

Ecosystem service importance and use vary with socio-environmental factors: A study from household-surveys in local communities of South Africa



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ABSTRACT

Ecosystem services (ESs) underpin human livelihoods around the world. Understanding how socio-environmental aspects influence stakeholders' perceptions and use of ESs, is important for decision-making processes that target the social expectations. In this study, face-to-face interviews were conducted with eighty-six householders in four villages of Limpopo province (South Africa), to assess the importance and use of ESs. Descriptive rank analysis, ordered logistic regression and Poisson generalised linear mixed-effects models were used. Supporting and provisioning ESs were rated the most important, followed by regulating and cultural ESs. Among the provisioning ESs, timber, firewood and edible plants were the most important, the most cited and used. Age, gender, income and prior recreational experiences played important roles in householders' perceptions. The frequency of collection of provisioning ESs declined with increasing distance to the forest and presence of foothills in landscape, which formed natural barriers. The results further revealed that employed householders benefited more from these services than unemployed householders. However, there was no significant effect of income variable on the use of the provisioning ESs, suggesting that the collection is more likely oriented towards a domestic usage. The implications of the results were discussed in a context of local development planning.

1. Introduction

Ecosystem services (ESs) represent a human centred concept of the benefits derived from nature, and can be broken into four categories: provisioning ESs (e.g. non-timber forest products, fire wood, fresh water, and fish), regulating ESs (e.g. climate regulation, water purification, and pollination), supporting ESs (e.g. habitat for species, soil formation) and cultural ESs (e.g. tourism, recreation) (MEA, 2005). Recognition of the concept began a few decades ago (Ehrlich and Ehrlich, 1981; Ehrlich and Mooney, 1983). The dynamics and complex interactions between people and ecosystems have triggered a need for further research on the services delivered, and the recent decades have witnessed a considerable research effort in the field of ES (Bennett et al., 2009; Castro et al., 2011; Costanza et al., 1997; Ego et al., 2007; García-Nieto et al., 2013; Nelson et al., 2009). Yet, the concept is still

being debated upon, between scientists, landscape managers and policy-makers. The establishment of many international initiatives such as the Millennium Ecosystem Assessment (MEA), The Economics of Ecosystems and Biodiversity (TEEB), and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) are manifestations of the ongoing debate.

Although ES is increasingly being used to inform and support management decisions at landscape level, most of the analytical efforts in ES assessment have been directed towards the capacity of ecosystems to supply ESs (Burkhard et al., 2012; Geijzendorffer and Roche, 2014; Maes et al., 2012; Seppelt et al., 2011), and their economic valuation (Costanza et al., 1997; Ninan and Inoue, 2013; Xie et al., 2010). Comparatively, few studies have approached the demand side of ES, leading to some lack of information on the social aspects of ES assessment (Geijzendorffer and Roche, 2014; Villamagna et al., 2013).

