Effects of Wildlife Resources on Community Welfare: Income, Poverty and Inequality

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Abstract

This paper demonstrates the importance of wildlife in the portfolio of environmental income in the livelihoods of poor rural communities living adjacent to a national park. The results show that wealthier households consumed more wildlife products in total than relatively poor households. However, poorer households derive greater benefit from the consumption of wildlife resources than wealthier households. Excluding wildlife compromised the relative contribution of environmental resources while at the same time increasing the relative contribution of farm and wage income. Environmental income had more impact in terms of poverty reduction in the lower income quintiles than in the upper quintiles. Wildlife income alone accounted for about 5.5% reduction in the proportion of people living below the poverty line. Furthermore, wildlife income had an equalizing effect bringing about a 5.4% reduction in measured inequality. Regression analysis suggests that the likelihood of belonging to a wealthier category of income increased with an increase in environmental income. As expected, household wealth significantly and positively affect environmental income generated by households. This seems to suggest that wildlife-based land reform also needs to empower poor households in the area of capital accumulation while imposing restraint on capital investments by well-off households.

JEL classification code: D63, I32, I38, Q22

Key words: Wildlife, environmental income, poverty, inequality, dependence, Zimbabwe

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1 Introduction

There is increasing consciousness among policymakers, development practitioners and academic scholars of the importance and value of environmental resources[1] in the livelihoods of poor rural communities scattered across the globe, and indeed the Southern Africa region is not an exception to this (Cavendish, 2000; Fisher, 2004; Shackleton & Shackleton, 2004; Thondhlana et al., 2012; Fonta & Ayuk, 2013; and Thondhlana & Muchapondwa, 2014). Rural households depend heavily on the natural capital base to sustain their welfare through the provision of both consumptive and non-consumptive goods. Apart from land restitution programmes or any other justice objectives, the realization that the livelihoods of poor rural households in the region depend heavily on environmental resources has led to devolution and decentralization of natural resource management, particularly wildlife resources, into the hands of local communities. Such a policy is believed to provide appropriate incentives to the communities in question to conserve natural resources while at the same time making sure that they also benefit from managing their own resources (Balint & Mashinya, 2006).

Demonstrating the complementarity between development and conservation goals, which were previously thought to be incompatible with each other, has been on the agenda of regional and international policy since the mid-1980s when devolution started in Southern Africa (Dubois, 2003; and Shackleton & Shackleton, 2006). Zimbabwe was among the first countries in the region to implement the so called 'people oriented approaches' to natural resource management. The Communal Areas Management Programme for Indigenous Resources[2] (CAMPFIRE) is one good example of local communities that are managing natural resources to their own benefit (Murombedzi, 1999; and Balint & Mashinya, 2006). The livelihood of local communities living adjacent to national parks is heavily dependent on natural resources including wildlife. As a result, enhancing the utilization of environmental resources in the domestic and wider markets will not only contribute to increased livelihood security, reduction in poverty and rural inequality, but will also provide incentives for conservation and sustainable utilization of resources (Wunder, 2001; and Thondlana et al., 2012).

Cavendish (2000) identified a number of channels through which environmental resources contribute to rural livelihoods. To begin with, households can harvest natural resources such as wild vegetables, wild fruits, timber or firewood and consume them directly as part of its own consumption activities. This is in line with the notion of a standard rural household as both a production and consumption unit. It is also possible that a household might use environmental

[1] We define environmental resources in this paper as goods that are freely provided by nature or "nature bounty" (Cavendish, 1999), accessible to everyone in the community and community members do not incur any other cost except their own time.

[2] The CAMPFIRE programme was established during the mid-1980s to cater for peasant farmers in communal areas that are located in the vicinity of national parks (Balint & Mashinya, 2006).

resources as inputs in another production activity or process, such as the use of firewood in beer brewing or brick making, in which case they are referred to as input goods. Environmental resources can also be used by rural households as output goods for sale, e.g., households gather natural resources which they do not consume themselves but rather sell to supplement total household income. Finally, rural households harvest resources from the environment to produce household durables such as furniture or keep stocks of environmental resources for future use, e.g., timber and firewood.

Closely related to the discussion above is the literature on forest income which explores the three roles of environmental resources, i.e., preventing poverty by acting as insurance or safety nets (Shackleton et al., 2008; and Thondhlana & Muchapondwa, 2014), reducing poverty via increased earnings or income augmentation (Fisher, 2004; and Vedeld et al. 2007), and finally income equalizing role (Cavendish, 1999; and Fonta & Ayuk, 2013). Shackleton et al. (2008) argued that income derived from the environment acts as a safety net for poor rural households by mitigating agricultural risk through direct and indirect provisioning. As a way of diversification, poor rural households use environmental income[3] to cushion themselves against idiosyncratic and covariate shocks associated with illness, crop failure, loss of employment changes in food prices or extreme weather conditions.

From the literature, a number of issues with regard to the study of the human-environment relationship stand out. These issues relate to unequal utilization and differentiation in the types of environmental resources used in communal areas, the contribution of environmental resources to total household income, wealth differentiation and resource utilization, and whether environmental income reduces poverty and rural inequality. There is evidence that rural households use environmental resources quite extensively and this is well documented in previous studies (e.g., Falconer, 1990; Scoones et al. 1992; Arnold et al. 1994; Cavendish, 2000; Twine et al., 2003; and Shackleton & Shackleton, 2006). Environmental resources offer goods to rural households that have considerable differentiation in terms of their economic characteristics and utilization (Cavendish, 1999; 2000). Shackleton & Shackleton (2006) and Kar & Jacobson (2012) argued that within any given community, there is significant socio-economic differentiation and it is important to acknowledge such differentiation when considering policy formulation and management interventions in order to support rural livelihoods and promote sustainable utilization of natural resources. Thondhlana et al. (2012) and McGregor (1995) emphasised the role of contextual factors such as culture, social institutions, ecological conditions and infrastructure in influencing access and the ultimate utilization of resources.

A number of studies done in Southern Africa established that environmental resources make a significant contribution to average rural incomes. For example, a study by Cavendish (2000) demonstrated that poorer households de-

[3]Environmental income is defined here as the sum of direct use values and cash income derived from environmental resources (Thondhlana et al., 2012).

pend heavily on these resources, which contribute about 40% to their incomes while richer households use greater quantities of environmental resources in total. Through a detailed examination of use and value of four non-timber forest products (NTFP), Shackleton & Shackleton (2006) found evidence supporting Cavendish's claim that poorer households benefit more from environmental resource utilization in per capita terms than wealthier classes. In addition, with an increase in wealth, households purchase more NTFP while a greater proportion of poor households were actually involved in selling NTFPs (McGregor, 1995; and Shackleton & Shackleton, 2006). Richer households generated more environmental income in total than poorer households since they have more assets (Cavendish, 1999; Uberhuaga et al., 2012; and Ambrose-Oji, 2003).

Poverty reduction is a pressing social dilemma since poor people usually face constraints that restrain households from commanding sufficient resources to meet a reasonable minimum standard of living (Cavendish, 1999; and Campbell et al., 2002). However, there are mixed results with regards to the effect of environmental income on poverty reduction. It is still not clear whether environmental income can actually move poor households across the poverty line, but there is agreement about the role of environmental resources in mitigating poverty and at least to make some households less poor than what they were without it. For example, using purpose-collected panel data, Cavendish (1999) reported that environmental income is important in mitigating poverty, but might not be responsible for lifting poor households out of poverty as claimed by other studies. In contrast, in a study of forest income and resource dependence in lowland Bolivia, Uberhuaga et al. (2012) reported that forest income has potential to move households out of poverty, provided that the environmental resources are fully commercialized and the rural households are integrated into the mainstream economy. Fonta et al. (2011) and Lopez-Feldman (2007) also found evidence that forest income reduces rural poverty in Nigeria and Mexico respectively. Using meta-analysis of 51 case studies from 17 countries, Vedeld et al. (2007) established that forest environmental income represents on average 22% of the total income in the sampled population.

Alleviating inequality is also an important ethical concern (Cavendish, 1999). There is general consensus about the role of environmental income in reducing rural inequality (Cavendish, 2000; Cavendish & Campbell, 2002; Fisher, 2004; Vedeld et al., 2007; and Fonta et al., 2011). For example, using a sample of 213 households from rural Zimbabwe to examine the effects of environmental income on household welfare, Cavendish & Campbell (2002) found that environmental income is strongly and significantly equalizing[4], bringing about a 30% reduction in inequality. A study by Fonta et al. (2011) found that forest income reduces income inequality in rural Nigeria. Using Gini decomposition, Fisher (2004) showed that access to forest income reduced measured income inequality in Malawi. Vedeld et al. (2007) found that forest environmental income has a strong equalizing effect on local income distribution.

[4] Environmental income has an equalizing effect on rural income distribution if it can result in a reduction in inequality. Therefore, access to environmental income improves social welfare through its role in both increasing and equalizing incomes.

All these results demonstrated considerable economic contribution made by environmental resources to the rural livelihoods. Based on the studies done in the Southern Africa region so far, it is still not clear how environmental income generation alters the analysis of welfare (total household income, poverty and inequality) when poor rural households living adjacent to national parks are considered. Previous studies were conducted in areas where wildlife conservation is not an important activity in the community. For this reason, wildlife conservation is therefore an important component of environmental income generation for these communities. However, unequal utilization of wildlife results in different contributions to livelihoods and incentives to conserve resources. Therefore, the purpose of this study is to examine the economic contribution of wildlife resources (in the portfolio of environmental income) to household welfare[5] and incentives to conserve wildlife. The study used a purpose-collected data set which systematically integrates environmental resource use with other household economic activities.

Little is also known about the relative contribution of environmental income (including wildlife) when compared with other income sources. From a policy standpoint, it has become imperative to recognize the relative importance of different income sources in deriving inter-household poverty and inequality (Leibbrandt et al., 2000). Using Gini decomposition, Leibbrandt et al. (2000) considered six income sources that include wage income, remittances, agriculture, capital income, transfers and self-employment for rural households in rural South Africa and found that wage income is both the most important income component and also the most important source of inequality. This paper applies such a technique and includes environmental income in the analysis in addition to the six components of standard household income considered above. In doing so, the paper extends existing knowledge about the human-environmental resources nexus in the context of developing countries. This study is also relevant given the occurrence of a major institutional reform in 2000 which affected both the land tenure system and wildlife policy in Zimbabwe.

