Dependence on Environmental Resources and Implications for household Welfare: Evidence from the Kalahari Drylands, South Africa

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Abstract

This paper examines dependence on environmental resources and impacts on household welfare among the indigenous San and Mier rural communities neighbouring Kgalagadi Transfrontier Park in the arid Kalahari region, South Africa. Data on the various household income types, including environmental income, were collected through a structured survey of 200 households. Environmental income constituted 20% of total income, indicating a substantial dependence on environmental resources. The poorest income quintile had the highest environmental income share (31%), though absolute income from environmental resources increased with total income. Analysis of household income with and without environmental income shows that environmental resources shield households, especially the low-income ones, from poverty. Further, Gini-coefficient analyses revealed an important income inequality reduction potential of environmental resources among households. Given the current proposal to grant local communities access to environmental resources inside the Kgalagadi Transfrontier Park, our results predict household welfare improvements from such a proposal. However, the findings underscore the need to sustainably manage environmental resources (access and extraction) inside and outside the park to balance ecological and socio-economic needs.

Key words: Kalahari drylands; environmental resources; indigenous people; dependence; income diversification; household welfare.

1 Introduction

Since the seminal work of Cavendish (2000) in the woodlands of Zimbabwe, interest on economic reliance on environmental resources and associated implications

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for household welfare has been growing. There is now increasingly shared interest in understanding how rural households in developing countries depend on goods and services provided by environmental resources (Pattanayak and Sills, 2001; Cavendish and Campbell, 2002; Shackleton and Shackleton, 2004; Mamo et al., 2007; Thondhlana et al., 2012). It has been argued that empirical investigations of rural people's dependence on environmental resources may help improve macro-level estimates of income inequalities, poverty alleviation and conservation planning (Cavendish, 2000; Fisher, 2004). Contemporary development strategies now realize the opportunity to achieve poverty reduction objectives through the use of environmental resources, and ecological economists, in particular, seek to demonstrate the importance of environmental resources to household welfare. According to Mamo et al. (2007), the quantification of environmental income may serve as an input into conservation policy, by determining the potential loss to rural dwellers of limited access to environmental resources.

In demonstrating the role of environmental resources to rural households, Vedeld et al. (2007) show in a meta-study of 54 case studies world-wide that the average total income share derived from forest environmental resources was 22%. A similar study in Latin America by Coomes et al. (2004) indicate that environmental resources contributed around 20% to total household income. Of particular interest and importance in environment-household welfare relationships is the impact of environmental income on poverty alleviation and income inequality (e.g. Cavendish, 1999; Fisher, 2004; Mamo et al., 2007). Empirical evidence on the role of environmental resources in poverty alleviation has yielded mixed conclusions because of the potentially conflicting impacts that environmental resources can generate. On the one hand, environmental resources may prevent poverty by functioning as safety nets (Shackleton et al., 2008) or reduce poverty through high earnings (e.g. Fisher, 2004). It is also argued that wealthier households derive substantially higher absolute income but the poor are the most dependent on environmental resources such that they are the most vulnerable in the face of resource degradation (Cavendish, 2000; Campbell and Luckert, 2002). On the other hand, there is much evidence that shows that most of the poorest people globally are primarily engaged and locked into environmental resource use which potentially perpetuates poverty (e.g. Pattanayak and Sills, 2001).

The use of and dependence on freely available environmental resources is conditioned by household-specific characteristics and contextual factors. For instance, larger households may harvest more environmental resources because they have more mouths to feed and people to harvest resources (Godoy et al., 1997). The age of household head may be positively related to environmental income until a point where environmental resource use declines with age, coupled with children moving away to seek new opportunities and start their own households elsewhere. However, households with older heads and members may extract more resources than those with younger household heads as they may possess more ecological knowledge regarding maximum harvesting of certain resources such as medicinal plants, wild food plants and wild game (Mamo et al., 2007). With regards to education, well-educated household heads may have the capacity to harvest more environmental resources than uneducated ones. However, other findings show that as household heads get more educated, resource use declines as the opportunity costs of labour increases (e.g. Adhikari et al., 2004). Total household income is often found to have a non-linear relationship with environmental income (Mamo et al., 2007), but the conventional wisdom is that with more total income, households tend to reduce dependence on environmental resources. However, a good asset endowment may increase the capacity to tap more from the environment. In reality, most of the factors that influence environmental income are household- and context-specific and hence vary from place to place.

One of the main reasons behind environmental resource use is income diversification. It is now well documented that income diversification is a key characteristic of rural livelihoods (e.g. Barrett et al., 2001). There are several explanations behind income diversification. On the one hand, income diversification can be used to reduce risk though this explanation is disputed since fluctuations in income sources tend to be correlated, such that diversification cannot be touted as an effective risk-reduction strategy (Dercon, 2000). On the other hand, evidence shows that environmental resources are often used as an income (not livelihood) diversification strategy by wealthy households to accumulate more wealth while poor households utilise resources out of necessity (Vedeld et al., 2007).