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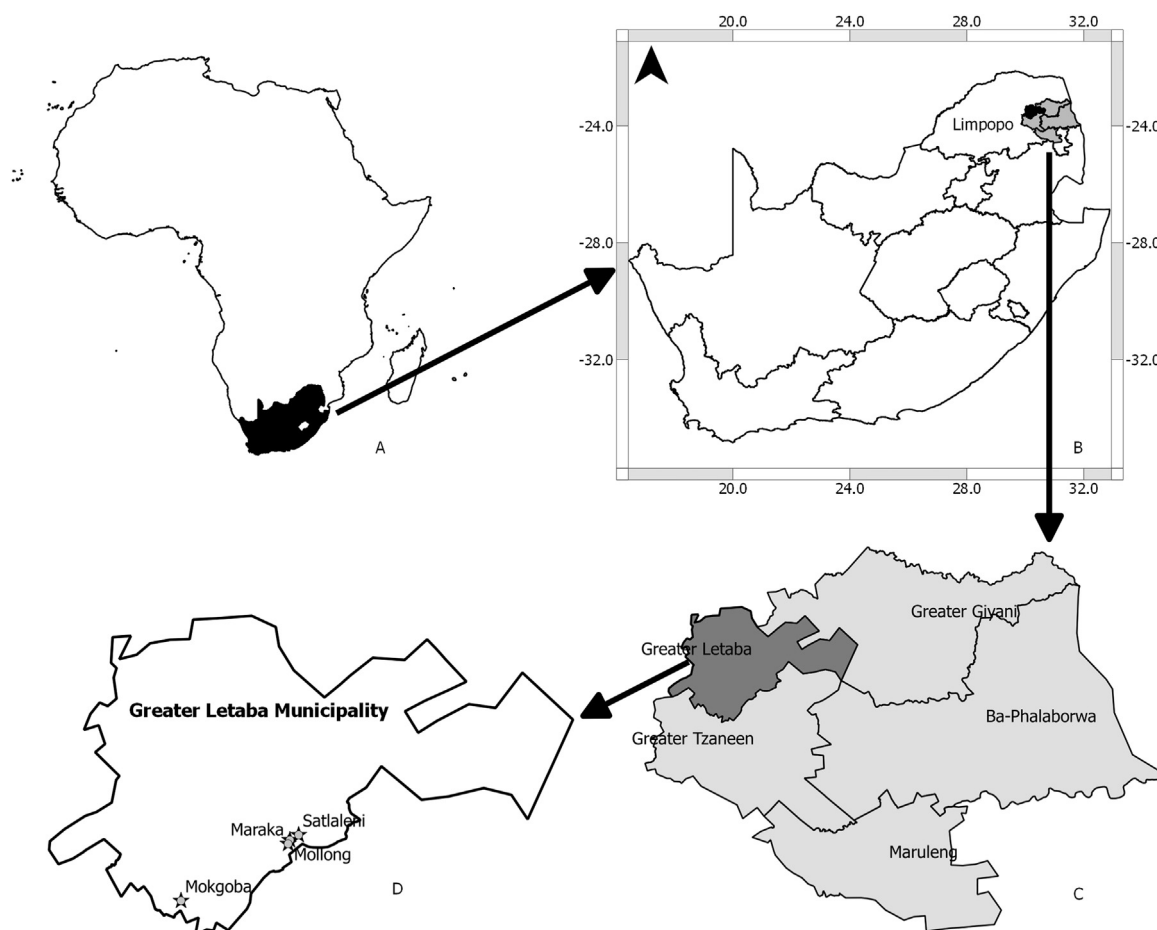


Fig. 1. Location of (A) South Africa in the African continent; (B) Mopani District in the Limpopo province of South Africa; (C) Greater Letaba municipality with neighboring municipalities and (D) studied localities in the Greater Letaba municipality.

Because ESs, as an anthropocentric concept, are per definition closely related to people, attempts to analyse ESs should also focus on the demand side and especially on their socio-cultural valuation.

The social demand for ESs involves different groups of stakeholders, from those directly or indirectly benefiting from these ESs to those involved in management and underlying policy development (Harrington et al., 2010). Different groups of stakeholders can have different interests in ESs, with respect to their importance, and the cultural and economic values they place on those. Thus, the identification of the ES beneficiaries is a step forward in the ES valuation (Hein et al., 2006).

Rural communities of different parts of the world develop dynamic links and interactions with environment, which they depend upon as source of material goods and services (Cuni-Sanchez et al., 2016; Gugushe et al., 2008; Kalaba et al., 2013; Ouédraogo et al., 2014). The importance of ESs to these communities is useful information for cultural valuation, because these services “exist” if these populations benefit from them (Bennett et al., 2009; Paruelo, 2012). In addition, their social perceptions towards the importance of ESs are crucial to identify (1) the most important and valued ESs at local scale, and (2) the potential trade-offs between ESs (Martín-López et al., 2012; Meijaard et al., 2013). These perceptions are also relevant information for the decision-making processes, because the socio-cultural contexts can usefully be integrated into the local development planning, thus linking the policy decisions to the social expectations (Cuni-Sanchez et al., 2016).

In socio-cultural valuation of ESs, a mere provision of a specific ES in a landscape may not guarantee optimal use, because the capacity of an ecosystem to produce a particular ES (Burkhard et al., 2012) may

not indicate the actual production nor the actual use of that ES (Villamagna et al., 2013). Within a group of beneficiaries, the benefits could be differently delivered, according to the access of these beneficiaries to the resource, and also according to the value they place on its wise management (Hein et al., 2006; Villamagna et al., 2013). There is mounting evidence that access to a particular ES and use of that service would be strongly influenced by a wide range of social factors (ethical, ecological knowledge, demographic), spatial and environmental factors (Cuni-Sanchez et al., 2016; Hein et al., 2006; Martín-López et al., 2012). For example, as pointed out by Kozak et al. (2011), the rate at which people visit for free, a recreational site, can diminish as a function of distance to that particular site. Therefore, accounting for these factors could also improve our investigation on the importance and use of ESs. The application of the socio-cultural and socio-environmental aspects is an advance in the multi-disciplinary assessment of ESs (Castro et al., 2013) since it improves the understanding of the complex interactions between people and the environment.

