacted. Through disaggregation we revealed a highly heterogeneous

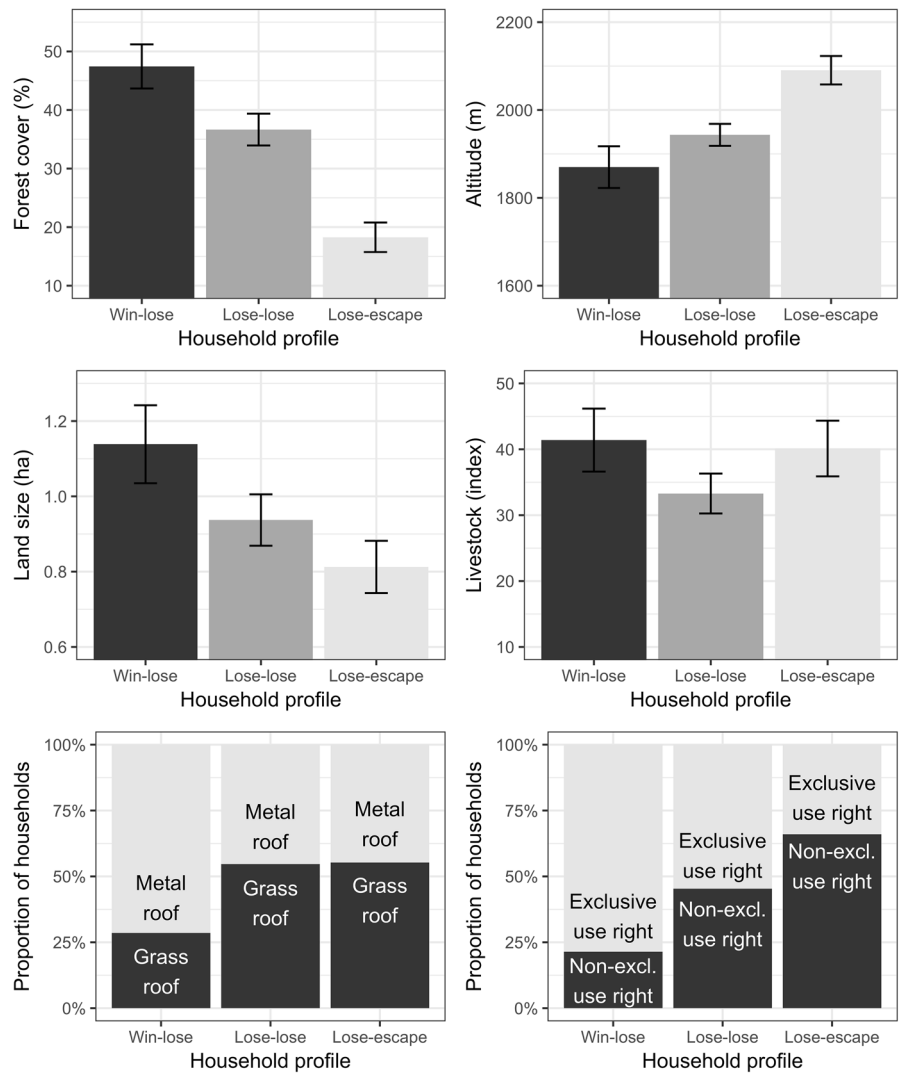
situation of ecosystem services and disservice impacts in the cultural landscapes of southwestern Ethiopia. Much of this heterogeneity goes unnoticed when only services or disservices are considered in isolation, leading to the risk of misunderstanding how rural communities experience and value cultural landscapes. We therefore suggest that a dual perspective on cultural landscapes is needed that disaggregates both the benefits and costs of (semi-)natural areas. While our study focused on the multiple dimensions of disservices that are mediated by wild animals—because of their dominating local importance—disservice assessments elsewhere should be adjusted according to local conditions. Relevant disservices may include ecosystem components competing with human land use for water, nutrients, light or pollinators; or that may harbor diseases or insect pests (Foli et al. 2014). Similarly, our study was limited to quantifying provisioning ecosystem services because of their local importance for human well-being in a poverty context, and because of our ability to capture these services for individual households. Other approaches, including more qualitative ones, may be needed to assess cultural ecosystem services and regulating or supporting services.

Cultural landscapes support distinct ecosystem service–disservice profiles

We found three groups of households representing distinct ecosystem services–disservice profiles. Location—which in our case was expressed by the relative proximity to forest and by altitude—may be a main determinant underlying this heterogeneity, but other factors such as wealth may also be important.