To the best of our knowledge, most valuation studies in South Africa are based on agrarian-based societies. Further, there is limited understanding of the links between environmental resource use and poverty issues especially among typically indigenous communities. In this paper, we attempt to address this gap by exploring the links between environmental resources and household welfare among the #Khomani San and Mier communities of southern Kalahari, widely considered the last indigenous people of South Africa (Lee, 2001; Chennells, 2009; Thondhlana et al., 2011).[1] The San are the aboriginal people of South Africa and their distinct hunter-gatherer culture stretches over millennia while the Mier are traditionally livestock farmers. Specifically, the study analyses dependence on and the distributional profile of environmental income, and the impacts of environmental income on poverty and income inequality. It also examines how environmental income is conditioned by various household and community socio-economic factors.

[1] The term #Khomani San was coined to represent members from a diverse set of San ethnic groups who together lodged a land claim in Kgalagadi Transfrontier Park. This group is often refered to as the San or bushmen in the literature. The original land claimants were the Kruiper family members but other San members were allowed to join the initial land claimants to make up the required number to claim a large piece of land (Holden, 2007).

2 Description of study area and local communities

Data for the study is based on household surveys among the indigenous San and Mier communities of southern Kalahari, South Africa. These communities live adjacent to the Kgalagadi Transfrontier Park (KTP), the first peace park in Africa, situated in the Northern Cape province of South Africa and into Botswana from 22 ° 10" East, 20 ° 0" West, 24 ° 6" North and 26 ° 28" South (Figure 1). The Northern Cape is the largest but driest province in South Africa and with an average rainfall of less than 200 mm per year, crop production is virtually impossible without irrigation. Mucina and Rutherford (2006) describe the Kalahari vegetation type as a mosaic of karroid bushveld, thornveld and shrubby grasslands characterised by the presence of small trees, tall shrubs, low shrubs, herbs, succulent herbs and grasses. The area under study is sparsely populated, located about 200 km away from the nearest major town (Upington) and with limited markets. The region ranks among the highest in terms of poverty incidence and income inequalities (Jacobs et al., 2009).

The San people, the earliest inhabitants of the southern African sub-continent (Lee, 2001), settled in the Kalahari drylands after they were pushed from their ancestral land by European and Bantu settlers in the 1800's. This was compounded when the KTP was created and the San were further marginalised. While some continued to hunt wild animals and gather plants on traditional land, others eked out humble lives in rural poverty, working for low wages on neighbouring farms (Chennells, 2009). The mixed race, Mier community of the Kalahari mainly originated from the people of Captain Vilander who fled British rule in the Cape Colony in 1865 (SANParks, 2006). They are believed to have settled in the Kalahari, displacing the San in the process. Most Mier people were predominantly farmers, with cattle, sheep and goat husbandry forming their main source of livelihoods – a practice still common today. The Mier were in turn displaced to pave way for the creation of the Kalahari Gemsbok National Park (now KTP).

With the onset of democracy in South Africa in 1994, the San and Mier communities lodged a land claim in the KTP in line with the government's land restitution programme. The land restitution programme aims to improve rural household welfare and alleviate poverty of those people marginalised by systems of segregation and discrimination (Bradstock, 2006), through restoration and use of land and its resources. In 1999 the two communities were allocated more than 80 000 hectares of resettlement farms outside the KTP and a further 50 000 hectares of land in the KTP. There are no readily available official figures but there were an estimated 163 San households or 1 000 people (Bradstock, 2006) and 6 000 Mier households at the time of the land-claim. The San's 8 resettlement farms are divided for various activities including game farming (Miershoop Pan), traditional purposes and ecotourism (Witdraai, Erin, Sonderwater and Rolletjies), subsistence use (Uitkoms) and livestock farming (Scotty's Fort and Andriesvale) (Figure 1). The Mier farms located in areas such as Rietfontein, Askham and Welkom consist of privately and communally-owned land. The private farms are either family farms or land leased from the local Mier Municipality to individuals with a chance to buy the farm after convincing the Municipality that they can manage the land and run livestock businesses viably and sustainably.

Land ownership and access rights in the KTP land parcel is divided as follows: (a) 2 San and Mier Heritage lands belonging to San and Mier communities but jointly managed as a Contract Park[2] with SANParks (b) Commercial Zone, belonging to SANParks but with San access for commercial joint venture use (e.g. eco-tourism) with SANParks, (c) Symbolic and Cultural Zone belonging to SANParks but with San access for uses such as visiting culturally and symbolically important sites, traditional gathering of food and medicines and educational trips. The lives of the majority of San and Mier people are directly and indirectly linked with land-based livelihood activities such as environmental resource use and livestock production. The study sets a context for testing whether or not the dependence on environmental resources by typically indigenous communities (and impacts on their welfare) is different from studies elsewhere.