In the present study, we assessed the importance and use of ESs by local inhabitants in Limpopo, the northernmost province of South Africa. We explored a range of ESs to account for the four identified categories (provisioning, cultural, regulating and supporting ESs). We also determined whether (and how) socio-economic and environmental aspects influenced the perceived importance and the actual use of these ESs. The following questions were addressed:

(1) What are the local people's perceptions of the importance attributed to different categories of ESs? And how are the socio-economic factors associated with these perceptions? We assume that (i) provisioning ESs are more valued than regulating and cultural ESs, and

(ii) socio-economic variables such as age, gender and employment would predispose some categories of beneficiaries to value some ESs more than others.

(2) What ESs do local people use the most? And what are the socio-environmental variables that influence the use? We assume that (iii) provisioning ESs are the most used, and that (iv) spatial location and presence of natural barriers would influence the use of these services.

2. Materials and methods

2.1. Study area

This study was carried out in the Greater Letaba Municipality, located in the Mopani District in the north-eastern part of the Limpopo Province (South Africa; Fig. 1A–B). Limpopo is one of the most productive provinces in South Africa, in terms of commercial farming (fruits and vegetables, tea, cereals and livestock) and commercial forestry (SSA, 2013). It also provides a variety of ESs to both rural and urban people (Rankoana, 2016). The Greater Letaba Municipality shares borders with the Greater Tzaneen Municipality in the south, the Greater Giyani Municipality in the east, the Molemole Municipality in the west and the Makhado Municipality in the north (Fig. 1C). The area is characterised by a highly variable topography, from zones of flat lowland plains to zones of high mountains and a mosaic of foothills and low mountains. Zones of high mountains are dominated by large patches of mistbelt forests (Mensah et al., 2016a, 2016b). Zones of low mountains and foothills are dominated by commercial and small scale subsistence farming, commercial plantation forestry with pines and eucalypts managed by private forest companies, small fragments of natural forest habitats and degraded woodlots not suitable for forest plantations.

A preliminary exploration was conducted in the Greater Letaba Municipality to identify the rural communities living around forested areas and making use of forest products to support their livelihoods. Four village communities, notably Magkoba, Maraka, Satlalani and Mollong (Fig. 1D), were selected for this study. Magkoba village is surrounded by commercial forests and patches of natural forests. Communities living in Magkoba village depend on these forests as principal sources of wood and non-timber forest products. The last three villages (Maraka, Satlalani and Mollong) are located in a mosaic of degraded bushvelds and forests. These lands are unmanaged, and owned by the village communities who have access to forest products.

2.2. Sampling and data collection

A pilot survey was conducted in each village, with 50 randomly selected householders to determine a proportion p of householders who benefit from any ES. The sample size was estimated afterwards for each village, using the proportion p and the following formula (Köhl et al., 2006):

$$n = \frac{1}{e^2} p(1-p) U^2_{1-\frac{\alpha}{2}} \quad (1)$$

In this formula, n is the estimated sample size, U is the value of the normal random variable (1.96 for $\alpha=0.05$) and e , the authorized margin error from this survey, held to be 10%. As a result, 86 householders (46 in Magkoba village ($p=86\%$), 10 in Maraka ($p=98\%$), 20 in Satlalani ($p=94\%$) and 10 in Mollong ($p=98\%$)) were considered and randomly selected for the survey. These householders were local residents. Some demographical characteristics of the studied samples are presented in Table 1.

A questionnaire (SI 1) was designed and administered to each householder, separately. The questionnaire was performed at the participants' houses to record the geographic coordinates of their location. The concept of ES was explained to each participant prior to the survey. The four categories of ESs (MEA, 2005) were considered

during this survey. These included provisioning ESs (timber and firewood, edible plants, honey, edible fruits, edible insects, medicinal plants and mushrooms), regulating ESs (benefits from natural and ecological processes; e.g. pest control, pollination), supporting ES (healthy soil) and cultural ESs (tourism and recreation). The questionnaire was designed to record first, the respondents' demographic and socio-economic data, including gender, age, economic situations (employment and income). Each respondent was presented with a list of ESs, and was given the opportunity to rate them in terms of their importance, from "not important" to "extremely important" (SI 1). The information regarding the actual use/benefits from ESs was also collected, which covered the ESs used, the frequency of collection/use, and presence of natural barrier (river/foothills) which could affect the access or use of the services (SI 1). The questionnaire and sampling design were submitted for Human Research Ethic clearance to safeguarding the rights, the safety and the dignity of the participants in this research. Before we begun the survey, the legal representatives of the participants were informed and consent forms were explained and signed (SI 2).

