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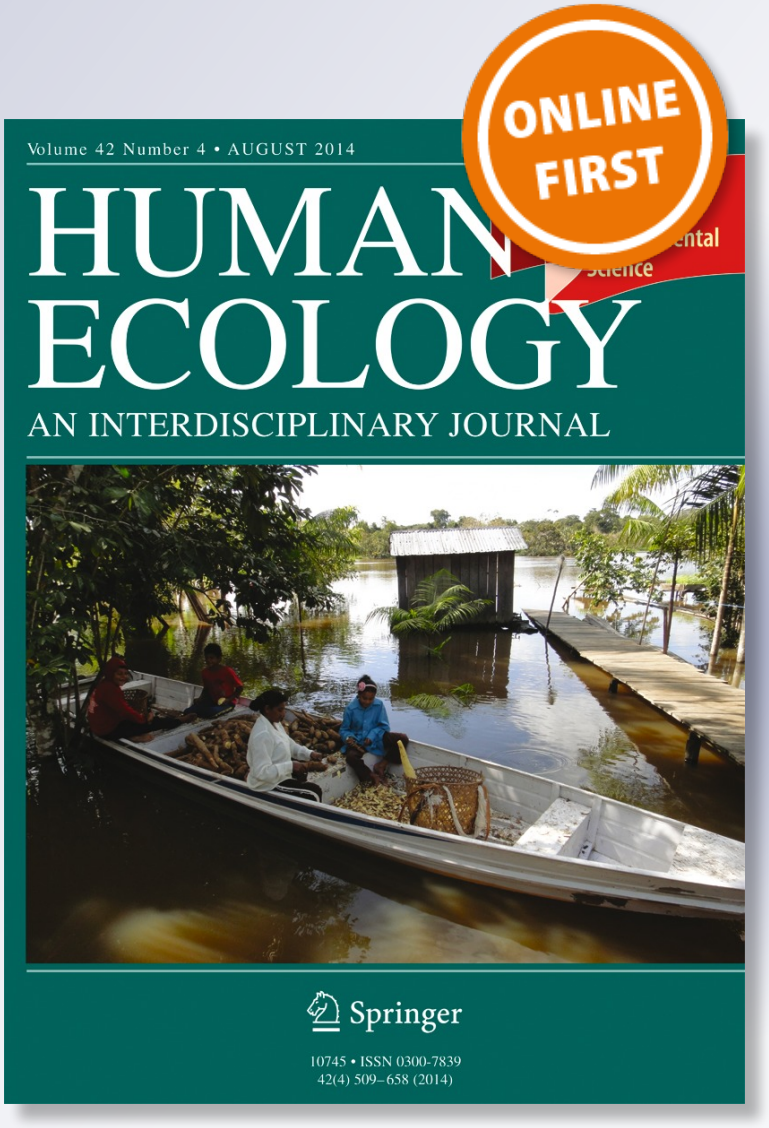

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Local Ecosystem Service Use and Assessment Vary with Socio-ecological Conditions: A Case of Native Coffee-Forests in Southwestern Ethiopia

Getachew Tadesse · Erika Zavaleta · Carol Shennan · Margaret FitzSimmons

Abstract Ecosystem-based management requires the promotion and integration of locally relevant ecosystem services. This needs an understanding of which ecosystem services local people value and how local valuation varies with socio-cultural and market factors. We convened ten focus group discussions and performed 105 household surveys from major indigenous groups and recent settlers about local values of various forest-based ecosystem services in changing landscapes of southwest Ethiopia. We found that the extent of ecosystem service use and assessment depends on socio-cultural background and gender of the informants, as well as income and cultural contributions of these services. Ecosystem service values vary in space and time where local people reported that they increasingly value services as they become scarce or in response to increased demands due to emerging markets or changes in production systems. Local people mostly appreciated a few services of high market value while most ecosystem services are not traded in local markets and hence not highly valued. Some low-rated ecosystem services such as fodder and medicinal plants were nonetheless widely used demonstrating the need to also conserve low rated ecosystem services that are used universally. We suggest promoting socio-cultural and other non-marketable ecosystem services to reduce the over-exploitation or exclusion of specific biodiversity components in conservation activities.

Keywords Forest-based ecosystem services · Local valuation · Socio-cultural services · Coffee-agroforests · Land-use changes · Ethiopia

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Introduction

Ecosystem services are the conditions and processes through which natural ecosystems and constituent biodiversity sustain human life (Daily 1997). Ecosystem service valuation (ESV) is the process of assessing the contribution of natural ecosystems to meeting a particular utilitarian or intrinsic value (Liu *et al.* 2010). ESV can bridge the existing gap between conservation and economic goals which in turn helps in management and policy decisions (Chee 2004). It motivates people to recognize the value of natural ecosystems and to mobilize in reducing deforestation and land-use changes that diminish ecosystem services (see Godoy *et al.* 2000; Liu *et al.* 2010).

Ecosystem service values are broadly classified as economic, ecological, and socio-cultural (de Groot *et al.* 2002). Values associated with ecosystem services result from day-to-day interactions of people with their environment (Millennium Assessment, MA 2005). The type and contribution of an ecosystem service depend on the scale at which it is generated. Accordingly stakeholders involved in appreciating, using, and managing ecosystem services can vary with spatial scales (Hein *et al.* 2006; Jose 2009). For example, many provisioning services generated at local scales are recognized and rated highly by local people. Since carbon sequestration, biodiversity conservation, or flood protection benefits are mostly generated outside the immediate landscape, they are less appreciated locally (Scherr and McNeely 2008; Jose 2009).

Values for ecosystem services vary with demographic and socioeconomic variables. For instance, some ecosystem services such as aesthetics, ecotourism, and supporting services become more appreciated with population growth and economic development (see Guo *et al.* 2010). Valuation and preferences for ecosystem services can vary by gender,

economic status, and socio-cultural background (e.g., indigenous people vs. recent settlers) (Lewan and Soderqvist 2002; Martın-Lopez *et al.* 2012).