3 Methods

3.1 Data collection

Data were collected using structured household surveys (between August 2009 and August 2010) and environmental resource use diaries (between September 2010 and April 2011) to generate income accounts for the combined San and Mier households. The communities generally perceived the survey period to be characterised by drier spells relative to preceding years, hence there is a potential for understating environmental income estimates. In this study, environmental income is operationally defined as the sum of subsistence and cash income from wild natural resources including wild foods, medicinal plants, fuelwood, bushmeat and crafts (see Sjaastad et al., 2005). Though some environmental resources have many categories of value, this survey only captured direct-use values.

The study focused on environmental resource use on the resettlement farms where all resources are harvested. Households were purposely selected for interviews on the basis of being part of San or Mier community group that benefitted from the 1999 land claim. These claimants are the descendents of the original San and Mier inhabitants. All San households who resided on the farms during the research period were interviewed, including a few households who resided in small settlements away from the farms, such as Welkom, Ashkam and Rietfontein (but known to be part of the #Khomani San). In those locations

[2]Contract Parks are defined as protected areas developed on government-, privately-, or community-owned land and managed through a co-management agreement with the private individuals or community through a joint management board (JMB).

(Ashkam, Welkom and Rietfontein) where San households were difficult to identify due to integration with Mier households, the snowball approach was used to identify such households[3]. In total, 100 San respondents were surveyed. A similar number of Mier households (100) were randomly selected for interviews.

The first part of the questionnaire captured the socio-economic characteristics of the households. The household survey targeted household heads (decision makers) for interviews. In the absence of household heads, adult household members who had knowledge about their household characteristics were interviewed. Thus, all responses were assumed as coming from the heads in the analyses. The environmental resource use section collected information on all the types of resources harvested, volumes of harvest, harvesting frequency, harvesting location, the use of resources, whether or not the harvest was for the market, and the associated price if marketed. The main natural resources harvested were fuelwood, medicinal plants and bush meat. The total amount of fuelwood harvested pear year was determined after adding 30 % of reported quantities to reflect increased usage during the winter season in line with other studies (e.g. Mmopelwa et al., 2009). The value of environmental resources was estimated using a market-based method (see Thondhlana et al., 2012). We used prices from a small shop that sells herbal products to local people to estimate the direct-use value of medicinal plants. The quantity of bush meat consumed was recorded, including data on whether the bushmeat was hunted, purchased or given as a gift. The direct-use value of bush meat was then estimated using prices from local shops (at Andriesvale).

To validate environmental resource use survey data, resource use diaries were administered. Twenty-five households (from the original samples) in each community were randomly selected to participate in the resource use recording exercise. The diaries were filled in for three months with close supervison from the researcher[4]. Only firewood and bushmeat categories were commonly filled. This is because most resources such as medicinal plants, wild foods, grass and camel thorn (*Acacia erioloba*) seed are infrequently collected depending on household needs. Key informant interviews were abitrarily conducted with traditional leaders, herbalists and elderly respondents to get insights on the intangible values of te environmental resources used.

Information on the type and size of livestock herds was captured, and the net value of the subsistence and commercial uses of livestock products and services was calculated, following Shackleton et al. (2005). The costs of livestock production included buying extra food, medicines and hiring herders, etc. Other non-environmental income sources for households (wages, remittances and social grants) were also captured to determine the average share of environmental

[3]The snowball approach can potentially result in sample selection bias. However, in this case, the affected respondents constitute a very small sub-sample (10%) and the approach is unlikely to affect the results in a significant way.

[4]A significant proportion of households (72%) managed to complete the diaries unaided. In cases where households had blank diaries due to not recording resource-use activities on a regular basis during the day, daily-recalls were used for filling in the blanks with the help of the research assistants. This was expected due to the high levels of illiteracy within the sampled communities (see Menton et al. 2010).

income per year. In our calculations, we did not incorporate the opportunity costs of labour as deducting these in situations of low earning skills and negligible labour opportunities can be misleading (Gram, 2001). All the reported income values in this study are estimated at a net income basis (after deduction of the cash costs associated with each income source) and values are reported in South African Rands. The average exchange rate between the South African Rand (ZAR) and the U.S. Dollar was roughly U.S. \$1.00 = ZAR7.5 during the data collection period.