2.3. Data analysis

We applied a descriptive rank analysis to evaluate the relative importance attributed to each ES and category of ESs. A 4-point scale was used to rate the levels of importance attributed to each service (where 1: not important, 2: somewhat important, 3: important and 4: extremely important).

To determine whether (and how) socio-economic factors influence the relative importance given to each category of ES, we grouped the participants on the basis of (1) the age (young householders: <30 years; adult householders: 30–60 years; and old householders: >60 years); (2) the employment status (employed householder, unemployed householder); (3) the gender (women, men) and (4) the income (yes vs no). Because of the nature of the response variable (ordered factor; 1: not important, 2: somewhat important, 3: important and 4: extremely important), we performed separate ordered logistic regression model (McCullagh, 1980) for each category of ES. Predictors for the model were householder age used as categorical variable with three levels (young, adult and old householder), employment status with two levels ('yes' if the respondent is employed and 'no' if not), gender (men vs women) and income considered as a dummy variable with two levels ('yes' if the respondent receives a monthly income and 'no' if not). Both employment and income factors were considered here to account for aged householders that are not employed, but receive a monthly income as state pension. An additional variable (past experience), indicating whether or not respondents had once visited a recreational or touristic site, was further considered for cultural ESs.

During this survey, it appeared that forest provisioning ESs were the ones mostly used in the studied local communities. The most used provisioning ESs were determined, based on the relative frequency of citation, which is the total number of citations for a particular provisioning ES divided by the total number of respondents for that ES. We next characterised the use of provisioning ESs, based on the frequency of collection (number of times people use/obtain a particular service on a monthly basis). The monthly frequency of collection was modelled as count data, assumed to follow a Poisson distribution. Therefore, using a generalised linear mixed-effects model with Poisson error structure (Poisson GLMM; Zuur et al., 2009), the frequency of collection was modelled as a function of (1) fixed effects of socio-economic variables (employment and income) and environmental variables (presence of barrier, time spent and the distance from forests), and (2) random effect of ESs. The approximate time spent was indicated by the respondents, but the distance to travel (0.3–2 km) was determined in the QGIS software (QGIS Development Team, 2009), based on the recorded geographic coordinates. ES was considered as random effect because (1) it is a categorical factor with seven

Table 1
Characteristics of studied householders.

| Land uses | Villages | Sampled household | Employed householder (Yes/No) | Income (Yes/No) | Gender (Women/men) | Age (Young/Adult/Old) |
|--------------------------------|-----------|-------------------|-------------------------------|-----------------|--------------------|-----------------------|
| Plantation and natural forests | Mokgoba | 46 | 15/31 | 28/18 | 29/17 | 13/18/15 |
| Degraded forest lands | Maraka | 10 | 1/9 | 8/2 | 7/3 | 0/4/6 |
| | Satlaleni | 20 | 6/14 | 15/5 | 16/4 | 3/9/8 |
| | Mollong | 10 | 5/5 | 9/1 | 6/4 | 1/3/6 |

levels and (2) we were not interested in assessing the exact nature of the each ES effect (Zuur et al., 2009). By including ES as a random factor in the model, we assumed that the variation around the intercept, for each ES, was normally distributed with a certain variance. The higher the variance, the greater the differences per ES (in terms of the intercept). A Shapiro-Wilk test was performed to test the assumption of normality. Both conditional R square (Cond. R²; variance explained by fixed and random factors) and marginal R square (Marg. R²; variance explained by fixed effects only) were calculated, following Nakagawa and Schielzeth (2013). Relatively similar values of Marg. R² and Cond. R² indicate that most of the variation explained in the GLMM is caused by the fixed effects, rather than by the random effects (i.e. ESs). All statistical analyses were carried out with the R Statistical software 3.2.3 (R Development Core Team, 2015). The ordered logistic regression models were performed using the “ordinal” package (Christensen, 2015). The mixed-effects Poisson GLM was performed using the ‘lme4’ package (Bates et al., 2015).

3. Results

3.1. Importance value of ESs

Healthy soil was the only supporting ES considered in this study, and was rated the most important, followed by provisioning ESs, and regulating ESs (Table 2). The less important category was the one of cultural ESs. Among the provisioning ESs, timber and firewood, edible plants and honey were considered the most important whereas edible insects and mushrooms were perceived to be less important. As for regulating ESs, pest control was perceived to be more important than pollination.