Local perspectives on ecosystem services are needed to accurately assess the importance ecosystem services for local people, and to understand factors determining social preferences and trade-offs associated with land-use changes and conservation decision-making (MA 2005; Martın-Lopez *et al.* 2012). Incorporating local perceptions and valuation of ecosystem services can increase local awareness and participation, and the legitimacy of regional assessment and planning for management of ecosystem services (MA 2005; de Groot 2006; Liu *et al.* 2010; Cerdan *et al.* 2012). It helps to understand how local values are related to the ongoing land-use preferences and trajectories and to evaluate the socio-economic and environmental impacts of specific land-use trajectories from the perspective of those who are directly affected by ecosystem change. It also promotes the sustainable use of natural ecosystems by mobilizing people in reducing deforestation and land-use changes that induce detrimental changes on ecosystems. Local ESV helps identify the social and ecological values important in conservation, management, and restoration of ecosystem components (Martın-Lopez *et al.* 2012). Local valuation will also help in understanding the scale at which a particular ecosystem service is important and to link local values with national and regional policies (Kumar *et al.* 2013). Therefore, we need to analyze the perceptions of local communities who intimately interact with their environment and recognize ecosystem services differently than other stakeholders (Meyfroidt 2013).

Previous local assessments of ecosystem services have been based on strictly economic and ecological outcomes at regional and global scales (Martın-Lopez *et al.* 2012). Local people identify cultural and non-use values from ecosystems but ecologists and economists ignore social and cultural services (Chan *et al.* 2012a). Empirical data on local assessment of ecosystem services is limited (Sodhi *et al.* 2009) especially from multiple socio-cultural perspectives (Atkinson *et al.* 2012; Chan *et al.* 2012a; Laband 2013).

Although there is no consensus as to whether local communities are actually aware of the importance ecosystem services (Kremen *et al.*, 2008), local people from different regions in Africa and Asia recognize the multifunctional values of forests and agroforests including income and ecosystem services (Pfund *et al.* 2011). Local use and awareness of ecosystem services influence the way people manage agroecosystems by reducing tradeoffs and promoting synergies between biodiversity and livelihood practices in southwest Ethiopian landscapes (Ango *et al.* 2014).

Southwest Ethiopia is home to various indigenous peoples and native coffee forest fragments with an intimate and long history of human-ecosystem interdependence and use of various ecosystem services of local and global importance (Tadesse *et al.* 2014a, c). We explored the use and preferences of locally relevant provisioning and cultural forest-based goods and services from intact forests or other converted landscapes that are collected, consumed and sold by indigenous and recently settled people. In this study, we considered all the goods and services available from wild forests and from modified landscapes with native tree cover as forest-based ecosystem services. We addressed the following three broad research questions: (1) Which ecosystem service types are appreciated by local people and what is the extent of local perceptions on services from forests and agroforests? (2) How do demographic, cultural and market factors affect local ecosystem service ratings and how do ratings and use-values vary from place to place and through time? and (3) What are the implications of local ratings in promoting biodiversity and sustainable livelihoods in the region? We expected indigenous peoples to value forest-based ecosystem services more than settlers given their intimate and long history of interactions with their forests and agroforests.

Methods

Study Area

We selected two districts of contrasting demographic and livelihood conditions, and varying degrees of forest and agroforest cover in southwest Ethiopia: Yeki (604 km^2) and Decha districts (1,390 km^2) (Tadesse *et al.* 2014b; Fig. 1). Yeki is at 7.2° N, 35.3°E latitude and longitude respectively with a population density of about 223 persons per km^2, comprised of various indigenous peoples (59 %) and settlers (41 %) (CSA 2012). The settlers came from other regions with diverse socio-cultural backgrounds (Oromo, Amhara, Hadya, Kembata, and Tigrai in Ethiopia) mainly after the 1984/5 Ethiopian famine. The indigenous peoples include the Majanger, Kafficho, Shakicho, Menit and Manjos. Settlers practice small-scale coffee and intensive cereal cultivation whereas the indigenous peoples practice less intensive practices such as forest apiculture, fishing, and collection of other non-timber forest products in addition to their recent adoption of cereal and coffee cultivation (Tadesse *et al.* 2014b). Between 1973 and 2010, forest cover of Yeki diminished by more than 50 % (Tadesse *et al.* 2014b). On the other hand, coffee agroforests, coffee plantations and annual crop fields expanded during the same period. In addition to small-scale agroforests, Yeki has more than 2,200 ha of large-scale and 2,000 ha of medium-scale coffee plantations (TCPE 2010; Tadesse *et al.* 2014b).

Decha district is at 6.15° and 7.2°N and 36.5° E latitude and longitude and has a population density of 77 persons per km^2 (CSA 2012) comprised predominantly of indigenous Kaffichos (81 %) who practice cereal cultivation mixed with