Analysis of the human-environment relationship is constrained by inadequate data encompassing both environmental and economic activities (Dasgupta, 1993; Deaton, 1997; Cavendish, 1999; Cavendish, 2000; and Luckert et al. 2000). Cavendish (2000) argued that traditional studies miscalculated rural incomes and welfare measures simply because they ignored environmental income in their analysis. He argued further and says that measures of poverty and inequality are overstated in conventional studies. As a result, such measures do not reflect the true picture of what is on the ground and policies endorsed based on these measures achieve limited success. The lack of appropriate and comprehensive household data-sets encompassing both economic and environmental aspects provided further stumbling blocks for previous researchers to undertake such rigorous quantitative analysis (Cavendish & Campbell, 2002; and Cavendish, 2000). To overcome this challenge, this study made use of purpose-

[5] Household welfare is measured in terms of three dimensions namely; total household income, poverty and income inequality.

collected survey data capturing both economic and environmental aspects from local communities around the Gorarezhou National Park in Zimbabwe.

In light of the policy issues discussed above, a number of questions arise. How does the utilisation of environmental resources affect welfare (total income, poverty and inequality) and incentives to conserve resources when wildlife is considered? Specifically, we ask: i. Does environmental income (including wildlife) contribute significantly towards total household income, reduction in rural poverty and income inequality? ii. How does environmental income compare with other sources of income? iii. What determines the different amounts of environmental income that households generate?

Our study of the role of wildlife income on welfare is organized as follows. Section 2 discusses data issues, defines key variables and gives an outline of the research methods, analytical framework and the empirical model specifications. We then proceed to discuss the results in the section 3 and wind up with conclusions and policy implications in section 4.

2 Research Methods

2.1 Description of the case study area, data sources and sample size

The data for the analysis was drawn from a household survey conducted in June/July 2013 with local communities living adjacent to the Gonarezhou National Park in Zimbabwe. The Gonarezhou National Park (located $20^{\circ}40'$S and $31^{\circ}40'$E) forms part of the Great Limpopo Trans-frontier Park, a peace park that links Gonarezhou with the Kruger National Park in South Africa and the Limpopo National Park in Mozambique. It has approximately 5 053km^2 of conservation land and is the country's second largest game reserve after Hwange National Park. The park is located in natural region five which is very dry with very low agricultural potential. The mean annual rainfall for the area is about 499mm with a standard deviation of about 195mm and the average maximum monthly temperature ranges from less than 25.9°C in winter to over 36°C in summer while the average monthly minimum ranges from 9°C to 24°C in winter and summer respectively (Gandiwa, 2011). The vegetation of the Gonarezhou ecosystem is typical semi-arid savanna and is dominated by *Colophospermum mopane* woodlands (Gandiwa & Kativhu, 2009).

The area under study is located approximately 100km away from the nearest town (Chiredzi), relatively sparsely populated and predominantly occupied by the Shangani people but other ethnics groups such as the Venda, Ndau, Shona and Ndebele people are also found in the area. Apart from the CAMPFIRE programme (which constitute over 90% of the local communities involved in wildlife conservation), there are also peasant farmers operating under resettlement schemes (slightly less than 10%) that are involved in wildlife conservation in the area. Comparing households in communal areas and those in resettlement schemes might be a little bit problematic since the sample for the latter tenure regime is quite small relative to the former[6]. The mode of production of peasant farmers in both communal areas and resettlement schemes is primarily substance in nature. While both types of farmers engage in a diversified portfolio of economic activities, the most dominant livelihood activities are livestock production and crop cultivation e.g., maize, sorghum, millet, groundnuts and cotton.

Both formal and informal methods of primary data collection were employed e.g., structured interviews using questionnaires and semi-structured interviews such as key informant interviews. The data was collected from 336 randomly selected households - coming from 13 Wards and 31 communities involved in community wildlife conservation. Local communities participating in wildlife conservation were identified with the help of community leadership, park authorities and the Rural District Council (RDC). From each community, the chairperson of the wildlife management committee was identified and interviewed as a key informant[7]. A simple random sample of households was then drawn using the list of households provided by the chairperson from each community as the sampling frame. Local communities around the Gonarezhou National Park share similar ecological conditions and perhaps similar culture, traditions or languages which makes the results comparable across communities.

2.2 Empirical strategy

The study is motivated by three specific questions. i) Does environmental income (including wildlife) contribute significantly towards total household income, reduction in rural poverty and income inequality? ii) How does environmental income compare with other sources of income? iii) What determines environmental income generation among poor households living adjacent to protected areas? To address these questions the paper used income quintile analysis, the Foster-Greer-Thorbecke poverty measure, Gini coefficient analysis, Gini decomposition analysis and regression analysis. Given in the next section below is a brief description of these analytical techniques.

To answer these questions, we first define three different income measures used in this study. Standard household income (Y_0) is defined as income derived when standard household budget surveys are implemented (Cavendish, 1999). This comprises of all household economic activities (i.e. wage income, remittances, net gifts & transfers, farm income, capital income and self-employment), but excludes environmental income. We expect the results of the standard household income not to differ significantly from previous studies. Standard

[6]We will not therefore compare the two tenure systems in most of the analysis except in regression models where an attempt is made to control for the effects of tenure. This implies that the poverty analysis will be based only on the pooled sample.

[7]Local communities are required to organize and form wildlife management committees by the government in order to participate and to benefit from wildlife conservation. All the communities visited during the field work had committees in place but the only difference between them was the extent to which these committees are functional and involved in wildlife management.

household income is used as the baseline in this study upon which we measure the relative contribution of environmental income. Environmental income includes both direct use values and cash income (i.e. direct consumption of resources by households, environmental-based labour income and sales of environmental resources).

Since we are dealing with local communities living adjacent to a game park and whose livelihood depends on wildlife conservation and the main goal of this paper is to examine the effects of wildlife resources on welfare. We are therefore concerned with two scenarios, i.e., a scenario with wildlife and without. As a result, a distinction is made between non-wildlife and wildlife income. Unlike non-wildlife income, wildlife income only captures household consumption and sales of bush meat, small animals, fish and birds, in addition to income generated from legal activities which includes the money and meat from wild animals killed through trophy hunting[8] in the community's conservation area. It is important to note that the term 'income' as used in this paper refers to income per adjusted adult equivalent unit and not per capita. This definition accounts for the different contributions between household members, e.g., children and adults. The different incomes defined above were measured for the 12 month period spanning the 2012/2013 agricultural season. As a result, all the calculations and analysis in this paper were done with reference to this period of time.

We also differentiate partial environmental income or environmental income without wildlife resources (X_0) from total environmental income (X_1) derived from both non-wildlife and wildlife resources. As suggested earlier, a distinction is made between these two categories of environmental income since other studies concerned themselves with the broader environmental income category. We define total household income excluding wildlife (Y_1) as the sum of standard household income (Y_0) and environmental income without wildlife resources (X_0). Finally, we define total household income (Y_2) in terms of standard household income (Y_0) and total environmental income (X_1). Thus, the main difference between the two measures of total household income, i.e. Y_1 and Y_2, is that the former does not include wildlife income, while the latter includes wildlife income. Figure 1 below summarises the different measures of income computed in this paper.

Cavendish (1999) highlighted a number of controversies in poverty research when it comes to measuring poverty and the choice of a measure of welfare. This study follows standard practice in the poverty research and disregards many of these issues by choosing income as a measure of welfare. There is also disagreement in the literature about whether the poverty line should be absolute (fixed), relative or subjective (e.g., Ravallion, 1992 and Deaton, 1997). Cavendish (1999) argued that deciding the exact position of the poverty line is not as important as comparing results for poverty measures under different assumptions about the location of the poverty line. For the purposes of this analysis, the robustness of

[8] Local communities get income from legal hunting activities by engaging a Safari operator or local professional hunter who utilizes the quota on their behalf.

poverty measures to different poverty lines is therefore more important than a point estimate of poverty. Following Cavendish (1999), the study used poverty lines, fixed with reference to the standard income distribution, that span a wide range of incomes in our sample. The poverty lines correspond to the uppermost incomes of the income quintiles of the standard income distribution and are consistent with other studies.

Income quintile analysis: To analyze the contribution of environmental income to total household income, the study used income quintile[9] analysis. Based on this technique, the sample was divided into five income groups in such a way that 20% of the population lies in each group, which made it easier to examine the contribution of environmental income with and without wildlife to total household income by income category. The household questionnaires included quantitative questions about a wide range of environmental goods, their uses and values as part of household's income, consumption and expenditure. As a result, household values were calculated on the basis of environmental use rather than resource availability. Mostly, economic transactions were valued at local market prices[10] and value addition calculated for subsistence agricultural output. In cases where market prices could not be determined, household reported values were used to allow for a comparison of environmental income against a full accounting of the household's other economic activities.

Using standard principles for agricultural households involved in both market and non-market activities, the environmental resource use and non-environmental economic data were valued and aggregated to produce household income accounts (see Grootaert, 1982; Cavendish, 1999; Cavendish, 2000; and Thondhlana et al., 2012). Therefore, the method employed for valuing environmental resource utilization was similar to all other economic transactions i.e. household's own reports of quantity, total value of resource utilization (consumption) or sales. However, there is a limitation to this method since most environmental goods are not traded on the market. This is the main reason why environmental resources have been excluded from standard household income analysis in the past (Cavendish, 2000). To minimize this problem, the quantitative data was supplemented by qualitative data collected through key informant interviews.

The Foster-Greer-Thorbecke (FGT) poverty measure: The Foster-Greer-Thorbecke (FGT) metric is used to examine whether environmental income (including wildlife) can reduce rural poverty. It is a generalized measure of poverty within an economy. We ask, is environmental income capable of lifting people out of poverty or, at least, make people less poor than they were without it. Hence, the FGT matric measures the income shortfall expressed as a share of the poverty line and is weighted by a "sensitivity parameter" α (Donaldson

[9] Quintiles are points taken at regular intervals from the cumulative distribution function (CDF) of a random variable such as income where the sample is divided into fifths according to their neighbourhood socioeconomic status.