3.2 Data analyses

Income quintiles were used to distinguish between absolute and relative environmental income among the different wealth groups. Sample households were divided into five income quintiles (n=40 each), operationally categorized as first, second, third, fourth and fifth quintiles respectively. We used a headcount index and poverty gap index to measure the proportion of poor households and the depth of poverty with and without environmental income respectively. The poverty gap index adds up the extent to which individuals on average fall below the poverty line, and expresses it as a percentage of the poverty line. It puts more emphasis on the poorest of the poor (Leibbrandt et al., 2010). The poverty gap index was calculated as the poverty gap (Gi) [poverty line (z) less average actual income (yi) for individuals], expressed as a percentage of the poverty line (z).The study adopted net household per capita income as the income measure, as it was the most easily comparable across the datasets available. While there is a plethora of poverty measures in the poverty literature, we used a 2008 rural poverty line of ZAR6 180 per capita per year (or ZAR515 per month) in line with other studies (e.g. Leibbrandt et al., 2010). The Gini coefficient was computed to assess whether environmental resources had income equalizing effects. Environmental resources have an income equalizing effect if the Gini coefficient decreases with environmental income.

The Gini-coefficient was calculated as follows:

$$G = \frac{2cov(y, r_y)}{n\bar{y}}$$

Where cov(y,r_y) is the covariance between income (y) and ranks of all individuals according to income (r_y), ranking from the poorest individual (rank = 1) to the richest (rank = N). N is the total number of individuals and $\bar{y}$ is mean income.

A Herfindahl index was used for measuring the level of income diversification, through an examination of the degree of household income concentration (scattered-ness) into various income sources. The Herfindahl index was constructed as the sum of squares of the shares of different income sources in the household income portfolio (McConnell et al., 2009). In equation form,

$$\text{Herfindahl index} = (\%S_1)^2 + (\%S_2)^2 + (\%S_3)^2 + \ldots .. + (\%S_n)^2$$

Where $\%S_1$ is the percentage share of income source 1, $\%S_2$ is the percentage share of income source 2, and so on for each of the n income sources. By squaring the percentage share of all income sources, the index purposely gives much greater weight to larger and more important income sources than to less important ones. Households with diversified income portfolios will have a low index close to 0, and the least diversified income portfolios are associated with a high index, close to 1.

An Ordinary Least Squares (OLS) approach was used to estimate the effect of selected explanatory variables on environmental income though the occurrence of some extreme values on predictor variables could suggest use of censored regression approach (tobit) estimated with maximum likelihood techniques. However, using a censored approach did not yield improved model fit. Household and household head characteristics such as non-farm income, age, education, gender, household size, membership in organisations and value of livestock herd among others were regressed against environmental income. The expected signs of explanatory variables' coefficients were based on past studies, economic theory and logical reasons.

4 Results and discussion

4.1 Socio-economic characteristics of the respondents and households

The majority of households were male-headed (65%). The mean household size was 5.2±2.7 and the mean age of household head was 49.8±15 years. With regards to education level, the average time spent in schools was very low (4.3±4.3 years). About 39% of all interviewed respondents did not have primary level education and most respondents did not complete primary education, hence illiteracy levels were high. As little as 9% of all respondents completed high school (matric) such that the majority of the household heads did not qualify for work in formal employment schemes. Most respondents were either not employed or temporarily employed as farm workers, cleaners, builders and waitresses in nearby commercial farms, privately-owned business enterprises such as lodges or in the KTP. Only a few were employed in paid public services such as education and health.

4.2 Different income sources

Households had several income sources with substantial variation in magnitude and contribution to total income (Table 1). Mean household income across all income sources was ZAR35 631 (about ZAR6 842 per capita) per year, slightly above the poverty line of ZAR6180 per capita per year (STATS SA, 2012). The estimated annual household income may hide huge differences in household welfare between and within groups. For example, households in the fifth quintile derived more income from most livelihood sources they engaged in, on average showing 11 times more absolute income than those in the first quintile. Out of the calculated mean household income, wages contributed the highest (36%), followed by social grants (27%) - which is consistent with the STATS SA 2010/2011 findings. In both communities, wage employment predominantly covered a range of unskilled farm and non-farm jobs, while self-employment included craft-making and selling, car-fixing and fence maintenance. On average households derived around ZAR6 925 (20% of total income) per year from environmental income. Environmental resources and social grants provided income for 89% and 73% of households respectively. Social grants (child maintenance, disability, child foster and old age grants) are considered be an important source of livelihoods within poor households of South Africa (National Planning Commission, 2010; SPII, 2012). According to Shackleton et al. (2008), in general, areas which are more dependent on government welfare grants are associated with high poverty, owing to lack of formal employment opportunities. Leibrandtt et al. (2010) suggest that the number of poor households would rise in the absence of social grants.

Livestock income contributed about 14% to total income. Livestock farming was predominantly on a subsistence basis and farmers only sold when there was cash need. Forty-five percent of all the sample households owned livestock (cattle, sheep and goats), but more Mier households (52%) had livestock than the San (38%). Small stock production was a common activity among many livestock-owning households as illustrated by a higher number of sheep (107±197) and goats (38±57) than cattle (6±16). Remittances were received by a few households (17%) and contributed the least to total household income.