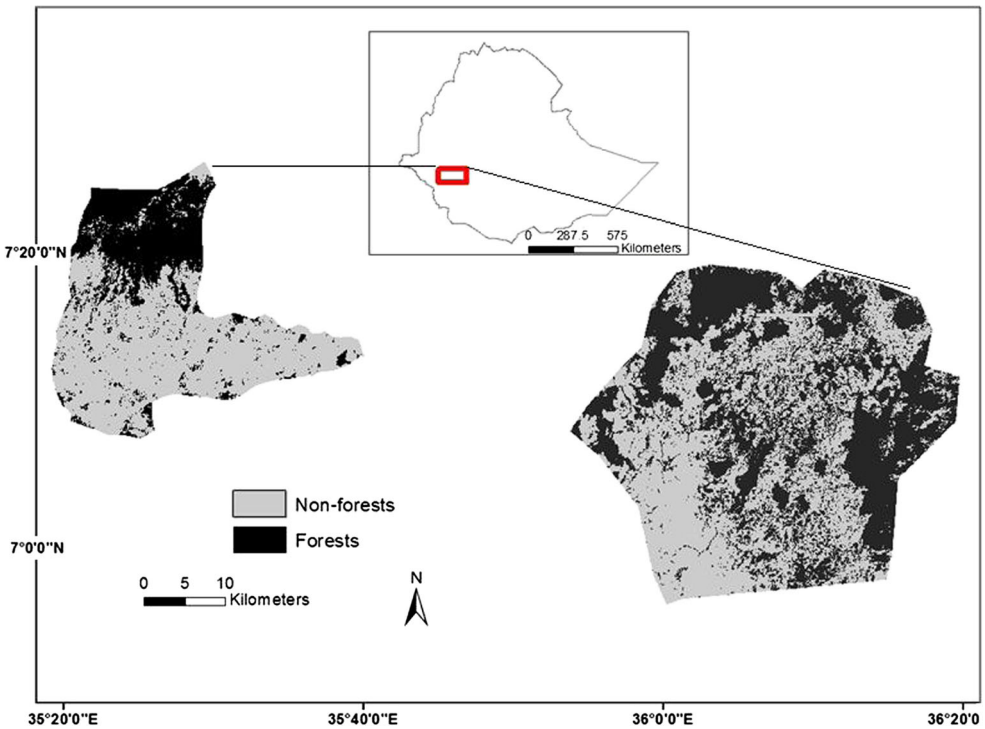

Fig. 1 Map of the study area in Yeki (*left*) and Decha (*right*) districts with forested areas (*dark shaded*) and non-forested areas (*grey shaded*) (G. Tadesse)

the production of wild and semi-forest coffee and collection of other non-timber forest products. The minority Manjos are indigenous inhabitants found in both districts who were hunters and gatherers and who used to move from place to place in search of arable land and forest products for their livelihoods, but started sedentary cereal cultivation after 1980 (Yosinda 2009). The forest cover of Decha was reduced by 30 % between 1973 and 2010 (Tadesse *et al.* 2014b). The region has about 1,900 ha of tea and 700 ha of eucalyptus plantations and several forest fragments have recently been converted to coffee plantations and other agricultural fields (Tadesse *et al.* 2014b).

Sampling Villages, Focus Groups and Households

We convened ten focus group discussions (FGD) in 10 villages with varying degrees of forest cover distributed across both districts in 2009–11. Each focus group was composed of 10–15 key informants of varying gender, age group, socio-economic and cultural backgrounds including settlers from different parts of Ethiopia and indigenous groups (Table 1). Focus group discussions addressed identification and ordinal ranking of locally valuable ecosystem services and major land-use sources (from 1 being highest rank, to higher successive number assigned to lower ratings). Preference ratings

Table 1 Socioeconomic composition/characteristics of focus group participants (V = village, SC = socio-cultural group) (G. Tadesse)

V	Focus groups			Households			
	Age range	Forest cover	Major economic activity in decreasing rank	Gender composition		Age	Dominant SC
				F	M		
1	25–65	Low	Crops, coffee, honey	12.5	87.5	43	Settlers
2	23–63	High	Crops, coffee, spices	14.3	85.7	41	Kafficho
3	20–62	Medium	Crops, coffee, spices	7.1	92.9	45	Kafficho
4	28–70	Medium	Coffee, crops, honey	15.4	84.7	44	Mixed
5	22–67	Low	Coffee, crops, honey	7.7	92.3	45	Settlers
6	27–68	High	Honey, livestock, crops	7.1	92.9	42	Shakicho
7	24–65	Medium	Crops, coffee, spices	9.1	90.9	44	Kafficho
8	26–67	Low	Crops, coffee, fishing/hunting	10	90	39	Mixed
9	28–30	High	Crops, honey, cultivated	10	90	40	Shakicho
10	35–37	Low	Coffee, crops, honey	8.3	91.7	54	Mixed

were based on the ranking of one use-value above another according to the informant or the focus group (see Brown 1984; Martin 1994).

We also interviewed 105 randomly selected households between 2009 and 2011 using semi-structured questionnaires to generate data about various ecosystem services and the factors that affected local preferences and use of ecosystem services at the household level (see Martin 1994). The number of samples was randomly selected from each village; the percentage of households in each socio-cultural group comparably represents the total population size of respective socio-cultural groups varying between 17.9 and 18.7 % of the total sample (Table 2). The Menit sample was very low since there were very few Menit households in the study region. Individuals who participated in focus group discussions did not participate in household interviews.

The household interview generated the identity of forest-based species that provide ecosystem services, purpose of collection, quantity collected in local units in a year, land-cover type where the ecosystem service was collected (mainly forest fragments and coffee agroforests), season of collection, distance travelled to collect, income due to these services, and the price of the goods and services if sold (Gavin 2004). Local valuation was assessed based on semi-structured interviews about the direct use-value either in terms of sale or consumption by each surveyed household during the year 2010. This was based on what people reported as annual income gained from their sales in local and regional markets, as well as direct utilitarian services (provisioning and cultural). We did not include livestock or managed cultivated crops in our valuation assessment except shade coffee and spices which are mostly forest-based under wild, semi-wild or plantation production systems. The indirect economic value of forests and working landscapes were not quantified in monetary measures for their role in regulating climate, water, and soil fertility.

Field and Market Surveys

We documented goods and services supplied in six local markets and their prices, and assessed which household members or socio-cultural groups sold these services. We carried out field surveys with guided field walks and observations on ecosystem service users in the forests and agroforests. In addition to the information reported by focus group participants and household informants, we recorded various ecosystem services used by people that we directly observed in the field surveys and supplemented this with information from local field assistants.