[10] Market prices are ideal because they represent clearing prices.

and Weymark, 1986). Algebraically, we have

$$FGT^{(\alpha)} = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z-y_i}{z}\right)^{\alpha} \tag{1}$$

where z is an agreed upon poverty line (e.g., the most common poverty line used for Africa by the World Bank is US\$450.00 per person per annum, which correspond to about US\$ 1.25 per day adjusted for purchasing power parity), N is the number of people in an economy, H is the number of poor households (i.e. those with income at z or lower), and$y_i$are individual incomes. The interpretation of the sensitivity parameter draws its inspiration from Artkinson (1970). A low value of the sensitivity parameter (α) implies that the FGT measure weights all the individuals with incomes less than z roughly the same, while a high value puts more weight on those individuals with lowest incomes (i.e. furthest below z). A very high FGT statistic implies more poverty in the economy.

For specific values o f α, the FGT statistic corresponds to other measures of poverty. For example, if $\alpha = 0$, the formula reduces to the Headcount ratio, which is the fraction of the population living below the poverty line. Mathematically, this is written as:

$$FGT^{(0)} = \frac{H}{N} \tag{2}$$

If $\alpha = 1$, then the FGT matric reduces to the average poverty gap[11], that is, the average amount of income required to move those in poverty up the poverty line. Thus, we have

$$FGT^{(1)} = \frac{1}{N}\left(\frac{z-y_i}{z}\right) \tag{3}$$

While a great deal of the literature on poverty uses these two versions of the FGT quite extensively, other studies make use of the FGT statistic where$\alpha = 2$, so that the index reduces to the poverty severity measure.

$$FGT^{(2)} = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z-y_i}{z}\right)^{2} \tag{4}$$

Using such a tractable form, the statistic combines information on both poverty and income inequality[12]. Rewriting the FGT statistic, we obtain

$$FGT^{(2)} = H\mu^2 + (1-\mu^2)C_v \tag{5}$$

Where H is the number of poor households as defined above, C_v is the coefficient of variation among those with income such that $y_i < z$ and $\mu = \frac{1}{N}\sum\limits_{i=1}^{H}\left(\frac{z-y_i}{z}\right)$.

[11] This is equivalent to the amount an average person in the economy would have to contribute in order for poverty to be barely eliminated.

[12] The FGT also considers the inequality among the poor, but as the proper amount for$\alpha$is not defined (i.e., it is a normative question). We are thus not able to say that the Gini is part of the FGT.

The FGT class of decomposable poverty measures discussed above were first introduced by Foster, Greer, and Thorbecke (1984).

Gini coefficient analysis: To establish whether environmental income reduced rural inequality, the Gini coefficient analysis is employed. The Gini index is a summary statistic that measures how equitable or inequitable a resource, e.g., income, is distributed in a society. The advantage of using the Gini coefficient is that the statistic is a self-contained summary of economic data which is easy to compute and interpret (Farris, 2010). It can be defined mathematically based on the Lorenz curve[13]. Therefore, the Gini coefficient can be thought of as the ratio of the area that lies between the line of equality (i.e. the 45 ° line) and the Lorenz curve over the total area under the line of equality. The Gini index is therefore defined as an integral that shows how much the Lorenz curve in question deviates from perfect equitability, i.e., the 45 ° line as follows:

$$G = 2 \int_0^1 \left[P - L(p) \right] dp \tag{6}$$

where the factor 2 scales the area in such a way that the Gini index varies between 0, perfect equitability where everyone in the economy has the same share of the good, and 1, where one person has everything. This is an indirect method of calculating the Gini coefficient through the construction of the Lorenz curve. However, the index can be computed through a direct method as follows:

$$G = \frac{1}{\mu N(N-1)} \sum_{i>j} \sum_{j} |y_i - y_j| \tag{7}$$

where μ is mean income, N is the total number of observations, y_i and y_j are the dollar values of income for individuals i and j (Thomas et al., 2000)

Gini decomposition method: This paper uses the Gini decomposition approach to investigate the relative contribution of income components to income inequality for local communities living adjacent to Gonarezhou National Park in Zimbabwe. In a South African study, Leibbrandt et al. (2000) considered income from six different sources i.e. wage income, remittances, agricultural income, capital income, state transfers and self-employment. In this study, we expand these variables and include environmental income in the analysis. By going deeper into each and every component, we ask, are there any interventions required to either increase or decrease income generation.

Following Leibbrandt et al. (2000) and Shorrocks (1993), we assume n households deriving income from K different sources. Let y_i represent the total household income $i = \{1, ..., n\}$ and y_{ik} represent total income for household i and

[13] By definition, the Lorenz curve shows the distribution of a quantity in a population. For a resource$Q$, it is the curve$y = L(p)$, where the$Q$-poorest fraction$p$of the population has a fraction$L(p)$of the whole and the value of$p$is called the percentile variable. If everyone in the economy had exactly the same amount of$Q$, then the order of our imaginary line-up would be completely arbitrary and$L(p) = p$, the curve of perfect equilibrium.

source $k = \{1, ..., K\}$, hence $y_i = \sum_{k=1}^{K} y_{ik}$. Assuming the distribution of household income and the income components are represented by $\gamma = \{y_1, ..., y_n\}$ and $\gamma_k = \{y_{1k}, ..., y_{nk}\}$ respectively, the Gini coefficient for the distribution of total income within the group can be defined as:

$$G = \frac{2Cov[\gamma, F(\gamma)]}{\mu} \tag{8}$$

where μ represent mean household income, $F(\gamma)$ is the cumulative distribution of total household income i.e. $F(\gamma) = f(y_i), ..., f(y_n)$, and $f(y_i)$ is the rank of y_i divided by the number of observations n. The key aspects of the Gini decomposition technique can then be summarised as in Leibbrandt et al. (2000) and Stark et al. (1986) as follows:

$$G = \sum_{k=1}^{K} R_k G_k S_k \tag{9}$$

where S_k denotes the share of income source k in total group income i.e. $S_k = \mu_k/\mu$,G_k represent the Gini coefficient measuring inequality in the distribution of income component k within the group and R_k is the Gini correlation of income from source k with total household income, defined as follows:

$$R_k = \frac{Cov[\gamma_k, F(\gamma)]}{Cov[\gamma_k, F(\gamma_k)]} \tag{10}$$

To check for the robustness of our results, we consider results from the Gini decomposition using the Rao's (1969) analytical approach, the Shapley (1953) decomposition approach and finally the FGT decomposition approach.

Econometric modelling of the relationship between relative poverty and the environment: This section is concerned with modelling the relationship between environmental income and relative poverty using regression analysis techniques. The human-environment relationship raises two important questions that need attention. Does environmental income affect households in various income quintiles the same? What are the determinants of environmental income? Given these two questions, it is hypothesized that environmental income is capable of moving households across income categories, and that household wealth and the status of biodiversity in an area are key determinants of environmental income generation. If this assertion is correct, then it is conceivable through appropriate policy designs to improve household welfare by increasing access to wildlife income by relatively poor households, while imposing restraint on wealthier households.

To answer the first question, it is possible to capture the impact of environmental income (EI) on households in different income quintiles using an ordered logistic regression model. These quintiles were calculated based on standard household income and therefore exclude environmental income. Suppose the sampled population can be divided into five categories according to the level of income by calculating the first, second, third, fourth and fifth income quintiles, then for$i = 1,\ 2,\ 3,\ 4,\ 5$ the dependent variable Y_i is ordered and increasing. We can therefore rewrite the dependent variable as follows: 1=low income, 2= lower middle income, 3=middle income, 4=upper middle income and 5=high income. Thinking in terms of relative poverty, we can say that households in a lower quintile are relatively poor than households in a higher quintile. Algebraically, we can write the following model.

$$Y_i = \beta_0 + \beta_1 Age + \beta_2 Areacult + \beta_3 EI + \beta_4 Hhsize + \beta_5 Employ + \beta_6 Lhead + \beta_7 Educ ... + \xi_i \tag{11}$$

where the explanatory variables in equation 11 are age of household head, area under crop cultivation, environmental income, household size, household head employed, number of years living in the area and number of years in school of the household head.

In the second part, we find the determinants of the different amounts of environmental incomes that people generate i.e. $EI = f(S_i, W_i, ...)$. So we propose a model of the form:

$$EI_i = \beta_0 + \beta_1 S_i + \beta_2 W_i ... + \mu_i ... \tag{12}$$

where EI_i represents environmental income, S_i denotes household characteristics, W_i indicate household wealth and μ_i is the error term. As used in the economic literature, the wealth variable is recovered from household asserts, livestock ownership and agricultural implements. In this study, it is assumed that as household wealth increases people invest in technology, such as carts and draught power, in order to harvest more environmental resources. Conversely, as households consume more environmental income, they use the excess income to accumulate more assets thereby increasing their wealth status. Because of potential reverse causality between environmental income and wealth, we suspect endogeneity to be an issue in this relationship. In such a case, the most appropriate way forward is using the instrumental variables regression model. However, due to the fact that sound external instruments for use in traditional instrumental variables estimation are difficult to find, the study made use of instrumental variables estimation with heteroskedasticity-based instruments which methodologically deals with the endogeneity problem (Lewbel, 2012; and Baum et al., 2013).

According to Lewbel (2012), this method estimates an instrumental variables regression model providing the option to generate instruments and allows the identification of structural parameters in regression models with endogeneity or mismeasured regressors in the absence of traditional identification information such as external instruments. Identification is achieved in this context by having explanatory variables that are uncorrelated with the product of heteroskedastic errors, which is a key feature of models where the correlations in the error terms are due to an unobserved common factor (Baum et al., 2013). Since instruments are constructed as simple functions of the model's data, the approach may be applied in cases where no external instruments are available or used to supplement weak external instruments in order to improve the efficiency of the instrumental variables estimator (Lewbel, 2012).