Geographical location can be an important driver of the distribution of ecosystem services (e.g. Schirpke et al. 2014) and of disservices (e.g. Lemessa et al. 2013). Increasingly, this spatial effect is also recognized for service–disservice outcomes (Mackenzie 2012; Salerno et al. 2015). In our study, the “win–lose” group and the “lose–lose” group lived in areas with a higher forest cover in their surroundings compared to the “lose–escape” group. The proximity to the forest exposed the former two groups to elevated levels of disservices. This supports findings from other areas where disservices are often relatively high near source locations such as protected areas (Mackenzie

Fig. 4 Measures of biophysical and socioeconomic characterization of the three household profile groups (win–lose, lose–lose and lose–escape), separately for means of forest cover in % (a), means of altitude in m above sea level (b), means of land size in oxen (8 oxen is approximately 1 hectare) (c), means of livestock index (d), proportion of households with metal or grass roofs (e), and proportion of households which owned or did not own a forest plot (f). Standard error bars are shown. Forest cover was calculated for a 500 m radius around the households. The livestock index was calculated as the cumulative scores of individual oxen, cow, and horse (each scoring 10), goat and sheep (each scoring 5), and chicken (scoring 1)



2012; Salerno et al. 2015). Interestingly, altitude may also play an important role in the differences between the “win–lose” and “lose–lose” groups, which were found at lower altitudes, versus the “lose–escape” group that resided at higher altitudes. Altitude in the region determines the distribution of the major cash crop, coffee, which does not grow naturally at higher altitudes. The absence of coffee as an incentive to keep forest in the landscape has resulted in the recent high deforestation rates at higher altitudes in southwest Ethiopia (Hylander et al. 2013; Ango 2016). This explains the relative paucity of disservices in the “lose–escape” group, and manifests as low forest access rights and ecosystem service use compared to the other two profile groups. In summary, location can

thus be seen as an ultimate determinant of service–disservice distribution in cultural landscapes.

At a more proximate level, socioeconomic factors can moderate the distribution of ecosystem services within communities (Dawson and Martin 2015; Lakerveld et al. 2015; Horcea-Milcu et al. 2016), but much less is known about their influence on disservices or service–disservice outcomes. Here we show that differences between household groups, especially the “win–lose” and the “lose–lose” groups, were associated with factors other than just location. While both groups lived close to the forest and within coffee-growing altitude, they differed in indicators of wealth (roof type and land holding size), and also in their relative appropriation of specific services and impacts

of disservices. The potential of provisioning forest ecosystem services to provide cash-income and diversify local people livelihoods and to equip households with important coping mechanism is well-known (Chilalo and Wiersum 2011; Tesfaye et al. 2011). In our case, the “win–lose” group had much better access to the economically important cash crop coffee and other services, and they usually had exclusive use rights to forest plots. In addition, despite the high impact of disservices through crop and livestock loss in the “win–lose” group, this may be related to their overall higher possessions, but their economic status and access to services may equip them with important coping mechanisms. The “lose–lose” group, in contrast, suffered mainly from opportunity costs and had lower food security, an important component of human well-being (Millennium Ecosystem Assessment 2003). In conclusion, although cause and effect are difficult to distinguish in this situation—and the process between use rights, appropriation and economic benefits may in fact be circular—socioeconomic status and service–disservice outcomes thus seem closely linked. This underlines the pivotal importance of socioeconomic information in a service–disservice context, similar to what has been argued for in ecosystem service research (e.g. Horcea-Milcu et al. 2016).

Managing cultural landscapes for outcomes that benefit both the environment and people, for example integrating conservation of natural resources with poverty alleviation or human well-being, or integrating the benefits from multiple ecosystem services, is often desirable but may be difficult in practice (Tallis et al. 2008; Howe et al. 2014). Indeed, our study did not find a group of households characterized by a “win–win profile” for ecosystem services versus ecosystem disservice impacts. It thus seems that the reception of ecosystem services may be difficult to separate from the occurrence of ecosystem disservices in some landscapes. However, and maybe more importantly, the majority of households still perceived themselves to be in a “winning” situation as they believed the benefits of the forests outweighed the impacts of forest mammals. In contrast, perceptions of residents living close to Kibale National Park in Uganda were shaped by loss aversion and not by the benefits they obtained from the Park (Mackenzie 2012). Also, in that case the cost–benefit balance was spatially inequitably distributed, and villages with

formal agreements to access to use the park for resources, such as beekeeping, received higher benefits (Mackenzie 2012). Thus, in addition to mitigating or minimizing ecosystem disservice impacts, secure access to natural resources may be a driving force for people in cultural landscapes to tolerate ecosystem disservice impacts.