Data Analysis

We compiled a spreadsheet of the socioeconomic survey data and analyzed the contribution of each ecosystem service to household uses and income. We used F-tests and t-tests to compare the economic and cultural values of major ecosystem services between wild forests and coffee agroforests. We used correlation analysis to examine the relationships between the use of various ecosystem services and household characteristics, mainly age, gender, and socio-cultural background. Unequal sample-size t-tests were used for comparing settlers with indigenous groups. We also used chi-square tests to examine associations between socio-cultural groups and ecosystem service use from major land-use types. Direct matrix ordinal ranking was averaged to analyze the relative importance of various ecosystem services across all study villages. For this, we calculated a universality index for each major ecosystem service in terms of the percentage of focus groups or villages which rated it as one of the 11 most rated ecosystem services. We used either focus groups or households as the unit of analysis depending on the question we addressed. Based on a unit price for each marketed good, we calculated the percentage of households who reported selling a particular good and the mean annual price of each ecosystem service per

Table 2 Livelihood ordinal ranking by households (C = Crop, L = Livestock, Co = Coffee, S = Spices, H = Honey, F = Fuel-wood), mean income per household from selling goods, and average time needed to collect ecosystem services (SC = socio-cultural, % = percentage of household samples from the total 105 surveys, SD = standard deviation, SE = standard error) (G. Tadesse)

SC group	%	Mean family size	Mean land size (ha) ± SD	Livelihood rankings						Mean Income $ ± SE	Mean time (hr) ± SD
				C	L	Co	S	H	F		
Kafficho	18.7	7	2.3^{ab}±0.7	1	4	2	2	4	6	363^{ab}±182	2.1^{ab}±0.77
Majangir	18.7	6.1	2.8^{ab}±1.2	1	6	2	2	2	5	431^{ab}±64	1.6^{ab}±0.27
Manjo	18.7	7	1.7^{b}±0.9	2	5	3	4	5	1	198^{b}±50	1.3^{b}±0.21
Menit	4.1	6	1.5^{b}±0.8	1	5	2	2	6	2	161^{a}±102	2.8^{a}±0.43
Shakicho	17.9	7.4	2.7^{a}±1.0	1	5	2	4	2	6	323^{ab}±64	1.0^{b}±0.27
Settlers	22.0	5.8	2.2^{a}±1.5	1	3	2	3	3	6	471^{a}±78	1.2^{b}±0.32

household in Ethiopian Birr (ETB), then converted to USD based on the exchange rate in December 2010.

Results

Ecosystem Services from Forests and Coffee Agroforests

About 96 % of the households recognized one or more forest-based ecosystem service. Of all ecosystem services acknowledged by focus groups, 62 % were provisioning, 20 % regulating, 10 % cultural, and 8 % supporting services (Table 3). Forty percent of the focus groups and 30 % of the households appreciated forests for services such as cultural values, maintaining a healthy environment, pleasing natural scenery, clean air and water sources, and regulation of climate, erosion, drought, and disease. For example, participants from one of the focus groups stated that "Forest is life; without it there is no life and we cannot improve our livelihoods. When the sun is very intense, we and our livestock go to the shade in the forest. Forests are as important as our children and families; the values we obtain from forests are beyond what we get from cultivation and the benefit from forests is greater and more sustainable than those obtained from expanding our farms. In court, we testify against our brothers and children who cut trees in forests. Those *Cordia* trees that our forefathers used to cut for fuel-wood or to make simple tools from are now becoming more rare and expensive, and we can sell one *Cordia* tree for up to 100 'dollars'. The wildlife from our forests (colobus, bushbuck, buffalo, lion, leopard, wild pig) could bring us significant income through ecotourism" (*Rimich* focus group, October 15, 2010).

Another focus group also described how they plant or encourage the tree species *Millettia ferruginea, Albizia schimperiana,* and *Cordia africana* in non-forested areas so that they will protect themselves from fire in the lowlands, in addition to the various goods and services these trees provide them and how drought will occur if trees are cut.

Table 3 Major ecosystem services reported by local communities with the percentage of services reported under each MA (2005) service category (G. Tadesse)

Categories	Reported services	(%)
Provisioning	Wild food (fruits, vegetables, meat, fish, mushroom), fiber, honey, spices, medicinal, fodder, construction (lianas, tools, material culture), bioenergy (biomass, fuel wood, charcoal), clean air, clean water	62
Cultural	*Kobbos*, *Guddos* (cultural forests), *Adbars*, ecotourism, recreation	10
Supporting	Nutrient cycling, foliage/trees, capturing leached nutrients, soil fertility, shade coffee	8
Regulation	(Micro) climate, watershed, disease, invasive species, pests, protecting landslide/erosion, flood and drought mitigation	20

The majority of people explained their special connections to honey bees and wild animals in the past and were concerned that landscape changes negatively affected the quality and quantity of honey by (1) decreasing native trees that are used for bee forage and bee-hive hanging sites, (2) allowing the spread of exotic plant species such as *Euphorbia cutinifolia* (Caribbean copper plant locally named 'Yebonga abeba') and *Jatropha crucas,* species that are locally perceived to be toxic to honey bees, and (3) agricultural intensification that decreases honeybees through use of modern agricultural herbicides and other chemicals.

Informants reported that wildlife populations (buffalo, elephant, gazelle, hedgehog and wild pig) have decreased in the area since the 1980s. They reported that some areas in the lowlands used to attract tourists for game hunting and were sites of illegal elephant poaching, but that as of the mid-1980s there have been no elephants living in the region. Although numbers of lions, buffalo, and hartebeests are declining abruptly, some "pests" such as baboons, hyenas and wild pig have increased in villages and agricultural areas and become a concern for people and livestock.

According to informants, cultural and ritual services include (1) *Kobbo* forests that are protected and used for traditional honey production, and (2) *Guddo* forests that are protected by communities for their spiritual role in promoting health and in fostering good climatic conditions (rains) for better harvest. Although forests were recognized as the major providers of cultural services, other land-cover types such as grazing lands in the highlands and big trees around settlements (*Adbar*) were also reported to provide spiritual services in addition to their roles as spaces for meetings and public gatherings.