3 Results and discussion

3.1 Household characteristics

A total of 336 interviews were conducted. Since 90% of the peasant farmers involved in the wildlife conservation are from the communal areas and less than 10% are from the resettlement schemes, the interviews consists of 306 households from the former and 30 households from the latter. Table 1 shows some characteristics of the sampled households around the Gonarezhou National Park in Zimbabwe. The mean age of the household heads, number of years in school, number of years living in the area, household size, area under crop cultivation, distance to the nearest town (i.e. some measure of market integration) and mean number of dogs[14] owned for the sampled population are 48.9years, 5.52years, 36.6years, 6.4, 2.7ha, 65.5km and 1.1 respectively. The proportion of household heads born in the area is about 70.8%, while the proportion of household heads that are Christians is 59.2%. Using a scale from zero to hundred, the mean wealth index (31.8) shows that the average household in the sampled population is generally poor since the index lies below half (50.0).

Households were categorised in terms of income quintiles. Five categories of income corresponding to the 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} income quintiles were defined as follows: low income, lower middle income, middle income, upper middle income and high income households. Table 2 presents the uppermost incomes of the income quintiles of the standard income distribution. 20% of the households lie below US$208.35 in the first income quintile, 40% of the households lie below US$280.63 in the second quintile, and so on. The analysis below, made use of two widely used poverty lines in the literature. Zimbabwe's official poverty line of US$1 per day or US$360.00 per annum (adjusted for purchasing power parity) corresponds to the threshold of the third income quintile (Zimbabwe National Statistics Agency, 2014). The lowest poverty line used by the World Bank (1990) of US$1.25 per day or US$450.00 per annum (average line of the poorest 15 countries) corresponds to the threshold of the fourth income quintile. The poverty line for the World Bank was chosen for comparison purposes, to check for robustness of the results and the idea of basing the analysis on a relative poverty line rather than a fixed line. However, the interpretation of the results is based on Zimbabwe's official poverty line.

3.2 Utilization of environmental resource

Around the Gonarezhou National Park there are a number of resources from which communities living adjacent to the park derive their livelihoods such

[14] The number of dogs owned by a household matters in this analysis because dogs are used by local people for hunting purposes.

as rangelands, woodlands, watering points, rivers and dams. These resources sometimes form part of what the community refers to as its conservation area or wilderness. By law, communities living adjacent to national parks are required to set aside a piece of land as conservation land if they are to participate in wildlife conservation or at least keep the land which usually lie between the community and the game park, but within the vicinity of the game park. This land traditionally belonged to the communities in question but with the establishment of the game park in 1975, communities lost part of their land to the state. Households are not allowed to harvest wildlife directly from their conservation area, but they can do so as a community through trophy hunting and tourism activities done by the Safari operators, in which case the community receives some income.

Table 3 below shows that households from the study site harvested and used an enormous range of environmental resources which in turn provided a wide range of economic characteristics. For example, wood can be used as firewood, fencing material, furniture or for construction purposes. Cavendish (2000) categorized these resources as consumption goods, input goods, output goods and durables or stocks according to their economic functions. The resources can also be categorised as food and non-food items. As stated earlier, these resources come from a wide range of different ecological niches and are either owned communally or individually, depending on whether the resources are found on communal land or on an individual plot such as in resettlement schemes. It is therefore common for access or use rules to exist for common pool resources, such as wildlife, in order to guide their utilization overtime. If such institutions are not in place, then the resource system is subject to an open access regime.

Considering major food items and non-food items consumed by local communities around the Gonarezhou National Park, our results show that richer households consume more environmental resources (both food and non-food items) in total than poorer households (see table 4 below). This is consistent with the results of Cavendish (1999; 2000), Shackleton & Shackleton (2006) and Thondhlana & Muchapondwa (2014). In line with the study of Twine et al. (2003), richer households consume more of valuable resources such bush meat, fish, timber, firewood and livestock fodder, while poorer households consume more of less valuable resources such as wild vegetables, wild fruits, insects and thatch grass. As one of the main motivation of this paper, our results reveal that relatively wealthier households consumed more wildlife products in total than relatively poor households.

The results in table 5 show that 53.1% of the households purchased environmental resources during the 2012/2013 agricultural season while 59.7% sold environmental resources. Consistent with the study of Shackleton and Shackleton (2006), wealthier households purchased more environmental resources than poorer households, while poorer households sold more environmental resources.

3.3 Contribution of environmental income (including wildlife) to total household income

The household income accounts in table 6 show that wage income, farm income and environmental income are the three most important sources of household income for communities around the Gonarezhou National Park. Although agricultural income (35.4%) dominates all the sources of income, the contribution of environmental income (28.7%) is also quite substantial. The environmental income sources is made up of environmental-based labour income[15], wildlife income and other environmental resources each contributing 7.8%, 6.2% and 14.7%, respectively, to total household income.

To examine the contribution of environmental income to total household income, the paper used income quintile analysis. Three important definitions of income are used to accomplish this objective namely; standard household income, total household income without wildlife (includes standard household income and non-wildlife income) and total household income (which include standard household income, non-wildlife income and wildlife income). The standard household income is used as the baseline in this analysis. Wildlife income is made up of income (including the actual consumption of game meat) from hunting and tourism activities done legally by the community through engaging Safari operators, game meat consumed by the household out of its own production (illegal hunting activities), and income realized from selling game meat.

In aggregate, non-wildlife resources contributed about 31.5% to total household income while the total contribution of environmental resources including wildlife is 40.1% implying a net effect of 6.6% from wildlife alone. Disaggregating the three measures of income by income quintiles, our results show that adding both non-wildlife and wildlife income to standard income increases total household income across income quintiles (see table 7 below). The increase in total household income resulting from the inclusion of non-wildlife and wildlife resources is much higher for households in lower income quintiles than it is for households in higher quintiles. This standard result confirms the findings of Cavendish (2000), Shackleton & Shackleton (2006) and Thondhlana & Muchapondwa (2014), that poor households derive greater relative benefits from utilizing environmental resources than richer households. In particular, poorer households derive greater benefit from the consumption of wildlife resources than wealthier households.

3.4 Environmental income and poverty

Table 8 below presents the results of the FGT poverty statistics. Three measures of poverty are used, namely the headcount ratio, the poverty gap and poverty severity measure. Overall, the results illustrate that the proportion of people in the full sample living below the poverty line is greatly reduced as we account

[15] Environmental-based labour income includes labour income derived from harvesting and processing environmental resources such as digging termitaria, thatching, brick moulding, etc.

for non-wildlife income initially and wildlife income later (i.e. from about 47.6% to 24.7% and then 22.1% respectively). The inclusion of non-wildlife resources accounts for approximately 48.1% reduction in poverty, while the inclusion of wildlife resources accounts for 53.6% reduction in poverty (refer to table A.1 in the annexes). The net effect of wildlife income alone is about 5.5% reduction in the proportion of people living below the poverty line. Comparing the results of the headcount ratio with the poverty gap and poverty severity indices, the reduction is massive. Poverty depth in the full sample reduced from 16.6% to 5.5% with non-wildlife income and then 4.3% with wildlife income.

Analysis by income quintiles when the poverty line is US$360.00 revealed that only the first income quintile had 100% poverty counts with or without environmental income and with or without wildlife. The second quintile reduces from 100% poverty counts with standard household income to 9.6% poverty counts with non-wildlife income and finally reduces to zero with the inclusion of wildlife income, while the third quintile reduces from 25.9% with standard income to zero with or without wildlife income. No poverty is recorded for the fourth and fifth quintiles for all the three scenarios suggesting that wealth in the area might be tied to environmental income. Using a different poverty line (e.g., the average line of the poorest 15 countries computed by the World Bank), there are still dramatic differences in measured poverty between standard income and total household income with and without wildlife. Table A.2 in the annexes shows that when the poverty line is changed to US$450.00, the first two quintiles had 100% poverty counts though out the scenarios. The third quintile reduces from 100% poverty counts in the baseline to 87.2% with non-wildlife, while the inclusion of wildlife reduces the headcounts to zero. Our results are robust to different poverty measures and poverty lines.

3.5 Environmental income and inequality

This section discusses the sample estimates of measured inequality for the Rao's (1969) approach, the Shapley (1953) decomposition and the FGT decomposition approaches. It is intuitive to start by comparing inequality in the sample data against measured inequality in other studies and to start with the standard household income measure as this closely resembles findings from other studies. Comparing the Gini indices computed from the survey data with studies done in other countries, the results show striking similarities in terms of measured inequality (see table 9 below).

Table 10 shows a significant reduction in measured inequality when environmental income is considered both with wildlife income (16.1%) and without wildlife income (11.3%). Thus environmental income (with and without wildlife) appears to have a strong and significant equalizing effect on income. Surprisingly, wildlife income on its own has also an equalizing effect bringing about a 5.4% reduction in measured inequality. As a result, policies that seek to increase access to wildlife income by poor rural communities through IDCP might help to reduce income inequality in rural areas. These results are also supported in Figure 2 in the annexes.

Disaggregating the Gini indices for our three measures of income by income quintiles we observe a tremendous reduction in inequality when we consider environmental income with and without wildlife, particularly for poorer households (refer to table 11 below). The reduction in measured inequality when we consider total household income (accounting for wildlife resources) is approximately 73.0%, 61.6%, 51.2%, 33.4% and 27.1% for households in the 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} income quintile against a reduction in inequality of 62.1%, 56.3%, 44.9%, 27.4% and 21.8% respectively with non-wildlife resources included. Wildlife alone accounts for about 28.9%, 12.6%, 11.3%, 8.2% and 6.8% reduction in measured inequality. These findings seem to suggest that environmental income and, in particular, wildlife income has a stronger equalizing effect for relatively poor households than wealthier households. This might be true because the ratio of environmental income to total household income is very high for relatively poor households than it is for richer households, implying that there is heavy dependence on environmental resources by the former households. Moreover, poorer households do not have many alternative sources of income compared to their wealthier counterparts.