3.2. Factors influencing the relative importance given to ES category

Results from the ordered logistic regression models are summarized in Table 3. The employment status had no significant effect for any of the categories of the ESs. The main factors that influenced respondents’ perceived importance of ESs were age, gender, income and past experience.

Table 2
Importance value of provisioning, regulating, cultural and supporting ESs (average 1–4 scale, with SE); SE: standard error.

| Category of ESs | ESs | Importance value of ESs | | |
|-----------------|------------------|-------------------------|-------------|-------------|
| | | Mean ± SE | Mean ± SE | |
| Supporting | Healthy soil | 3.81 ± 0.04 | 3.81 ± 0.04 | |
| | Provisioning | 3.80 ± 0.04 | 3.26 ± 0.03 | |
| Regulating | Edible plants | 3.56 ± 0.07 | | |
| | Honey | 3.46 ± 0.08 | | |
| | Medicinal plants | 3.32 ± 0.10 | | |
| | Edible fruits | 2.96 ± 0.06 | | |
| | Edible insects | 2.82 ± 0.07 | | |
| | Mushrooms | 2.42 ± 0.10 | | |
| | Pest control | 2.92 ± 0.10 | 2.79 ± 0.07 | |
| | Pollination | 2.64 ± 0.11 | | |
| | Cultural | Tourism | 2.28 ± 0.09 | 2.15 ± 0.07 |
| | | Recreation | 2.02 ± 0.10 | |

Table 3
Ordered logistic regression results showing the determinant socio-economic variables influencing the perceived importance of ESs. Standard errors are shown in brackets.

| | Provisioning ES | Regulating ES | Supporting ES | Cultural ES |
|-----------------|---------------------------------------|---------------------------|---------------------------|--------------------------|
| | Coefficient estimate (standard error) | | | |
| Old | 0.57 [*] (0.27) | 1.28 ^{**} (0.53) | 3.61 ^{**} (1.29) | −0.39 (0.47) |
| Adult | 0.36 (0.24) | 0.56 (0.47) | 1.20 (0.75) | 0.12 (0.42) |
| Employment | 0.34 (0.37) | 0.87 (0.71) | 2.02 (1.17) | 0.68 (0.62) |
| Yes | | | | |
| Gender Men | −0.44 [*] (0.25) | −0.20 (0.52) | −1.86 [*] (0.84) | 0.16 (0.44) |
| Income Yes | −0.24 (0.23) | −0.27 (0.46) | −1.92 [*] (0.97) | 0.57 (0.39) |
| Past experience | – | – | – | 0.98 [*] (0.53) |
| Yes | | | | |
| | Condition number of Hessian | | | |
| | 3.18E+01 | 5.90E+02 | 6.70E+01 | 8.40E+01 |

* P<0.05.

** P<0.01.

Old householders were significantly and positively associated with the importance of provisioning ESs. The regression coefficient for this group was 0.57 higher than the ones for adult and young householders (Table 3). This suggests that older householders, as compared with younger, perceived provisioning ESs as more important. Gender also significantly influenced the ability of informants to value provisioning ESs (P < 0.05; Table 3). Unlike age and gender, income and employment status did not significantly affect respondents’ perceived importance of the provisioning ESs.

There were no significant effects of categories of gender, employment and economic situations on the importance value of regulating ESs (biological control and pollination). Only the age category revealed positive perception of old householders towards the importance value (Table 3).

Age, gender and income were significant predictors of the householder’s ability to value supporting ES (Table 3); accordingly healthy soil was perceived to be more important for older householders, than for adult and younger householders; as for the gender, men exhibited less positive attitude towards healthy soil, while comparatively, women showed more positive attitude.

For the cultural ESs (recreation and tourism), neither the age and gender, nor the employment and economic situations had significant influence on the perceived importance. The results further showed that only respondents’ past experiences determined their positive perception towards the cultural ESs (P < 0.05; Table 3).

3.3. Most used ESs across study sites and factors affecting their use

Forest provisioning ESs were the most used among the respondents. The highest frequency of citation was recorded for timber and firewood (97.7%), followed by edible plants (83.7%), edible wild fruits (79.1%) and edible insects (69.8%). Mushrooms, medicinal plants and honey were less used. The results also indicated that the patterns of citation and use varied with the surrounding land uses; accordingly, edible plants, wild fruits and insects were more considerably used in Maraka, Satlalani and Mollong villages, surrounded by degraded forest lands, than in Magkoba village, which is surrounded by established plantations and natural forest patches.