About 87 % of respondents reported that they used wild and semi-wild forests and home-gardens for coffee production. Most traditional coffee farmers we interviewed reported that they encouraged or planted many multipurpose tree species to meet their diverse ecosystem service needs, including microclimate regulation for coffee production, fodder, beehive support, bee forage, timber, fuel-wood, and soil fertility. The most highly ranked multi-purpose trees included species such as *Millettia ferruginea, Albizia schimperiana, Cordia africana, Ficus sur, Erythrina abyssinica, Schefflera abyssinica*, and *Morus mesozygia*. People perceived that some shade tree species maintain moist conditions for coffee (e.g., *Ficus* spp., *Milicia excelsa, Morus mesozygia, Mimusops* spp.) while other species (e.g. *Croton macrostachyus*, *Eucalyptus* spp., *Sapium ellipticum*) dry out coffee are not favored for coffee shade.

Spatio-Temporal Variation in Local Ecosystem Service Values

We found that regional and temporal variations in the use-value and ratings of ecosystem services are a function of (1) socio-cultural background and gender of the informant, (2)

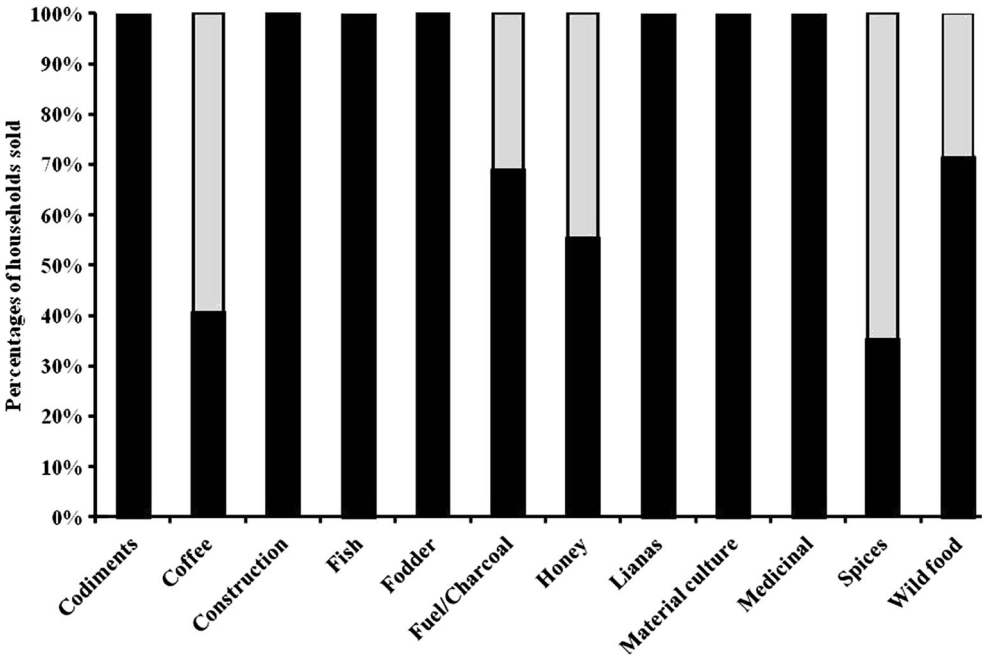

Fig. 2 Proportion of indigenous (*dark*) and settler (*light grey*) households who used major marketable ecosystem services in 2010 (G. Tadesse)

market and non-market contribution of ecosystem services, and (3) emerging markets and scarcity overtime.

Socio-cultural Background and Gender

The reported importance for ecosystem services varied among socio-cultural groups in both districts ($\chi^2_{94}=121$, $p=0.04$), with indigenous people reporting more dependence on a wider range of forest-based ecosystem services (85 % of all ecosystem services) such as fish, honey, lianas, material culture, hunting, and medicinal plants mainly from forests. Fish were considered as forest-based ecosystem services since they are caught mainly from the river Beko which passes through the forests, agroforests, and coffee plantations in Yeki district.

Settlers depended on a few marketable ecosystem services (15 % of all ecosystem services) such as coffee, construction materials, and spices mainly from coffee agro-forests (Table 2; Fig. 2). Households with small land holdings or who described themselves as 'poor' depended more on selling fuelwood, charcoal, lianas and honey mainly collected from forests ($F_{1,269}=3.95$, $p=0.05$; Table 2). Additionally, about 28 % of indigenous households used wild meat (at least once in 2010) from hunting colobus and savanna monkeys, porcupines, wild boars, and buffaloes compared to only 7.6 % of settlers ($F_{5,15}=3.6$, $p=0.05$).

Men and women in a household used distinct categories of goods and services ($\chi^2=6.7$, df=1, $p=0.01$; Fig. 3), with men travelling longer distances to collect ecosystem