3.6 Contribution of individual income sources to total household income

Six income sources were considered namely; employment, agricultural income, capital, transfers, remittances and environmental income. As suggested earlier, three different approaches were employed to check for robustness of our results i.e. the Rao's (1969) method, Shapely (1953) approach and FGT decomposition. Overall, the results in table 12 below show that agriculture is the biggest contributor to total household income and the most important source of rural inequality. This finding diverges from the study of Leibbrandt et al. (2000) done in rural South Africa, which established that wage income is both the most important income component and also the most important source of inequality. This might be true because employment opportunities are scarce in rural Zimbabwe than in South Africa, and most households depend heavily on agriculture (crop cultivation and livestock rearing) than any other livelihood activities. Although employment is the second most important source of inequality, the relative contribution of environmental income to total household income surpasses that of wage income.

If we compare the two scenarios, with and without wildlife resources, we find that agriculture remains both the most important income component and also the most important source of rural inequality though wage income quickly catches up as another important source of inequality if wildlife is excluded from the analysis. The without wildlife scenario severely compromises the relative contribution of environmental income which is now completely overshadowed by employment or wage income. Our results cast doubt on the credibility of capital income, transfers and remittances as important sources of income in the study area. Furthermore, the relative contribution of these income sources is not affected by the inclusion or removal of wildlife resources. The same conclusion is quickly arrived at if we consider the results of the Shapely decomposition technique in table A.5 in the annexes.

The use of the FGT decomposition approach brings in a different flavour to the analysis by making use of the idea of the relative poverty line which is missing in the Rao decomposition approach. Table 13 presents the FTG decomposition results based on the relative poverty line with and without wildlife resources. The first column shows the income share of each income source. The results confirm that employment, agriculture and environmental income are the most important sources of income in the study area. Considering the headcount ratio and accounting for wildlife income, our results show striking similarities between the relative contribution of environmental income and agricultural income to total household income when the poverty line is pegged at US$360.00 per capita. However, the poverty gap and poverty severity measures indicate that the relative contribution of environmental income clearly surpasses that of agricultural income and employment. If we change the poverty line from US$360.00 to US$450.00 while holding other things constant, the relative contribution of agricultural income dominates that of environmental income only for the headcount ratio. The results, however, remain the same under other two measures of poverty.

With the removal of wildlife, the relative contribution of agricultural income completely overshadows that of environmental income for all the three measures of poverty. At the same time, the relative contribution of farm income increases tremendously, while that of environmental income worsens or plunges to lower levels. The contribution of wage income is also increased but slightly when compared to farm income implying that in the absence of wildlife income, employment also becomes an important contributor to total household income. These results seem to suggest that the exclusion of wildlife severely compromises the relative contribution of environmental resources to the livelihoods of poor rural communities living adjacent to the national park in the study area. The fact that the relative contribution of farm income completely dominates that of environmental income as we move from a lower to a higher poverty line suggests that the relative contribution of environmental income to total household income might be more pronounced in poor households, while the relative contribution of agricultural income is noticeable in wealthy households.

3.7 Econometric modelling of the relationship between relative poverty and environmental income

To examine the nature of the relationship between poverty (measured in relative terms) and environmental income we used regression analysis. Firstly, the ordered logit model is used to establish whether environmental income has differential impact on households in different income quintiles. To derive the dependent variable, sampled households were grouped into five categories of income, namely, low income, lower middle income, middle income, upper middle income and higher income[16]. We can also think of these income categories in terms of relative poverty, i.e., households in the first quintiles are relatively poor than households in the second, third, fourth and fifth income quintile while households in the second quintile are relatively less poor than households in the first quintile but relatively poorer than those in upper quintiles and so on.

Secondly, the paper used both ordinary least squares (OLS) technique and instrumental variables estimation with heteroskedasticity-based instruments to model the determinants of environmental income generated by these poor households. We suspect the endogeneity problem to exist between environmental income and household wealth. The test for endogeneity revealed that the instrumental variables estimation with heteroskedasticity-based instruments could be better than the OLS results. However, for the purposes of comparison, we present the results of both models, but the OLS results are not interpreted. The VIF tests for the two models whose results are interpreted and discussed below rule out the possibility of multicolinearity among the explanatory variables (see table A.6 in the annexes).

Table 14 below presents the results of the ordered logistic model of the relationship between poverty (measured in relative terms) and environmental income, plus other household characteristics. The model is highly significant (at 1% sig. level) and tells us that the amount of environmental income generated by households, educational level of the household head, whether the household head is employed or not, household size, religion of the household head and tenure have an effect on households in the different income quintiles or relative poverty. There is no evidence of the effects of the age of the household head and whether or not the he/she was born in the area on the dependent variable.

As anticipated, the coefficient of environmental income is positive and highly significant. The results suggest that the likelihood of households moving from lower income quintiles to higher quintiles rises with an increase in environmental income generated by households. In other words, the chance of belonging to a wealthier category of income increases with an increase in environmental income. Considering table A.7 in the annexes, the marginal effect of environmental income is very small, suggesting that only households that are positioned on the boundary might be able to move to the next income quintile because of the increase in environmental income, while its impact may be less pronounced for households that are located further away from the boundary. Although environmental income might not be able to push household further away from the boundary into the next income class, we argue that such households are better off since they are less poor with environmental income than without it.

The coefficients of education, employment status and religion are also positive and significant, while household size and tenure have negative and significant coefficients. These results suggest that the likelihood of belonging to a wealthier category of income increases with educational attainment and employment. This might be true if wage income is substantial enough to impact

[16]Note: The environmental income (EI) is excluded from the dependent variables since it also appears on the right hand side (RHS) of the equation.

positively on total household income. Educated household heads find it easier to secure employment than his or her uneducated counterparts. Being a Christian increases the likelihood of belonging to a wealthier class. The likelihood of belonging to a wealthier category of income diminishes with household size. This might be true because a larger household implies many mouths to feed. This is a problem especially when the majority of the household members are unemployed. The likelihood of belonging to a wealthier category also diminishes as we move from resettlement schemes to communal areas. Evidence gathered through qualitative interviews established that households in the former tenure regime are relatively richer than households in the latter.

Table 15 present the results of the determinants of environmental income generated by household living adjacent to the Gonarezhou National Park. The instrumental variables estimation model explains about 73.3% of the variation in our dependent variable. The endogeneity test suggests that instrumental variables estimation yields better results than OLS. Both the Kleibergen-Paap LM test for underidentification and the Hansen J statistic for overidentification show that it is safe to proceed with the instrumental variables estimation procedure. Moreover, the number of explanatory variables that are significant increases, and the value of R-squared and significance level also improve. All variables were significant except for area under crop cultivation, whether or not the household head live on the farm and whether or not the household head was born in the area.

As expected, household wealth significantly and positively affect environmental income generated by households. The relationship between environmental income and wealth has got some interesting policy implication given that wealthier households accumulate more assets to harvest more environmental resources than relatively poor households. This implies that wildlife-based land reform also needs to empower poor households in the area of capital accumulation while imposing restraint on capital investments by well-off households. We also expected the age of the household head and household size to have a positive relationship with environmental income. Thus, as the household head grows older, household size increases and the amount of environmental income generated by the household also increases since the number of people required to harvest environmental resources has increased. Interestingly enough, the results show a negative relationship between the educational attainment of the household head and environmental income. As the number of years in school increases, dependence on environmental income diminishes since the head of the household has more opportunities at his or her disposal because of his or her education. Employment reduces environmental income generated by the household *ceteris paribus.*

Again, being a Christian reduces dependence on environmental resources. Maybe this is because Christian households feel more embarrassed if they are caught cheating or breaking the rules pertaining to resource utilization and overharvesting than non-Christian households. In addition, by virtue of belonging to a group and the fact that Christian households are better educated, there is more social cohesion among group members. Also, when children leave the villages to find greener pastures elsewhere, they keep ties with their relative and send back money in times of need. Blakemore (1975) established that Christian households in Ghana have better education and hence better employment opportunities than non-Christian households. The author further posits that allegiance to Christianity significantly reflects a shift towards the acceptance of formal education, suggesting that Christian households represent 'family environments' generally oriented towards success norms and educational achievement. As discussed above, better education and more employment opportunities will lead to less dependence on the natural capital base.

Our results show that as the distance to the market increases, environmental income generated by households also increases. This might be true because rural households face fewer opportunities as we move further away from the urban areas. If there are fewer opportunities for households, especially employment opportunities, then the natural capital base becomes the most important source of livelihoods. Environmental income also increases as the number of dogs owned by household increases. Dogs are very important and form an integral part of the livelihoods of poor rural households in the study area because of their role in the provision of security at home (sometimes including protecting field crops) and hunting activities.

Our results reveal some evidence of the relationship between benefits and the quality of the resource system. As anticipated, environmental income increases as biodiversity increases[17]. This means that households generated more environmental income in areas with good biodiversity than in areas where there is an unhealthy population of wild animals. Finally, our results also show that households in communal areas generate less environmental resources than households in resettlement schemes. This might be true because households in resettlement schemes are relatively wealthier compared to those in communal areas. As a result, they possess better technology and more assets (e.g., carts, draught power and guns) required to harvest environmental resources. The policy implication of this result is that wildlife-based land reform also needs to empower poor households in communal areas while imposing restraint on well-off households in resettlement schemes.

In this section we have conducted different kinds of analysis to establish the role of wildlife resources in the portfolio or context of environmental income. All the results in this analysis speak to each other since they address key policy issues pertaining to the effects of environmental income on household welfare and its role in alleviating rural poverty and income inequality through its contribution to livelihoods or total household income. Several policy implications can be drawn from this analysis. First, there is need to design policies that increase access to wildlife income by poor rural households living adjacent to national parks since this could have an impact on their welfare. Attention to equity in resource management and access should be a prime consideration, particularly with valuable resources such as wildlife to avoid further marginalisation of the

[17] The Shannon index was used as a measure of the health of biodiversity in the study area. The index provides information about rarity and commonness of wildlife species in the area.

poor. Second, complete devolution of wildlife management into the hands of local communities could help to promote or allow more access to wildlife income and potentially contribute towards reducing poverty and inequality. Finally, wildlife-based land reform also needs to empower poor households in the area of capital accumulation while imposing restraint on capital investments by well-off households.