When disaggregated by income quintiles, the pattern emerging from the findings is that of uneven dependence on different income sources (Table 1). The contribution of wages increased from the first quintile to the fifth quintile in absolute and relative terms. By contrast, social grants income was most important for quintile one (48%), but decreased with income to just 13% for the fifth quintile. With regards to livestock income, dependence generally increased with income. The fifth quintile derived higher absolute income and a higher proportion of their income from livestock products and services than all the other quintiles. Income share from environmental resources was highest (31%) for the first quintile and decreased with income (non-linearly) to 18% for the fifth quintile. However, the fifth quintile derived roughly two to six times more income from environmental resources than the other income quintiles. This confirms the hypothesis that poor households depend more on environmental resources though the well-off may extract more from these in absolute terms as reported by Cavendish (2000), Fisher (2004) and Narain et al. (2005) among others.

4.3 Key sources of environmental income

Environmental income in the study area includes natural resource-based earnings and resources consumed at household level such as fuelwood, medicinal plants, bushmeat and wild foods (Table 2). On average, the value of fuelwood was ZAR5 460 per household per year, compared with the mean environmental income of ZAR6 950. This means that fuelwood alone, constituted almost 80% of total environmental income (Table 2). Fuelwood is particularly important because 86 % of all sample households used fuelwood for cooking and heating. This was due to either necessity or the desire to minimise electricity costs. Around 50% of the sample population had access to electricity, which is lower than the provincial average of 78.5% (National Planning Commission, 2010). Out of the households with access to electricity, almost half benefitted from free basic electricity units. In South Africa, free basic electricity is the amount of electricity considered sufficient to provide basic energy needs (lighting, media access, ironing and water heating) to poor households estimated at 40kwh per month. Only 11% of households reported harvesting of fuelwood for sale and the overall reported cash share of environmental income was less than 20%, illustrating a largely subsistence-based environmental income extraction. However, it is important to note that it is a challenging task to fully assess the full value of fuelwood sales, as information was not readily provided due to the illegal nature of commercialisation activities. Almost half (44%) of the respondents reported that they now spent more time during fuelwood collecting trips than they did a few years ago, suggesting overharvesting of fuelwood resources, notably harvesting of the nationally regulated camel thorn tree for commercial purposes (see Thondhlana et al., 2011, Thondhlana 2011, Anderson and Anderson undated).

The second major contributor to environmental income was crafts made from natural materials (13%), though analysis showed that this was only practiced by only 17% of mainly poor San households. Total income from bushmeat, wild food plants and medicinal plants ranged from less than ZAR1 to ZAR497 per year. Thus, the relative contribution to total environmental income was generally small. Medicinal plants were used by about 60% of the households while bushmeat hunting was reported by just 39% of the respondents (mostly San households). Interviews with key informants however revealed that the cultural values attached to crafts, bushmeat, wild foods and medicinal plants are important especially for the San, despite the low economic values reported.

4.4 Environmental income and household welfare

The proportion of people (for pooled households) living below the poverty line increased from 60% to 72% with and without environmental income component respectively (Table 3). Poverty severity respectively increases from 47% to 54% with and without environmental income. However, it is likely that analysis by pooled data could shield disparities within income groups and the figures (of households living below the poverty line) could be relatively low due to the influence of a few well-off households who get high income from other sources such as wages, game farming or livestock.

Decomposition by income quintiles revealed that, on average, all people in the first, second and third quintiles live below the poverty line even with environmental income. While no person in the fourth and fifth quintile lives below the poverty line, 45% and 13% of the people respectively will be poor without environmental income. Poverty depth increases for people in all the households except for the fifth quintile if environmental income is excluded. While poverty gap index increases by up to 9% for the first, second and fourth quintiles, the third quintile shows a substantial increase of up to 16% without environmental income (Table 3). The first quintile still shows the highest poverty gap index. The increases in the proportion of poor households and poverty gap suggest the use of environmental resources is important in reducing not only the number of poor people but the depth of poverty among rural households, particularly the poorest ones. Overall, our findings support the contention that rural households are generally highly dependent on environmental resources, and poor households in particular are more dependent on environmental resources than the well-off.

4.5 Environmental resource use and income distribution

The Gini coefficient of total household income was calculated without income from interventions (state social grants and environmental income). Following this, a Gini coefficient was then estimated, with social grants but excluding environmental income. The calculated Gini coefficient without interventions was 0.38, but rose to 0.51 with social grants, suggesting that other interventions aimed at reducing income inequalities at national levels such as the South African Government social grants programme, could inadvertently result in localised income disparities. In South Africa, pension grants, disabled persons grants and child grants are only paid to people who are either unemployed or get less than ZAR2 500 per month, physical challenged, above 60 years old and whose children are under 18 years respectively. However, not all household members are eligible for these grants, creating localised income inequalities.