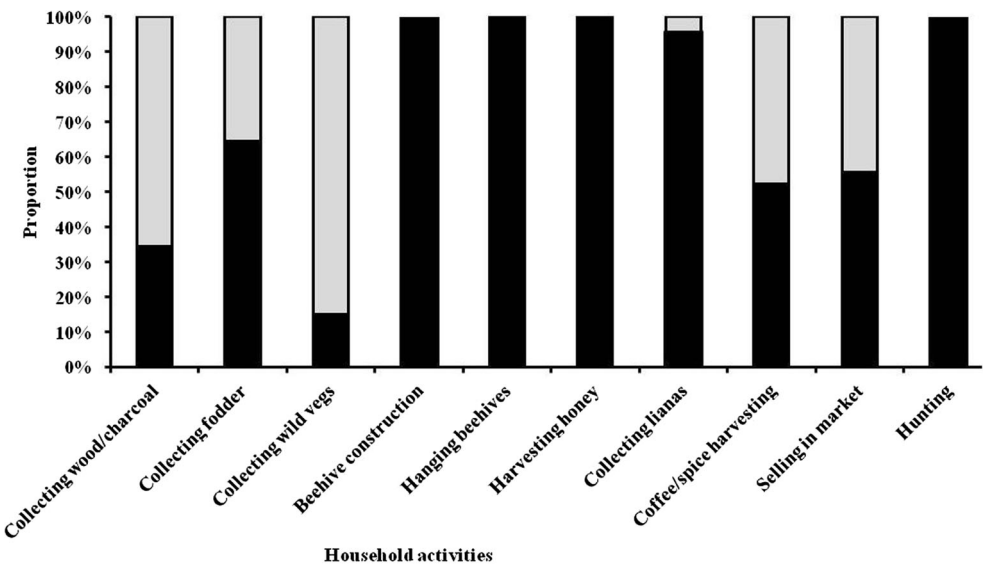

Fig. 3 Roles of women (*light grey*) and men (*dark*) in collection and marketing (and hence ratings) of ecosystem services (G. Tadesse)

services than women (t=1.29, p=0.03). Usually, men went far into the forest for honey production, collecting lianas or hunting, whereas women traveled to the forest margins and coffee farms to collect mostly wild vegetables, fodder and fuel-wood for domestic use and sale (χ^2=2.4, df=2, p<0.001). Accordingly, women had more knowledge and appreciation for wild vegetables and domestic fuel, while men valued forest honey, lianas, wildlife and construction materials.

Direct Market and Non-market Value

Various provisioning services contributed to supplementary and major incomes for households, varying from 30 to 75 % of total household cash income. The results show that the mean (±SD) annual income from sales of all forest-based services per household per year was $827±$84.4. The mean direct market income from sale of forest-based provisioning services from forests and coffee agroforests was $570 per hectare per year.

Over 50 % of all reported forest-based goods and services were marketable and the majority of market sales (93.7 %) were from coffee (66 %), spices (16.5 %), and honey (11 %) (Fig. 4). Coffee and honey are usually co-produced and provide relatively higher incomes than all other forest-based services such as wild vegetables, wild meat, fodder, or medicinal plants. Accordingly, coffee and honey were universally valued across all villages (100 %, 82 %) and households (81 %, 56 %), respectively (Fig. 5). About 45 % of the participants within a focus group and 56 % of households reported that they practiced forest honey production in 2010. About 87 % of the honey was reported to be produced traditionally, with 92 % of the hives constructed from and hung under native trees where the honey bees mostly forage.

We found that market values were not always correlated with people's rankings (r^2=0.58, df=9, p=0.06), indicating that non-marketed ecosystem services such as cultural and regulating services were also valued by local communities. For instance, fodder (mean rank=5, universality=90 %) and water clarification and erosion control (mean rank=6, universality=80 %) were ranked low, but used by people in most villages (Table 4). Others with low market or exchange values, such as wild meat, mushrooms, medicinal plants, cultural services and soil conservation, were still highly appreciated but had low universality, i.e., reported in only a few villages (Table 4). On the other hand, some ecosystem services such as pollination, dispersal, biological pest control, biodiversity conservation, and carbon sequestration were not commonly perceived by local people in southwest Ethiopia.

Emerging Markets and Ecosystem Service Scarcity Over Time

According to our informants, the use-values for some forest-based services such as fodder, lianas, honey, increased significantly over the years. For example, they reported that the price for a kilo of honey has tripled since the 1980s; accordingly, local appreciation for honey increased. Similarly, use-values for some ecosystem services have increased with the increased rarity of those services over time. About 80 % of our informants reported an increase in the value for lianas and

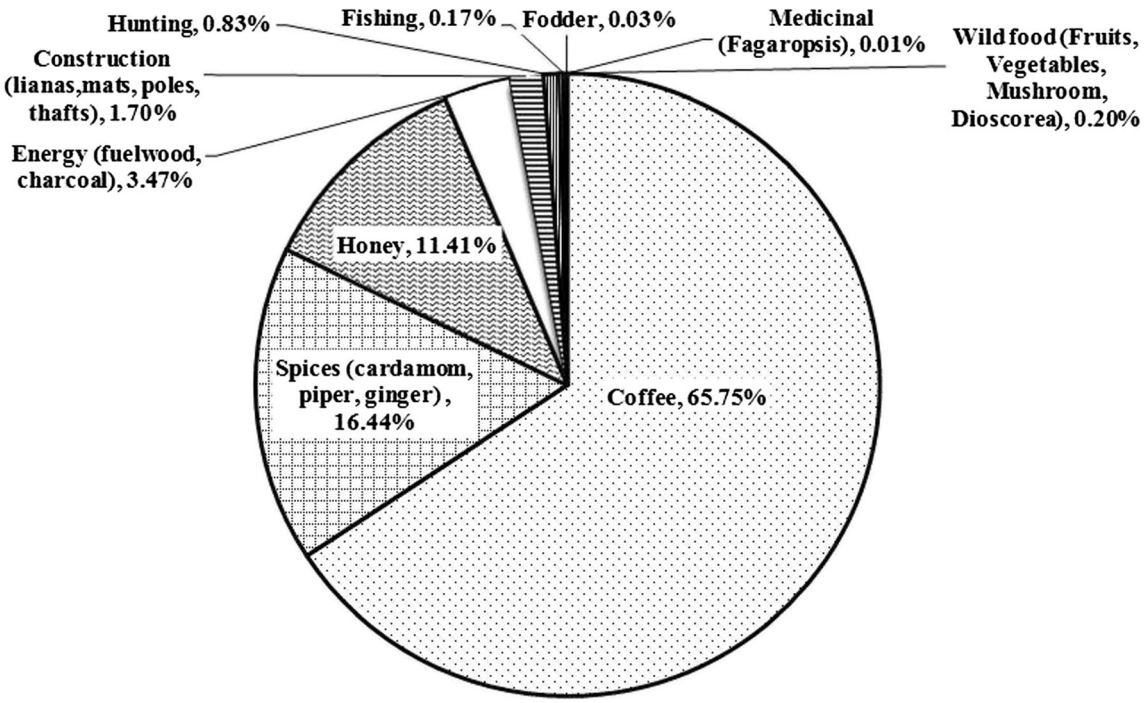

Fig. 4 Contribution of major ecosystem services by total direct market value (average per household) in the year 2010 (G. Tadesse)