4 Conclusion and policy implications

Awareness of the importance and value of environmental resources in the livelihoods of poor rural households in developing countries has increased tremendously. As a result, there has been a growing body of literature attempting to quantify the value of environmental resources and their impact on poverty and inequality in the rural economies of Southern Africa. Specifically, wildlife has become popular with policymakers and development practitioners as a vehicle for rural development. However, unequal utilisation of wildlife has resulted in different contributions to livelihoods which require to be examined. Therefore, the main objective of this study was to investigate the effects of environmental resources and, in particular, wildlife on household welfare. Specifically, we asked the following questions: i) Does environmental income (including wildlife) contribute significantly towards total household income, reduction in rural poverty and income inequality? ii) How does environmental income compare with other sources of income? iii) What determines the different amounts of environmental income that households generate?

To address these questions, the paper made use of income quintile analysis, the Foster-Greer-Thorbecke poverty measure, Gini coefficient analysis, Gini decomposition analysis and instrumental variables estimation using heteroskedasticity-based instruments on purpose-collected household data from local communities living adjacent to the Gonarezhou National Park in Zimbabwe whose livelihoods depend on wildlife conservation. By so doing, the paper expands the existing knowledge concerning poverty and inequality versus environmental income nexus. From a policy standpoint, it has also become imperative for policymakers and development practitioners to understand the relative importance of wildlife income in driving rural poverty and inequality as they formulate strategies for operationalising wildlife-based land reform.

A total of 336 interviews were conducted in June/July 2013. In line with previous studies, the sampled households harvested and used an enormous range of environmental resources, which in turn provided a wide range of economic characteristics. Considering major food items and non-food items consumed by local communities around the Gonarezhou National Park, our results show that richer households consume more environmental resources (both food and non-food items) in total than poorer households. Richer households consume more of valuable resources such bush meat, fish, timber, firewood and livestock fodder, while poorer household consume more of less valuable resources such as wild vegetables, wild fruits, insects and thatch grass. As one of the main motivation of this paper, our results suggest that relatively wealthier households consume more wildlife products in total than relatively poor households. However, poorer households derive greater benefit from the consumption of wildlife resources than wealthier households. Furthermore, wealthier households purchase more environmental resources than poorer households, while poorer households sold more environmental resources.

The household income accounts show that wage income, farm income and environmental income are the three most important sources of household income for communities in question. Although agricultural income (35.4%) dominates all the sources of income, the contribution of environmental income (28.7%) is also quite substantial. The increase in total household income resulting from the inclusion of non-wildlife and wildlife resources is much higher for households in lower income quintiles than it is for households in higher quintiles.

Overall, the results illustrate that the proportion of people in the full sample living below the poverty line is greatly reduced as we account for non-wildlife income initially and wildlife income later. The inclusion of non-wildlife resources accounts for approximately 48.1% reduction in poverty, while the inclusion of wildlife resources accounts for 53.6% reduction in poverty. The net effect of wildlife income alone is about 5.5% reduction in the proportion of people living below the poverty line.

The results show a significant reduction in measured inequality when environmental income is considered both without wildlife (11.3%) and with wildlife income (16.1%). Thus, environmental income (with and without wildlife) appears to have a strong and significant equalizing effect on income. In particular, wildlife income has an equalizing effect, bringing about a 5.4% reduction in measured inequality. Disaggregating the Gini indices for our three measures of income by income quintiles, we observe a tremendous reduction in inequality across income quintiles when we consider environmental income with and without wildlife. The reduction in inequality is greater for poorer households than relatively wealthier households. Wildlife alone accounts for about 28.9%, 12.6%, 11.3%, 8.2% and 6.8% reduction in measured inequality. These findings seem to suggest that environmental income and, in particular, wildlife income has a stronger equalizing effect for relatively poor households than wealthier households. As a result, policies that seek to increase access to wildlife income by poor rural communities through IDCP might help to reduce poverty and income inequality in rural areas.

Agriculture is both the most important income component and also the most important source of rural inequality. Considering the headcount ratio and accounting for wildlife income, our results show striking similarities between the relative contribution of environmental income and agricultural income to total household income when the poverty line is pegged at US$360.00 per capita. The without wildlife scenario severely compromises the relative contribution of environmental income which becomes completely overshadowed by both farm and wage income. At the same time, the relative contribution of farm income increases tremendously while that of environmental income worsens or plunges to lower levels.

The results of the ordered logit model suggest that the likelihood of belonging to a wealthier category of income increases with an increase in environmental income. The marginal effect of environmental income is very small. This suggests that only households that are positioned on the boundary will be able to move to the next income quintile because of the increase in environmental income while its impact may be less pronounced for households that are located further away from the boundary. This implies that wildlife has no effect on households that are located further away from the boundaries. As expected, household wealth significantly and positively affect environmental income generated by households. The relationship between environmental income and wealth has got some interesting policy implication given that wealthier households accumulate more assets to harvest more environmental resources. This implies that wildlife-based land reform also needs to empower poor households in the area of capital accumulation while imposing restraint on capital investments by well-off households. Our results reveal some evidence of the relationship between benefits and the quality of the resource system. Households generated more environmental income in areas with good biodiversity than in areas where there is an unhealthy population of wild animals.

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Table 1: Household characteristics by tenure category

Variables	N_i	*Mean*
age of household head	336	48.88
number of years in school	336	5.524
number of years living in the area	336	36.64
household head born in the area [0,1]	336	0.708
religion of household head [0,1]	336	0.592
household size	336	6.423
area under crop cultivation	336	2.656
distance to the nearest town	336	65.45
wealth index	336	31.84
number of dogs	336	1.080

Source: survey results 2013

Table 2: Income quintiles

Income quintiles	**Uppermost income**
1st quintiles	208.35
2nd quintiles	280.63
3rd quintiles	376.23
4th quintiles	495.25
5th quintiles	668.63

Source: survey results 2013

Table 3: Classification of Environmental Resources by Economic Function

Consumption goods	**Inputs**	**Output goods**	**Durables & stocks**
Wild vegetables	Firewood-brick making	Wild vegetable sales	Furniture
Mushroom	Firewood-beer making	Mushroom sales	Timber
Wild fruits	Leaf litter	Wild fruit sales	Firewood store
Bush meat (large animals)	Thatching grass	Bush meat sales	
Small animals	Livestock fodder	Wine sales	
Fish	Termitaria	Firewood sales	
Wild medicines	River sand	Insect sales	
Insects	Watering points	Construction wood sales	
Wine	Pastures	Thatching grass sales	
Firewood (cooking & heating)		Carpentry/furniture sales	
Agricultural implements		Woven goods sales	
Household utensils		Pottery sales	
Woven goods - Baskets		Gold sales	
Pottery		Broom grass	
		Carving	
		Bricks	

Source: Adapted from Cavendish (1999)

Table 4: Quantity consumed by income quintile (kgs)

Variables	**Income quintiles**					**Total**
	1st quintile	*2nd quintile*	*3rd quintile*	*4th quintile*	*5th quintile*	
Quantity of major wild foods items consumed						
vegetables	9.14	7.843	7.455	6.306	4.537	**7.056**
mushroom	0.485	0.56	0.179	0.761	0.946	**0.586**
Insects	11.75	10.6	8.881	7.34	7.981	**9.310**
Fruits	2.787	2.582	1.928	1.067	0.791	**1.831**
honey	0.326	0.328	0.459	0.994	1.545	**0.730**
Sub-total	**24.49**	**21.91**	**18.90**	**16.46**	**15.80**	**19.51**
Wildlife products only						
bush meat	3.397	6.269	8.075	10.537	15.104	**8.676**
small animals	4.787	4.299	4.903	3.903	3.881	**4.355**
Fish	1.809	4.515	5.254	8.313	10.851	**6.148**
Birds	1.934	1.687	1.858	1.082	0.724	**1.457**
Sub-total	**11.93**	**16.77**	**20.09**	**23.84**	**30.56**	**20.64**
Quantity of major non-food items consumed						
timber	19.55	19.85	24.94	26.25	46.04	**27.33**
firewood	664.2	679.9	688.3	754.9	825.9	**722.64**
thatch grass	61.49	59.49	52.84	44.1	39.78	**51.54**
basket	1.897	2.045	2.612	3.343	3.851	**2.750**
livestock fodder	3.235	9.552	9.848	12.16	20.3	**11.02**
Sub-total	**750.374**	**770.840**	**778.514**	**840.756**	**935.873**	**815.271**
Total consumed						
Total	**786.794**	**809.522**	**817.535**	**881.062**	**982.235**	**855.437**

Source: survey results 2013

Table 5: % Household purchased or sold environmental resources by income quintile

Quintile	**% Household purchased or sold environmental resources**	
	Purchased	*Sold*
1st quintile	0.429	0.762
2nd quintile	0.507	0.657
3rd quintile	0.463	0.616
4th quintile	0.582	0.582
5th quintile	0.672	0.367
Total	**0.531**	**0.597**

Source: survey results 2013

Table 6: Household income accounts per adjusted adult equivalent unit per annum

Variable	Obs	Mean	Std. Dev.	Income share
Full time employment	336	60.20	198.4	9.5
Casual labour	336	34.48	43.45	5.4
Self -employment	336	44.65	101.9	7.0
Total wage income	**336**	**139.3**	**228.8**	**21.9**
Crop sales	336	108.9	120.6	17.2
Livestock sales	336	100.3	135.4	15.8
Animal product sales	336	15.26	19.33	2.4
Manure sales	336	0.0818	1.046	0.01
Total farm income	**336**	**224.5**	**216.0**	**35.4**
Income from land rented out	336	0.470	2.460	0.07
Income from draught power hired out	336	41.20	41.66	6.5
Capital income	**336**	**41.67**	**42.02**	**6.6**
State transfers	336	3.237	16.47	0.5
Community projects	336	2.755	14.02	0.4
Food relief	336	6.929	6.902	1.1
Net gifts	336	1.978	7.867	0.3
Total transfers	**336**	**14.90**	**30.18**	**2.3**
Remittances	**336**	**32.59**	**44.32**	**5.1**
Environmental based labour income	336	49.33	83.25	7.8
Wildlife income	336	39.19	46.29	6.2
Environmental income (without wildlife)	336	93.19	91.47	14.7
Environmental income	**336**	**181.7**	**174.8**	**28.7**
Total household income	**336**	**634.7**	**381.6**	**100.0**