Table 4
Results of Poisson GLMM describing the effects of employment and environmental variables on the frequency of collection. The last column is a significance measure.

| | Estimate | SE | Z | P |
|---------------------------------|----------|------|-------|---------|
| (Intercept) | 2.03 | 0.25 | 8.23 | < 0.001 |
| Environmental variables | | | | |
| Foothill Yes | -0.33 | 0.07 | -4.57 | < 0.001 |
| Time spent (hours) | -0.11 | 0.03 | -4.01 | < 0.001 |
| Distance to forest (km) | -1.12 | 0.33 | -3.39 | < 0.001 |
| Social variables | | | | |
| Employed householder Yes | 0.16 | 0.08 | 2.07 | 0.04 |
| Income Yes | -0.04 | 0.08 | -0.54 | 0.59 |
| Variance random intercept (ESs) | 0.34 | | | |
| Conditional R square (%) | 67.02 | | | |
| Marginal R square (%) | 11.34 | | | |
| Shapiro-Wilk normality | | | 0.93 | 0.56 |

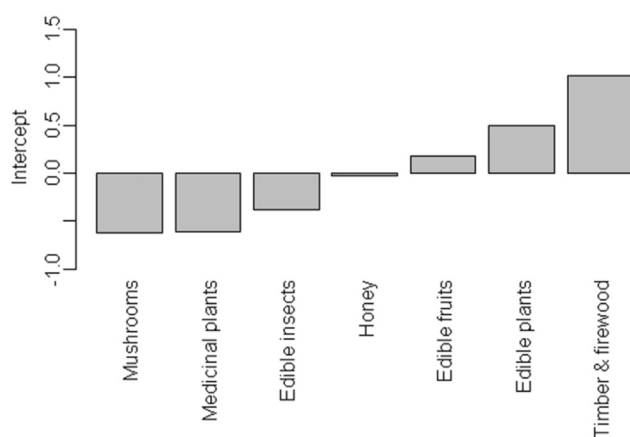


Fig. 2. Random intercept for each provisioning ES.

The results from the Poisson generalised linear mixed-effects model (Table 4) revealed that 67% of the variance in the frequency of collection was explained by the fixed effects of environmental variables and employment status, and the random effect of provisioning ESs. The presence of foothills, the distance and the time spent had negative significant impacts on the frequency of collection of these services ($P < 0.001$; Table 4). There was also a significant ($P=0.04$), but positive effect of employment status, which suggests that employed householders benefit from these ESs more than unemployed householders. Unlike employment status, income did not show any significant effect on the frequency of collection. The conditional and marginal R squares values were 67% and 11%, respectively, suggesting that most of the variation explained in the GLMM was caused by the random effects of ESs. This is further corroborated by the considerable variance (0.34) in the random intercept (Table 4; Fig. 2). Examination of the random intercept (Fig. 2) suggests that the frequency of collection of provisioning ESs increased due to a high interest in timber and firewood, edible plants and edible fruits, while comparatively, there was very little interest in the collection of other provisioning services such as edible insects, medicinal plants and mushrooms.

4. Discussion

4.1. Householders' perception on the importance of ESs

Evaluating the importance of ESs for people's livelihoods is essential part of the ES assessment framework. The understanding of the socio-economic variables and perceptions behind the importance and use of ESs is a primary goal. In this study, we assessed the importance and use of ESs by local inhabitants in Limpopo province (South Africa), finding out that (1) supporting and provisioning ESs

were the most important; (2) age, gender, income and prior recreational/touristic experiences influenced respondents' perceived importance of ESs; (3) the patterns of citation and use of provisioning ESs varied with the surrounding land uses; (4) the frequency of collection of provisioning ESs varied significantly with socio-environmental factors.

We found that supporting and provisioning ESs were perceived as the most important, compared with regulating and cultural ESs. This result is consistent with previous studies that approached the social aspects of ES assessment (Hartel et al., 2014; Hartter, 2010; Martín-López et al., 2012). Among the provisioning ESs, timber, firewood and edible plants were the services perceived to be the most important. The interest of local people in these forest provisioning ESs concur with the ideas that rural communities show a high appreciation of material benefits from forest ecosystems, in contrast to urban communities (Martín-López et al., 2012) who highly appreciate cultural services such as aesthetic value, recreational activities, tourism, environmental education (Kroll et al., 2012). The fact that provisioning ESs are often highly valued within rural inhabitants may be because these populations have a close connection to the ecosystems (Martín-López et al., 2012). However, the high importance value attributed to the studied supporting ES (healthy soil) reflects more the level of local people awareness of the soil quality. Indeed, in agricultural and forestry systems, soil quality has a major impact on the delivery of almost all other services (TEEB, 2011), because soil influences the primary production through factors such as nutrient availability, soil moisture and soil structure.