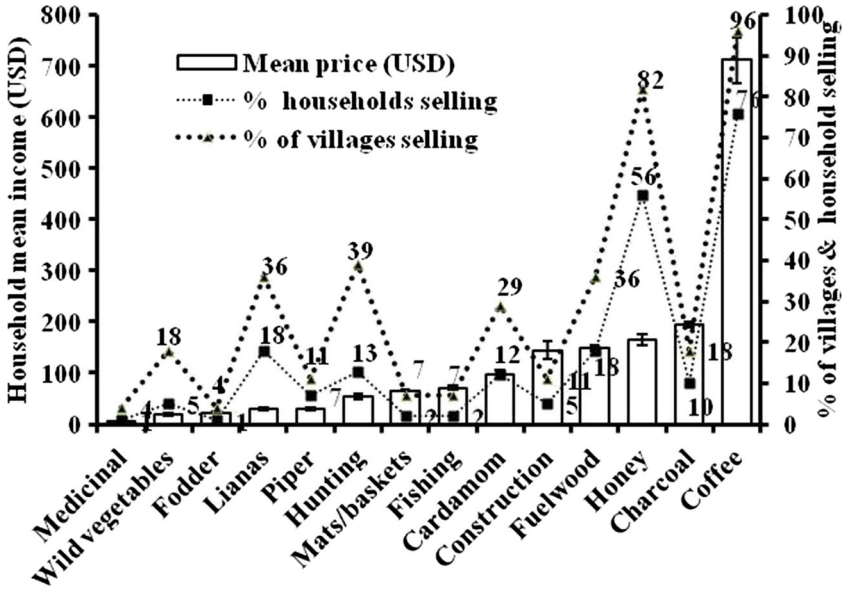

Fig. 5 Mean annual household sales from major ecosystem services in 2010, village and household frequencies denote the percentage of villages and households reported for sold services (G. Tadesse)

fodder because they became rare due to deforestation and overharvesting. In addition, the values of fuel-wood, charcoal, fish and wild vegetables are increasing with emerging markets and growing local demand. People also reported growing value for soil fertility services as farming practices intensify, unlike in the past when soil fertility was not an issue due to swidden systems and fallowing that used to regenerate soil nutrients.

Discussion

Local people in southwest Ethiopia reported all of the four major categories of ecosystem services described in MA (2005). We found high awareness of and values placed upon forest-based ecosystem services similar to findings in some protected areas in southeast Asian countries (Sodhi *et al.* 2009), and coffee farmers in many other regions (Cerdan *et al.* 2012). Monetary income from ecosystem services influenced the way people in southwest Ethiopia ranked forest-based ecosystem services more than socio-cultural and ecological services (see Feintrenie *et al.* 2010). The perceived value of ecosystem services increased with an increase in the relative contribution of these services to household income since people's priority is to improve their livelihoods. Coffee and honey, for instance, were highly ranked across all villages for their greater cash value in local and regional markets than other goods and services.

Table 4 Ordinal ranking of the top rated ecosystem services by studied villages (V1 to V10); 0 in the matrix refers that the ecosystem service was not among the top ten rated, and 1 is the highest rating while 10 is the lowest; universality refers how widely is a particular service highly rated across all surveyed communities (G. Tadesse)

Ecosystem services	V1	V2	V3	V4	V5	V7	V8	V9	V10	Mean rank	Universality (%)
Construction	2	3	1	2	1	1	3	2	2	1.9	100
Fodder	3	7	4	0	2	6	6	6	5	4.9	90
Honey production	1	5	2	4	4	4	0	3	4	3.4	90
Water/soil conservation	7	2	5	5	5	0	0	7	8	5.7	80
Coffee shade/production	0	4	3	3	0	2	5	1	1	2.7	80
Fuel wood	3	0	0	0	3	3	4	0	3	3.2	60
Medicinal	6	6	0	0	0	0	7	5	0	6.0	50
Climate regulation	0	1	0	1	0	5	0	8	0	3.8	50
Hunting	0	0	6	6	0	0	1	0	6	4.9	50
Wild food	4	0	0	0	0	0	1	0	0	2.5	30
Cultural/Ritual services	5	0	0	0	0	0	0	4	0	4.5	30

However, the emphasis on a few marketable ecosystem services neglects important socio-cultural and other associated services (see Chan *et al.* 2012a & b), in addition to the risk of excessive extraction and depletion of such marketed goods and services. Overharvesting of high value forest products in wild forests, semi-wild and plantation coffee agroforests, or other converted landscapes in southwest Ethiopia will eventually disconnect the people from their forests if many other non-marketable services including cultural and regulating services are not also conserved. Overlooking non-marketed biodiversity and associated ecosystem services (e. g. cultural services, water purification, erosion control, or drought regulation) is contributing to deforestation and land-use changes in the region. Additionally, the risks of focusing on forest valuation using monetary measures alone have been described as cases of forest commodification and "green grabbing," i.e., the appropriation of land and resources for environmental ends such as carbon offset programs while marginalizing local stewards (Fairhead *et al*. 2012). We noticed similar risks in our study region where attention is being given only to high value non-timber forest products such as wild coffee and spices, and where forests and traditional agroforests are being replaced with low shade coffee and exotic *Eucalyptus* plantations.

Although our results show that promoting the market values of various forest-based ecosystem services could increase their contribution to alleviate poverty, Ruiz-Perez *et al.* (2004) found that an over-emphasis on marketable forest products and services drives intensified management, cultivation, and production among forest peoples globally. This implies that sustainable management and poverty alleviation should be based on market and non-market, use and non-use, socio-cultural and ecological values.