Source: survey results 2013

Table 7: Income measures by quintile

Quintile	Standard household income	Total household income without wildlife		Total household income		Effect of wildlife
		Mean	*% change*	*Mean*	*% change*	*% change*
1st quintile	204.6	279.9	36.9	300.1	45.7	7.2
2nd quintile	301.1	405.6	34.7	432.6	45.0	6.6
3rd quintile	367.8	502.4	34.6	542.8	43.6	6.5
4th quintile	527.2	668.3	29.8	710.1	35.7	6.2
5th quintile	867.9	1126.0	26.7	1194.0	32.6	6.0
Total	**453.0**	**595.5**	**31.5**	**634.7**	**40.1**	**6.6**

Source: survey results 2013

Table 8: Comparison of FGT indices assuming a poverty line of US$360.00 per capita

Units of analysis	Mean income	Headcount ratio (%)	Poverty gap	Poverty severity
Standard household income				
All households (N=336)	452.97	47.6	16.6	7.4
1st quintile	204.62	100.0	42.5	20.1
2nd quintile	301.06	100.0	17.1	6.2
3rd quintile	367.75	25.9	9.2	4.2
4th quintile	527.22	0	0	0
5th quintile	867.93	0	0	0
Total household income without wildlife resources				
All households (N=336)	595.50	24.7	5.5	1.7
1st quintile	279.95	100.0	22.7	6.9
2nd quintile	405.59	19.6	0.5	0
3rd quintile	502.44	0	0	0
4th quintile	668.29	0	0	0
5th quintile	1125.96	0	0	0
Total household income with wildlife resources				
All households (N=336)	634.69	22.1	4.3	1.2
1st quintile	300.12	100.0	17.9	4.8
2nd quintile	432.59	0	0	0
3rd quintile	542.76	0	0	0
4th quintile	710.13	0	0	0
5th quintile	1194.00	0	0	0

Source: survey results 2013

Table 9: Gini indices from other studies

Country/study	Indices		% reduction in inequality
	Standard income	*Total household income*	
Zimbabwe (Cavendish, 1999)	0.36	0.30	18.6
Morocco	0.33	-	-
Guinea	0.47	-	-
Lesotho	0.56	-	-
South Africa	0.58	-	-
Zambia	0.46	-	-

Table 10: Gini indices for standard income and total income with & without wildlife

Standard income		Total income (without wildlife)		Total household income	
Estimate	*Std. Error*	*Estimate*	*Std. Error*	*Estimate*	*Std. Error*
0.333176	0.016490	0.295609	0.015028	0.279633	0.013661

Effect of including non-wildlife resources on total household income

Standard income	Total income (without wildlife)	% reduction
0.333176	0.295609	11.28

Effect of including wildlife resources on total household income

Standard income	Total household income	% reduction
0.333176	0.279633	16.07

Contribution of wildlife resources

Total income (without wildlife)	Total household income	% reduction
0.295609	0.279633	5.4

Source: survey results 2013

Table 11: Comparison of the Gini indices by income quintile

Group	Standard income	Total income (without wildlife)		Total household income		Effect of wildlife
	Index	*Index*	*% reduction*	*Index*	*% reduction*	*% reduction*
1st quintile	0.156	0.059	62.1	0.042	73.0	28.9
2nd quintile	0.137	0.060	56.3	0.053	61.6	12.6
3rd quintile	0.144	0.079	44.9	0.070	51.2	11.3
4th quintile	0.132	0.096	27.4	0.088	33.4	8.2
5th quintile	0.275	0.176	21.8	0.164	27.1	6.8
Population	0.333	0.296	11.1	0.280	15.9	5.4

Source: survey results 2013

Table 12: Decomposition of the Gini Index by Incomes Sources - Rao's 1969 Approach

Sources	With wildlife				Without wildlife			
	Income Share	**Concentration Index**	**Absolute Contribution**	**Relative Contribution**	**Income Share**	**Concentration Index**	**Absolute Contribution**	**Relative Contribution**
employment	0.194	0.286	0.0554	0.145312	0.2581	0.328	0.0632	0.213219
	(0.0169)	(0.0625)	(0.0159)	(0.0249)	(0.0162)	(0.0580)	(0.0155)	(0.0449)
agriculture	0.401	0.385	0.155	0.552284	0.4093	0.415	0.166	0.579487
	(0.0153)	(0.0251)	(0.0131)	(0.0429)	(0.0146)	(0.0235)	(0.0124)	(0.0409)
capital	0.0732	0.232	0.0170	0.062878	0.0728	0.263	0.0192	0.06460
	(0.0034)	(0.0255)	(0.0019)	(0.0079)	(0.0034)	(0.0255)	(0.0019)	(0.0077)
transfers	0.0194	0.00289	0.0000056	0.000208	0.0193	0.0450	0.00087	0.002935
	(0.0020)	(0.0892)	(0.0017)	(0.0064)	(0.0020)	(0.0920)	(0.0017)	(0.0059)
remittances	0.0580	0.0675	0.00392	0.014503	0.0577	0.0152	0.00088	0.002965
	(0.0044)	(0.0404)	(0.0024)	(0.0088)	(0.0046)	(0.0439)	(0.0025)	(0.0086)
environmental	0.204	0.0392	0.254	0.205232	0.1827	0.194	0.0500	0.168589
	(0.0242)	(0.0068)	(0.0111)	(0.0520)	(0.0068)	(0.0184)	(0.0047)	(0.0125)
Total	**1.000**	**---**	**0.270**	**1.000000**	**1.0000**	**---**	**0.296**	**1.000000**
	(0.0000)	**---**	**(0.0191)**	**(0.0000)**	**(0.0000)**	**---**	**(0.0193)**	**(0.0000)**

Source: survey results 2013
NB: Shown in brackets are the standard errors

Table 13: Decomposition of the FGT index by income components

Income Source	**Income share**	**Relative contribution**			
		With wildlife		**Without wildlife**	
		Poverty line (360.00)	*Poverty line (450.00)*	*Poverty line (360.00)*	*Poverty line (450.00)*
Headcount (α=0)					
employment	0.194	0.178931	0.193688	0.192810	0.197343
agricultural income	0.401	0.330893	0.383689	0.354966	0.401268
capital income	0.073	0.072899	0.073194	0.085627	0.068350
transfers	0.019	0.018698	0.019432	0.019648	0.019594
remittances	0.058	0.069015	0.058009	0.075116	0.068026
environmental income	0.254	0.339564	0.262998	0.271834	0.254409
Poverty gap (α=1)					
employment	0.194	0.174060	0.175109	0.181909	0.184369
agricultural income	0.401	0.266978	0.281742	0.278442	0.296615
capital income	0.073	0.132913	0.118989	0.140351	0.127007
Transfers	0.019	0.035194	0.031898	0.036525	0.033463
Remittances	0.058	0.098059	0.091576	0.101748	0.095726
environmental income	0.254	0.292795	0.300686	0.261024	0.262819
Poverty severity (α=2)					
employment	0.194	0.170979	0.172269	0.176046	0.178615
agricultural income	0.401	0.247143	0.257112	0.253930	0.266195
capital income	0.073	0.150435	0.141412	0.154699	0.146971
transfers	0.019	0.046950	0.042072	0.048110	0.043337
remittances	0.058	0.110622	0.104853	0.11311	0.107878
environmental income	0.254	0.273870	0.282281	0.254104	0.257004

Source: survey results 2013

Table 14: Ordered logit regression model

Ordered logit estimates	Number of obs	= 336	
	LR chi2(8)	= 99.12	
	Prob>chi2	= 0.000	
Log likelihood = -491.2	Pseudo R2	= 0.0916	
Quintile	**Coef.**		**Std. Err.**
environmental income	0.00118		0.0003***
age of household head	0.00838		0.0106
education of household head	0.671		0.1661***
household head employed [0, 1]	0.457		0.2392*
household size	-0.225		0.0489***
household head born in area [0, 1]	-0.111		0.2344
religion of household head [0, 1]	0.0671		0.2083**
Tenure [0, 1]	-0.884		0.3942**
cut1	-2.026		0.8484
cut2	-0.889		0.8405
cut3	0.0768		0.8393
cut4	1.285		0.8480

Source: survey results 2013

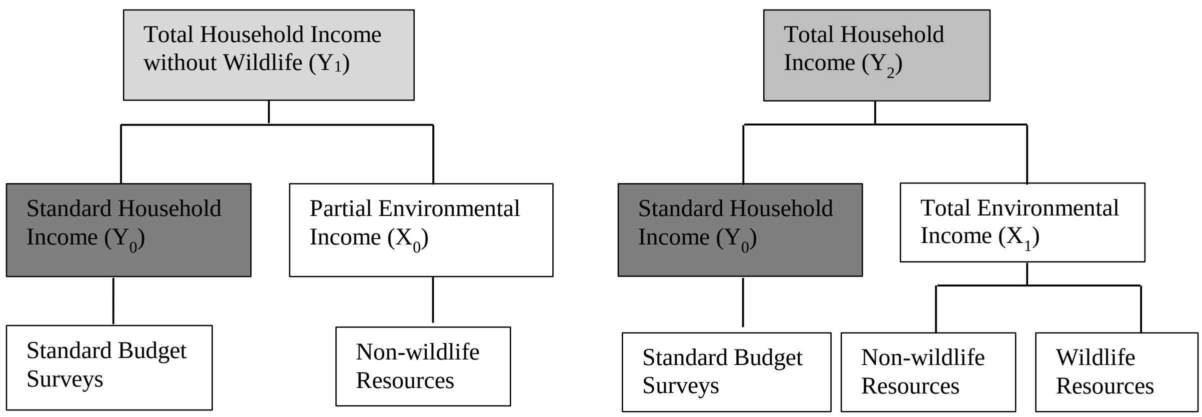
Table 15: Determinants of environmental income generation