Nevertheless, these localised income disparities are reduced, through the use of environmental resources. The calculated Gini coefficient with environmental income went down from 0.51 to 0.45, which is lower than the Northern Cape provincial average of approximately 0.58 (National Planning Commission, 2010). The percentage point reduction (0.06) in income inequality is close to that found in Uganda (5%) (Tumusiime et al., 2011), but lower that the 30% reduction in Zimbabwe (Cavendish, 1999). The findings generally suggest that environmental resource use contribute to income inequality reduction but may still be little appreciated in provincial poverty assessments or by decision makers. Typically the measures of household income reported in most studies do not include income from environmental resources, often resulting in underestimation of rural household income (Moyo et al., nd). This is a potentially grave omission given that most studies show that many rural households, especially the poorest, depend on environmental resources for their livelihoods (e.g. Cavendish, 2000; Thondhlana et al., 2012).

4.6 Environmental resources and income diversification

Table 4 explores the variation of the Herfindahl indices of household income concentration with and without environmental income by pooled data and income quintiles. The

Herfindahl index for pooled data fell from 0.34 to below 0.25 with environmental income, implying that income from environmental resources were generally used as an income diversification strategy. An analysis of household diversification index against different income quintiles showed that the first quintile had the highest index reduction (0.18), followed by the third quintile (0.12) when environmental income was included. This index reduction generally confirms our findings that the poorest depend more on environmental income than the wealthy households. However, the 0.10 index reduction for both the fourth and fifth quintiles suggests that well-off households also diversify their income through participation in environmental resource use activities consistent with other studies (e.g. Barrett et al., 2001). In this study context, well-off households generally had more non-farm income (wages, remittances, social grants and livestock income) than poorer households – which could have provided easy entry into and increased extraction of environmental resource use for both household use and commercialization (of fuelwood). A closer look at the different environmental resource-based income sources, show that poor people primarily engaged in low return activities such as low-wage casual employment, film appearances, craft making and subsistence use as they could not break income barriers into high-return activities (Thondhlana et al., 2012). This desperation-led diversification (Barret et al., 2001) may neither reduce the risk of income variability nor increase incomes (Moyo et al., nd). Literature suggests that high-income households generally see environmental resource use as an opportunity to diversify and accumulate income while poor households diversify their income through resource use to be cushioned against poverty (e.g. Mamo et al., 2007; Kamanga et al., 2009; Uberhuaga et al., 2011).

4.7 Determinants of environmental income

Membership to the San community group, mode of fuelwood transportation and income quintiles; poor (middle), less-poor (higher) and well-off (highest) were positively and significantly related to environmental income (Table 5), while age of household head, non-farm income and livestock value yielded negative relationships. The latter two support the hypothesis that high non-farm income reduces the need for environmental income but would seem to contradict our earlier findings that well-off households extracted more environmental resources. The contradiction could be due to the fact that non-farm income does not take into account income from assets such as livestock. However, regressing income quintiles against environmental income yielded positive relationships. According to Nielsen et al. (2012) combining income and assets such as livestock provides a more realistic picture on environmental income dependence. Education and gender of household head, household size, membership in organisations, access to electricity and number of household assets did not yield significant results.

As expected, being a member of San group resulted in a significantly higher environmental income (t =4.058; $p < 0.001$) than being Mier, in line with their respective traditional modes of survival and access to basic services. The San are traditionally hunters and gatherers while the Mier are livestock farmers (Lee, 2001; Thondhlana et al., 2011). Environmental resources such as bushmeat, medicinal plants and wild plant foods were used by a higher proportion of the San households than the Mier and were highly valued for their cultural values especially by the more 'traditionalist' San groups (Thondhlana et al., 2012).The Mier people are generally involved in wage employment and livestock production as livelihood sources. To the contrary, the San do not generally work for other people and when they work for themselves, the work involves resource utilisation. Further, only 12 % of the San households had access to electricity compared to the Mier's 87%. Thus, the San use more fuelwood as a primary energy source than the Mier (as noted, fuelwood is the major environmental income contributor).

The mode of fuelwood transportation influenced environmental income in the study area, simply because households with cars and donkey carts harvested and transported more fuelwood with ease, than those who had to carry it on their heads. This confirms the hypothesis that better asset endowments allow households to exploit more environmental resources (e.g. Kamanga et al., 2009). Key informant surveys revealed that high-income households were interested in fuelwood harvesting because it offered good cash income opportunities (it has a ready local market amongst tourists who visit the nearby Kgalagadi Transfrontier Park).

With regards to age, the Kalahari environment is dry and trees and other resource are spatially distributed that physical strength is needed to harvest these resources. Thus, it is expected that as age increases, resource extraction decreases due to a decline in physical strength. In the study area, many households with older members (60 years and above) were small, in part, due to children moving away to seek new opportunities in towns and cities or to start their own households. Further, most of the households with old members received social grants that cushioned them against poverty. Thus, the demand for resources in these households was low.