In this study, not all locally valuable ecosystem services were exchanged in local and regional markets, and many could not be easily quantified (see Costanza *et al*. 1997; de Groot *et al*. 2012). As intimate users of ecosystem services, local people relate to, care for, and value ecosystems not only based on their marketable ecosystem values but also based on other non-market values such as socio-cultural and spiritual services (MA 2005). Some communities in southwest Ethiopia also highly ranked the cultural ecosystem services from forests which implies that people's valuation was based not only on direct consumptive or market values but also on other non-exchange use values. Cultural ecosystem services from forests were highly ranked by several indigenous groups even in situations where traditional cultural practices are often deemed "backward" by outsiders and recent converts to Christianity.

We found that people valued and somehow conserved forests in the region for their provisioning and socio-cultural services such as traditional apiculture in forest plots (*Kobbos*), ritual services in forests (*Guddos*), and spiritual practices under big and sacred trees (*Adbar*). Globally, cultural services play significant role in the conservation of forest biodiversity and ecosystem services (Bhagwat and Rutte 2006). In addition to provisioning services, cultural and spiritual services recognized by local people have possibly played vital roles in conserving southwestern Ethiopian forests, similar to other parts of Africa such as Zimbabwe (Byers *et al*. 2001) and Mozambique (Virtanen 2002). Cultural values from forests have been considered more important for sustainable forest conservation than many provisioning services especially for people whose cultural identity is intimately linked to forests (Farber *et al*. 2002).

In southwest Ethiopia, some low-rated ecosystem services such as fodder and medicinal plants were used almost universally by study communities. This suggests the "diamond-water paradox" in people's ratings, diamonds having high value due to their scarcity but being rarely used compared to less valued and widely used water (Farley 2012). This paradox commonly occurs in ecosystem service valuation (Farber *et al*. 2002) where high use-value goods essential to human well-being such as water or fodder have low exchange values compared to wild meat or fish in the region. This implies the need to also conserve ecosystem services that are locally rated low but used widely.

Our findings show that local use-values from forest-based ecosystem services varied with the experience and socio-cultural background of individual users. The perceptions and ratings of ecosystem services varied between the two districts in southwest Ethiopia since they have different levels of forest cover, socio-cultural composition and forest dependence. Indigenous people interacted with more ecosystem services, and valued cultural services more than settlers, who valued more marketable provisioning ecosystem services. Higher awareness of socio-cultural and environmental services by people with longer residency in Southeast Asia has also been reported by Sodhi *et al*. (2009).

Women interacted with forest margins, agroforests, and homegardens more than men who interacted with and recognized more forest services. Hence, men and women will be affected differently by the loss of forest fragments, with men possibly needing to travel more to continue forest-based activities, or to substitute new activities for lost forest-based livelihood options. This indicates the need to consider landscape level approaches and involve both men and women in conserving ecosystem services.

These patterns also vary among the poor who are more dependent on ecosystem services and more vulnerable to ecosystem service declines but who are often marginalized and excluded in decisions about the services upon which they depend (see MA 2005). This indicates the need to conserve forest-based biodiversity to benefit the poor and indigenous people (see Yang *et al.* 2013). Local assessment or values for forest-based ecosystem services generally varied depending

on the degree of interactions between the people and forests in southwest Ethiopia. This pattern is similar to people living in Usambara Mountains of Tanzania who give high value to their forests due to strong dependence on forest products (Rantala and Lyimo 2011).

Similar to the spatial variations in ecosystem values, our findings show that the temporal scale at which a particular ecosystem service is locally generated from forests and agroforests is variable. Ecosystem service needs of local people vary with time depending on emerging markets, scarcity of forests, and growing needs in quantity and quality of currently used or new classes of services that may be needed in the future.

Additionally, according to local informants the use of some forest-based ecosystem services such as traditional honey production and fishing has declined with disappearing traditional knowledge and practices as a result of cultural transformation or by diluting effects of resettlement in the region. Therefore, further long-term studies are important to fully understand the dynamics of ecosystem service values with detailed understanding of ethnoecological knowledge over broader temporal and spatial scales in the region.

Conclusion

We found high local recognition and dependence on forest-based ecosystem services that varies with socio-economic and cultural background of people in southwest Ethiopia. It is essential to include preferences and knowledge of women as well as indigenous and minority groups about managing ecosystem services in order to incorporate more diverse sets of ecosystem service providers and land-cover types for restoration, biodiversity conservation, and poverty alleviation.

Although various forest benefits reported by local informants have partly contributed to forest conservation in southwest Ethiopia, the short-term economic benefit of forests to local people is generally low compared to the benefits obtained from converting forests into agricultural land, or compared to global estimates of forest ecosystem values such as biodiversity conservation and carbon sequestration. Since local forest-based ecosystem service value is low compared to the short-term benefit of conversion to agricultural land, people continue deforesting for other land uses (see Godoy *et al.* 2000). In order to reduce deforestation, we need to promote forest values beyond non-timber forest products and their market values or other than specific biodiversity components in order to promote more socio-economic and ecological benefits. While it is important to promote markets for diverse ecosystem services, attention should be given to those most affected by land-use changes, particularly cultural, supporting and regulating services. In addition to promoting provisioning and regulation services, prioritizing socio-cultural ecosystem services that are provided by total biodiversity (e.g., the *Guddo* systems, aesthetic and ecotourism benefits) can reduce the overexploitation or neglect of particular components of biodiversity. We observed that neither local nor global ecosystem service assessment alone is adequate for planning biodiversity conservation and promoting sustainable ecosystem-based livelihoods. In addition to promoting locally underappreciated ecosystem services, integrating local ecosystem values into regional and global ecosystem assessments and environmental incentive programs will critically determine the ability of these coffee agro-ecosystems to sustain biodiversity and human well-being in the region.

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