Age, gender, income and past touristic/recreational experiences played important roles in the importance of ESs. These findings accord with some recent studies that found age and gender as significant predictors of people's attitude towards ESs (Allendorf and Yang, 2013; Castro et al., 2011; Martín-López et al., 2012; Meijaard et al., 2013; Sodhi et al., 2010). Interestingly, our results further suggest that the influence of these factors depends on the category of ESs (Table 3). For instance, gender and age variables clearly influenced the respondents' perceived importance of provisioning and supporting ESs, however, both factors did not affect people's attitude towards cultural services. The positive attitude of women towards the importance of provisioning and supporting ESs is likely a result of the sense of duties that women have in the household, and how they are aware of the direct benefits from the environment (Allendorf and Yang, 2013). Therefore, the gender effect on the perceived importance of ESs can be explained by the gender-related roles in the house (Martín-López et al., 2012). Local women have a close relationship with the collection of forest resources, and most of the provisioning ESs studied in this context (e.g. timber, firewood, edible plants, edible fruits, and medicinal plants) were harvested by women, as part of domestic roles.

Contrary to what was observed for provisioning and supporting ESs, neither the age and gender nor the employment and economic situation had significant influence on the importance attributed to the studied cultural ESs. Interestingly, only respondents who visited a recreational site in the past, showed positive attitude towards these cultural ESs. This suggests that rural people do not highly appreciate the cultural services from the environment, such as recreation and tourism, unless they acquired their own experiences. This also suggests that the lack of information and prior experience may have negative influence on the perception about the cultural services, and in turn the value they attribute to these services.

Older community members had a more positive perception on provisioning ESs than younger members. This may be explained by the fact that old people/householders, in general, support the basic necessities (e.g. water, foods) of the entire household. Alternatively, the result could be explained by an indirect effect of knowledge, which is accumulated over time. Moreover, the positive attitude of old people towards regulating services and supporting services stresses the importance of the knowledge transfer (Allendorf and Yang, 2013), in that youngsters usually learn from elders. We did not detect any

significant effect of respondents' employment status and income on the perceptions of provisioning, regulating and cultural ESs. This is surprising since unemployed householders were expected to use more forest resources and to have a positive perception of their importance. This result, however, suggests that employment status may have less influence on local people's perceptions towards the importance of these services.

4.2. Use of ESs across study sites

The importance accorded to the ESs reflects the actual use of these services. Indeed, wood for construction and fuelwood were the major products rural people derived from the forests. This is in line with previous findings by Shackleton et al. (2007) on the importance of woodlands in rural livelihoods in South Africa. Fuelwood is still the main source of energy because most of the remote communities are exposed to an unreliable electricity supply (Gugushe et al., 2008). Except for timber and firewood which were highly cited in the studied communities, there were considerable differences in the frequency of citation of edible plants, edible fruits and edible insects. Such differences reflect the effects of land use; communities living in Maraka, Satlalani and Mollong villages are surrounded by degraded forest vegetation and seem to benefit from other forest provisioning services (e.g. edible plants, edible fruits and edible insects) more than people living in Makgoba village, surrounded by commercial eucalypt forests and small patches of natural forest habitats; the establishment of these eucalypt commercial plantations provide economic benefits to private owners and companies, and considerable quantities of wood for local people, but reduce the availability of other forest products, because the existing edibles fruit trees and edible plants are frequently treated as weeds. This means that wood and other timber products are supplied in these managed landscapes at the expense of provisioning ESs such as edible plants, indigenous fruits and edible insects, suggesting potential trade-offs between ecosystem services from managed landscapes (Bennett et al., 2009). But the fact that local people still use forest products even in areas where closed-canopy forests are absent, reinforces the importance of degraded indigenous forests for rural people's livelihoods (Meijaard et al., 2013), as compared with commercial plantations.