5 Conclusion and policy issues

This paper explores the contribution of environmental resources to the welfare of indigenous San and Mier communities of southern Kalahari, South Africa. The communities under study are generally characterised by heterogeneity with regards to their income levels and income shares from different sources, poverty levels, dependence on and motivation for environmental resource use. With an income share of 20% from and a higher proportion of households (89%) making use of environmental resources, our findings imply that dependence on environmental resources by indigenous communities of South Africa is similar to findings elsewhere and that many rural dwellers are highly dependent on environmental income to sustain their welfare (Narain et al. 2005; Vedeld et al. 2007; Tumusiime et al., 2011); Uberhuaga et al. 2011 In the study area, environmental income is characterised by several sources but fuelwood is the dominant natural resource contributor, which is consistent with other studies (e.g. Fisher 2004; Mamo et al. 2007).

Overall, environmental resources provide more subsistence "in kind" income than cash income to local people. Environmental income reduces income inequalities and poverty (in terms of both poverty incidence and depth) - acting as insurance against falling deeper into poverty especially for many poorer households. Environmental income acts as an important "buffer" against household shocks (reduces society's vulnerability) especially in and during times of change and crisis. However, the buffering effect of environmental income – particularly of the "in kind" contribution, derived from ecosystem goods and services, is rarely acknowledged. Yet, as our results suggest, the "in kind" contribution of such environmental resources is very high and meaningful – which is consistent with results found by Libanda and Blignaut, (2008) in Namibia's community based natural resource management areas. The food, income and fuel/energy security provided by environmental resources adds to the value thereof, and reduces people's vulnerability.

From a policy perspective, the findings generally imply that promoting and allowing resource access in the KTP can potentially contribute towards reducing poverty and livelihood insecurity for the local communities. However, resource use rules in the KTP currently do not permit collection of a wide range of resources including fuelwood, though our results show that fuelwood is the most important source of environmental income. We believe current resource access arrangements in the KTP need to be revised (e.g. permission of collection of dead fuelwood) to balance intersecting livelihood and conservation needs. Lack of access to income from fuelwood and other resources may force local people to prioritise extraction within their immediate environment for short-term benefits over long-term sustainability of the environment. This may result in future pressure on KTP resources, especially given that local communities have ownership and use rights in part of the park. Nonetheless, resource access should be designed with input from resource users to avoid potential overharvesting of environmental resources due to fears by users that they may not be allowed access again. This is particularly important given the fragility of the semi-arid Kalahari ecosystem (Mogotsi et al., 2011) that our results suggest unsustainable harvesting practices in the communally-owned resettlement farms. Immediate attention should be focussed on the communal land given the ecological linkages between parks and their surroundings.

When disaggregated by income quintiles, dependence on environmental income is disproportionate as poor households showed higher income shares from environmental resource extraction than well-off households, though the later tapped more absolute income as found elsewhere (e.g. Cavendish, 2000; Shackleton and Shackleton, 2006; Kamanga et al., 2009). Economic challenges such as a lack of job opportunities and low wages may mean that certain resource types with high returns such as fuelwood become more attractive and valuable such that the well-off groups of people will maximise their extraction to supplement their incomes. Poorer households are unable to break entry barriers (e.g. costs, assets) into high return activities, with the result that they will be locked in a poverty cycle. Therefore, for a balanced environmental conservation policy inside and outside the KTP, differential patterns of environmental income across income groups should be considered. Specifically, resource use designs should be pro-poor to avoid marginalisation of the poor by the relatively better capacitated households.

Further, conservation policies targeted at improving resource use, such as the one proposed by the KTP should be tailor-made to suit inter-community heterogeneity. For example, the San community showed more resource use than the Mier due to their history of close association with nature. However, environmental resource use cannot be considered as the panacea to poverty reduction, but should be complimented by alternative sources of income and innovative programmes including improved access to proper job opportunities, credit and market facilities for livestock production, payment for ecosystem services (e.g. eco-tourism) as suggested by Dikgang and Muchapondwa (2012) and provision of alternative energy sources to reduce heavy dependence on the environment. Such efforts can provide poor households with a means to escape poverty and become relatively well-off, while maintaining the resource base that sustains the livelihoods of the rural people.