Our finding that attitudes towards the natural ecosystem were overwhelmingly positive and independent of ecosystem (dis)service distribution is encouraging, because local attitudes and behavior are important for conservation outcomes (Waylen et al. 2010). We caution, however, that people’s positive attitudes despite the costs of forests—apart from resulting from the importance of provisioning services—could also stem from the local appreciation of the forests’ cultural or regulatory functions, which we did not study in depth. We acknowledge that our understanding of the reasons for overall positive attitudes remained somewhat superficial, because we did not explore their deeper, and likely complex psychological reasons. Yet, whatever the reasons, maintaining the generally positive attitudes of rural communities towards the forest should be an important management priority.

Finally, we focused on disservices where wildlife directly reduces crop availability, but also redirects time and energy away from other livelihood activities. Such indirect impacts are known from landscapes around the globe (e.g. Mackenzie and Ahabyona 2012; Barua et al. 2013; Ango et al. 2016). We are aware that partly indirect impacts of forest disservices (here in the form of wild animal raids) may not balance intuitively with the direct (provisioning) services forests provide. However, we believe that the distinction whether (dis)service are direct or indirect is of little relevance to local realities. Rather, the questions “why are forests advantageous” versus “why are forests disadvantageous” are important, which inherently relate to both direct and indirect effects. Future work could more deeply explore the multiple dimensions of (dis)services to better understand the distribution of benefits and costs of ecosystems among local people.

Challenges for the cultural landscapes of southwest Ethiopia

Maintaining positive attitudes while trying to balance services and disservices between the different profile groups more equitably is a major challenge in the

cultural landscapes of our study area. Currently, forest management in the region is changing in contrasting ways. On the one hand, and motivated by economic incentives, the government is increasing its appropriation of forestland for private investments in coffee production systems (Ango 2016). It seems likely that such development could aggravate the observed inequities, because it would limit direct forest access while failing to provide a solution to disservices. Medium-scale appropriation of forestland in other kebeles of our study area has already led to the loss of access to important forest ecosystem services, negatively impacting local people's livelihoods and increasing deforestation and forest degradation (Ango 2016). Thus, an increase in external coffee investment in the region could push rural communities into a "lose–lose" scenario, especially those with already limited access rights.

On the other hand, the government is expanding participatory forest management to promote local livelihood development and forest conservation (Tadesse et al. 2016), providing an opportunity to balance service–disservice profiles among the community. Participatory forest management schemes in Ethiopia can improve local livelihoods, forest condition, and contribute to social equity (Gobeze et al. 2009; Ameha et al. 2014). Here, local solutions must be found that allow a continued, equitable access to ecosystem services. Considering the lack of support and capacity of governments to deal with the impacts of wild mammals in Ethiopia and Africa in general (e.g. Tchamba 1996; Bulte and Rondeau 2005; Ango et al. 2016), participatory forest management schemes could also include mitigation of ecosystem disservice impacts. Local, traditional institutions for communal crop growing and guarding are a promising tool to achieve this (Ango et al. 2016). In conclusion, improved local planning with community participation, instead of allowing external land appropriation, could help to facilitate more equitable service–disservice outcomes.

Conclusions

Cultural landscapes—which are threatened by globalization worldwide—can be managed for the conservation of natural resources as well as for improving local people's livelihoods (Plieninger et al. 2014). The ecosystem services framework has been proposed as a

tool to manage these landscapes for both goals, but the use of conventional ecosystem service assessments has also been criticized (Plieninger et al. 2014). Here, we showed that for rural communities in Ethiopia, disaggregating the benefits from locally relevant ecosystem services as well as the impacts from relevant disservices is important for the management of cultural landscapes. Not disaggregating costs and benefits could lead to a skewed view of reality—groups that benefit from ecosystems at the same time may be strongly affected in negative ways, and the balance of costs and benefits may not be equally distributed across landscapes. Despite the limitations of the service–disservice framework (Saunders and Luck 2016), it may be a useful tool for the management of cultural landscapes in poor rural settings.

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