Unlike timber and firewood, relatively low frequencies of citation were recorded for forest provisioning ESs such as mushrooms, medicinal plants and honey. This could be explained by local people disinterest towards the collection of these forest products. The rural communities in South Africa are relatively similar to communities in other parts of the developing world (Gugushe et al., 2008), but the level of industrialisation makes the context different. For example, in Zambia, forest ecosystems, especially Miombo woodlands were revealed to provide number of services (foods, timber, firewood, health, and spiritual benefits) to local people (Kalaba et al., 2013). This is also the case in West Africa, for instance in Burkina Faso, where local people benefit from provisioning services such as firewood, construction material, medicinal plants (Ouédraogo et al., 2014). One could thus, hypothesize that, in South Africa, the development of forest industry combined with the conversion of natural lands, has a substantial contribution to the production of major services such as timber and fuelwood, and at the same time limits the provision of other services supplied by natural forests. The conversion of natural habitats into plantations has been found to negatively affect biodiversity (Stephens and Wagner, 2007; Vellend, 2004), and probably the availability of medicinal provisioning and supporting ESs.

Factors that significantly influenced the use of provisioning ESs were: presence of foothills in the landscape, the time spent and the distance to the forest. The frequency of collection of forest provisioning ESs decreased with increasing distance to the forest and presence of foothills in the landscape. This result accords with the idea that local communities close to forest stands benefit from forest services more

than those living far away from these forests (Colfer et al., 2006). The influence of environmental variables on the frequency of collection of forest goods indicates that small scale geographical and topographical patterns are important for the use of ESs. Large scale environmental indicators (e.g. rural-urban gradient) might also have strong influence, because of the spatially differential interest of beneficiaries in ESs (Hein et al., 2006; Kozak et al., 2011; Kroll et al., 2012). It was also found that provisioning ESs were more frequently used when the householder was employed. This is because most employment opportunities in the studied areas are related to timber harvesting in plantation stands and wood processing in sawmill. These jobs contribute to increase the accessibility to the forest provisioning services to rural employed householders. In contrast to our expectations, income did not significantly affect the use of these provisioning services. This result runs against our prior finding on the influence of employment status, however, it may be due to the type of the income, which includes the state pension, especially for aged people. The nonsignificant effect of income on the use of the provisioning ESs may suggest that these services are not subject to trade in the studied areas, but instead, are used for domestic purposes, contrary to other rural communities where the trade of forest products is major source of household income (Kalaba et al., 2013).

4.3. Limitations of the study

All being considered, it is important to acknowledge that our study has some limitations. First, the formula applied to estimate the sample size for each village, was only based on the proportion p of households that benefit from ESs, and a margin error of 10%, which do not necessarily insure the representativeness of the sample in each village. However, we believe that this has a minor impact, because the study was designed to target the households that benefit from the studied ESs (provisioning, regulating, cultural and supporting), and not the entire village householders. Secondly, the study only focussed on four village communities and a limited set of regulating, cultural and supporting ESs, while other villages in the province could have also been studied. Future research could investigate other potential villages as well as other regulating and cultural ESs such as places used for burial sites, cultural practices and initiations. Thirdly, the information on the frequency of use was documented on "average monthly basis" to account for probable seasonal variations. Thus, we could not consider the possible implications of the temporal or spatial variability within the results, especially with regards to the relevant aspects such as climate and geographical constraints. Future studies would benefit from assessing such temporal variations in more details.

5. Conclusion and implications for local development planning

This research assessed the importance and use of ESs by local inhabitants in Limpopo (South Africa), and revealed how socio-economic factors such as age, gender, income and prior recreational/touristic experiences were associated with the perceived importance. Furthermore, the study highlighted that participants' perceptions about importance of ESs were consistent with the actual use of these services. Therefore, the results could be used to propose some institutional actions in a context of local development planning. First, the lower importance value attributed to regulating and cultural ESs (compared with provisioning ESs), suggests that new local development planning should favour, in addition to the supply of provisioning ESs, an explicit recognition of regulating and cultural ESs. As prior recreational/touristic experiences increase the probability that local stakeholders assign high importance value to cultural ESs, recreational areas should also be promoted in rural localities to increase people's interest in these ESs. Secondly, participative actions involving local populations (young people, women and households close to the forests), land managers and

decision-makers could be taken to increase the awareness on importance of ESs and develop win-win scenarios for a sustainable use of these services and the benefits of future generations. Finally, our findings support the need for management interventions that aim at restoring the native vegetation on the degraded lands. Restoration of the native vegetation could be achieved by (i) identifying suitable lands for community forests; (ii) planting forests in close proximity of natural areas to offer alternative fuelwood source and create more local employment opportunities; (iii) training local people on the sustainable management and protection of these forests against fire and degradation; and (iv) improving the access to electricity and markets.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ecoser.2016.10.018](https://doi.org/10.1016/j.ecoser.2016.10.018).

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