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Table 1: Mean annual net household income and % share (in parenthesis) of total income by source for pooled data and quintiles

Income source	% of households receiving income source	All households (n=200)	Income quintiles					ANOVA test (F)
			Poorest (n=40)	Poorer (n=40)	Poor (n=40)	Less-poor (n=40)	Well-off (n=40)	
Wages	42	12 732 (*36*)	1 010[a] (*13*)	3 569 (*21*)	7 181 (*27*)	9 490 (*25*)	41 520[b] (*47*)	7.09***
Remittances	17	1 217 (*3*)	185 (*2*)	1 426 (*9*)	351 (*1*)	1 612 (*4*)	2 517 (*3*)	2.44**
Social grants	73	9 679 (*27*)	3 798[a] (*48*)	7 305[a] (*44*)	11 368[b] (*43*)	14 554[b] (*38*)	11 359[b] (*13*)	8.88***
Livestock	45	5 053 (*14*)	465[a] (*6*)	2 003[a] (*12*)	2 468[a] (*9*)	3 520 (*9*)	16 533[b] (19)	10.82***
Environmental resources	89	6 950 (*20*)	2 494[a] (*31*)	2 443[a] (*15*)	5 016[a] (*19*)	8 928[b] (*23*)	15 635[b] (*18*)	11.61***
Mean total income per household per annum	-	35 631	7 952[a]	16 746[b]	26 384[c]	38 104[d]	87 564[e]	29.94***

***, ** indicate 1% and 5% level of significance respectively; [a,b,c,d,e] means significantly different between income groups ($p<0.05$)

Table 2: Key sources of environmental income

Source	Mean net annual household income ±SE (in ZAR)	Contribution to environmental income (%)
Fuelwood	5 460±733	79
Crafts	888±215	13
Bush meat	497±164	7
Medicinal plants	101±70	1
Wild plant foods	0±1	<1
All sources combined	6 950±818	100

Table 3: Headcount poverty rates and poverty gap indices with and without environmental income, assuming an annual poverty line of ZAR6 180 per capita

Unit of analysis	With Environmental income			Without Environmental Income		
	Mean income per capita	Poverty head count index (%)	Poverty gap index (%)	Mean income per capita	Poverty head count index (%)	Poverty gap index (%)
All households *(n=200)*	ZAR6 852	60	47	ZAR5 516	72	54
1st quintile *(n=40)*	ZAR1 528	100	75	ZAR1 048	100	83
2nd quintile *(n=40)*	ZAR3 220	100	48	ZAR2 750	100	56
3rd quintile *(n=40)*	ZAR5 074	100	18	ZAR4 109	100	34
4th quintile *(n=40)*	ZAR7 315	0	0	ZAR5 598	45	9
5th quintile *(n=40)*	ZAR16 839	0	0	ZAR13 832	13	0

Table 4: Herfindal index with and without Environmental Income for all households and income quintiles

Herfindal index	**All households**	**Quintile**				
		First	Second	Third	Fourth	Fifth
HI with Environmental Income	0.34	0.53	0.35	0.41	0.37	0.41
HI without Environmental Income	0.22	0.35	0.28	0.30	0.27	0.31

Table 5: OLS regression of environmental income against socio-characteristics for pooled data

	Expected sign	Coefficient	Standard Error	t	p-value
Intercept		4132.90	3548.007	1.16485	0.245587
Social-demographic variables Age of household head	-	-106.88	51.122	-2.09061	0.037937*
Education (in years) of household head	-	-39.55	175.268	-0.22564	0.821731
Gender of household head (Dummy 1= Male; 0 = female)	+	-776.66	1358.309	-0.57179	0.568164
Household size	+	262.30	239.565	1.09489	0.274996
Community group (Dummy 1= San; 0 = Mier)	+	4869.01	1935.700	2.51538	0.012747*
Membership in organisations (Dummy 1= membership; 0 = non-membership)	+	-1319.76	1814.457	-0.72736	0.467931
Household income and assets Non-farm income	+	-0.05	0.017	-3.12739	0.002051**
Household income Lower 20%-2nd quintile Dummy = 1 if household income is lower 20%	+	446.24	1777.987	0.25098	0.802109
Middle 20%-3rd quintile Dummy =1 if household income is middle 20%	+	-200.56	1896.969	2.16268	0.031856*
Higher 20%-4th quintile Dummy = 1 if household income is higher 20%	+	4102.54	1610.061	2.35390	0.019632*
Highest 20%-5th quintile Dummy = 1 if household income is highest 20%	+	3789.93	2283.691	7.17776	0.000000***
Livestock value	+	-0.02	0.008	-2.43831	0.015706*
Means of fuelwood transportation (Dummy 1= Donkey cart or car; Head = 0)[1]	+	9952.63	1437.038	6.92579	0.000000***
Access to electricity (Dummy 1= Have electricity; 0 = No electricity)	-	-1531.80	1980.122	-0.77359	0.440168
Number of household assets	-	-200.56	232.919	-0.86105	0.390332

***, **, *Represent 1%, 5% and 10% levels of significance respectively.

[1] The biases that result from endogeneity problems are noted, especially with respect to asset ownership. For example households with donkey carts or cars may collect more fuelwood but those who collect more may also get a donkey cart or car.

Figure 1: Location of Kgalagadi Transfrontier Park and the surrounding resettlement farms