	Ordinary Least Squares		IV Estimation	
Environmental income	*Coef.*	*Std. Err.*	*Coef.*	*Std. Err.*
wealth index	7.773***	4.381	8.18***	3.500
age of household head	3.157**	7.608	2.889***	7.462
education of the household head	-51.70**	96.95	-71.98***	98.69
household head employed [0, 1]	-229.1**	174.1	-248.3***	177.1
household head live on the farm [0, 1]	9.074	48.66	4.555	54.03
household head born in this area [0, 1]	189.1	143.0	202.9	151.6
household head is a Christian [0, 1]	-239.1*	133.2	-244.3**	131.6
household size	27.27**	31.79	30.67***	33.90
area under cultivation	14.35	28.64	10.40	54.77
distance to the market	5.292**	3.048	5.473**	2.520
number of dogs	40.45	38.07	42.19*	39.51
biodiversity	104.7*	89.48	99.4**	87.84
tenure [0, 1]	-648.0***	216.2	-644.4***	331.5
constant	227.0	662.6	225.4	774.7
Observations	336		336	
R-squared	0.634		0.733	
Underidentification test (Kleibergen-Paap rk LM statistic):			Chi-square	16.938
			P-value	0.00757
Weak identification test (Cragg-Donald Wald F statistic):			F-statistic	9.206
Hansen J statistic (overidentification test of all instruments):			Chi-square	9.157
			P-value	0.6074

*** p<0.01, ** p<0.05, * p<0.1

Source: survey results 2013

Figure 1: Summary of income measures



Annexes

Table A.1: Poverty analysis results

Alpha	Poverty line	Standard income	Total income without wildlife		Total household income		Effect of wildlife
		Estimate	*Estimate*	*% reduction*	*Estimate*	*% reduction*	*% reduction*
α=0	360	0.476367	0.247451	48.1	0.221038	53.6	5.5
	450	0.643188	0.442539	31.2	0.369323	42.6	11.4
α=1	360	0.165532	0.054980	66.8	0.042633	74.2	7.5
	450	0.246873	0.112226	54.5	0.093163	62.3	7.7
α=2	360	0.074261	0.016523	77.8	0.011573	84.4	6.7
	450	0.122178	0.040607	66.8	0.031729	74.0	7.3

Source: survey results 2013

Table A.2: Comparison of headcounts, poverty gap and poverty severity indices

Poverty line	Units of analysis	Mean income	Headcount ratio (%)	Poverty gap	Poverty severity
	Standard household income				
360	All households (N=336)	452.97	47.6	16.6	7.4
	1st quintile	204.62	100.0	42.5	20.1
	2nd quintile	301.06	100.0	17.1	6.2
	3rd quintile	367.75	9.5	9.2	4.2
	4th quintile	527.22	0	0	0
	5th quintile	867.93	0	0	0
450	All households (N=336)	452.97	64.3	24.7	12.2
	1st quintile	204.62	100.0	54.0	30.8
	2nd quintile	301.06	100.0	31.8	12.9
	3rd quintile	367.75	100.0	16.9	7.2
	4th quintile	527.22	0	0	0
	5th quintile	867.93	0	0	0
	Total household income without wildlife resources				
360	All households (N=336)	595.50	24.7	5.5	1.7
	1st quintile	279.95	100.0	22.7	6.9
	2nd quintile	405.59	100.0	0.5	0
	3rd quintile	502.44	0	0	0
	4th quintile	668.29	0	0	0
	5th quintile	1125.96	0	0	0
450	All households (N=336)	595.50	44.3	11.2	4.1
	1st quintile	279.95	100.0	38.1	15.7
	2nd quintile	405.59	100.0	9.9	1.6
	3rd quintile	502.44	87.2	0.5	0
	4th quintile	668.29	0	0	0
	5th quintile	1125.96	0	0	0
	Total household income with wildlife resources				
360	All households (N=336)	634.69	22.1	4.3	1.2
	1st quintile	300.12	100.0	17.9	4.8
	2nd quintile	432.59	0	0	0
	3rd quintile	542.76	0	0	0
	4th quintile	710.13	0	0	0
	5th quintile	1194.00	0	0	0
450	All households (N=336)	634.69	36.9	9.3	3.2
	1st quintile	298.12	100.0	34.2	12.8
	2nd quintile	430.59	100.0	5.7	0
	3rd quintile	542.76	0	0	0
	4th quintile	713.13	0	0	0
	5th quintile	1193.88	0	0	0

Source: survey results 2013

Table A.3 (a): Test for significance difference between Gini coefficients

Index	Estimate	Std.Err.	t	P>|t|	95% Conf.	Interval
GINI Dis1|	0.333	0.0165	20.21	0.0000	0.301	0.366
GINI Dis2|	0.296	0.0150	19.67	0.0000	0.266	0.325
diff.|	-0.0376	0.00408	-9.203	0.0000	-0.0456	-0.0295

Source: survey results 2013

Table A.3 (b): Test for significance difference

Index	Estimate	Std.Err.	t	P>|t|	95% Conf.	Interval
GINI Dis1|	0.333	0.0165	20.21	0.0000	0.301	0.366
GINI Dis2|	0.280	0.0137	20.47	0.0000	0.253	0.307
diff.|	-0.0535	0.00706	-7.584	0.0000	-0.0674	-0.0397

Source: survey results 2013

Table A.3 (c): Test for significance difference

Index	Estimate	Std.Err.	t	P>|t|	95% Conf.	Interval
GINI Dis1|	0.296	0.0150	19.67	0.0000	0.266	0.325
GINI Dis2|	0.280	0.0137	20.47	0.0000	0.253	0.307
diff.|	-0.0160	0.00454	-3.522	0.0005	-0.0249	-0.00705

Source: survey results 2013

Table A.4: Comparison of the Gini indices by income quintile

Group	**Standard income**		**Total income (without wildlife)**		**Total household income**	
	Index	Std. Err	Index	Std. Err	Index	Std. Err
1st quintile	0.156	0.0124	0.0992	0.00676	0.0921	0.00670
2nd quintile	0.137	0.0129	0.0502	0.00358	0.0426	0.00215
3rd quintile	0.144	0.0187	0.0493	0.00417	0.0403	0.00256
4th quintile	0.132	0.0167	0.0558	0.00431	0.0479	0.00307
5th quintile	0.275	0.0302	0.176	0.0255	0.168	0.0244
Population	0.333	0.0165	0.282	0.0141	0.200	0.0137

Source: survey results 2013

Table A.5: Decomposition of the Gini Index by Incomes Sources – Shapley decomposition (1953)

Source	**With wildlife**			**Without wildlife**		
	Income share	*Absolute Contribution*	*Relative Contribution*	*Income share*	*Absolute Contribution*	*Relative Contribution*
employment	0.194	0.0650	0.160318	0.258086	0.0739	0.279398
agricultural income	0.401	0.133	0.493624	0.399289	0.148	0.500797
capital income	0.0732	0.0157	0.058299	0.072833	0.0176	0.059284
transfers	0.0194	0.00280	0.010360	0.019336	0.00226	0.007630
remittances	0.0580	0.00988	0.036596	0.057723	0.00697	0.023516
environmental income	0.254	0.0433	0.240803	0.192732	0.0472	0.159375
Total	**1.000**	**0.270**	**1.000000**	**1.000000**	**0.296**	**1.000000**

Source: survey results 2013

Table A.6: VIF test results

Model 1 - Ordered logit regression model			*Model 2 - Determinants of environmental income generation*		
Variable	**VIF**	**1/VIF**	**Variable**	**VIF**	**1/VIF**
age of household head	2.100	0.476	tenure	2.320	0.431
education of the household head	1.860	0.538	age of household head	2.100	0.477
household head employed	1.250	0.800	area under cultivation	2.040	0.491
Tenure	1.180	0.849	household head live on the farm	1.510	0.660
household size	1.160	0.864	household head born in this area	1.360	0.734
household head born in this area	1.150	0.869	distance to the market	1.310	0.765
environmental income	1.090	0.920	education of the household head	1.230	0.810
household head is a Christian	1.040	0.958	household head employed	1.180	0.846
Mean	**VIF**	**1.350**	household head is a Christian	1.150	0.867
			household size	1.140	0.877
			number of dogs	1.130	0.886
			biodiversity	1.230	0.725
			Mean	**VIF**	**1.500**

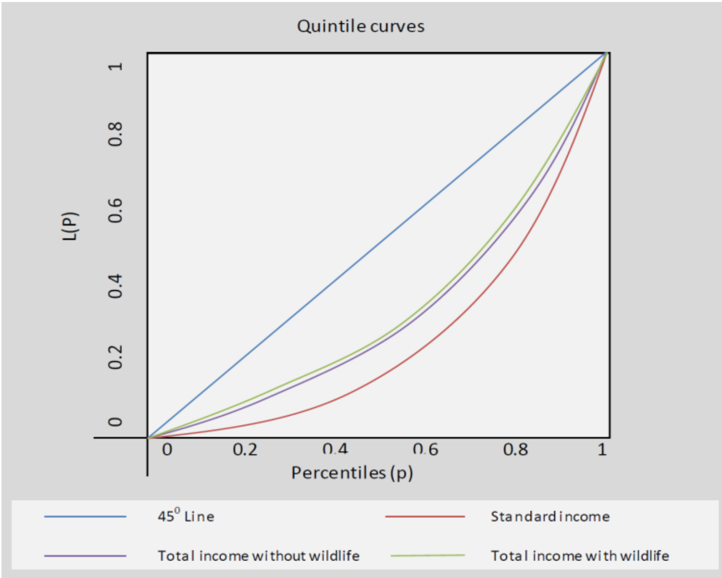
Source: survey results 2013

Table A.7: Marginal effects for the ordered logit model

Average marginal effects	Number of obs = 336	
Model VCE:	OIM	
Expression:	Pr(quintile==),	predict()
dy/dx w.r.t:	environmincome b4_age1 b5a_educ1 b7_occup1 b_hhsize b11_born b12_religion a10_tenure	
		Delta-method
	dy/dx	*Std.Err.*
environmental income	0.0000167***	0.00000385
age of household head	0.00119	0.00151
education of household head	0.0953***	0.0236
household head employed	0.0649*	0.0343
household size	-0.0320***	0.00684
household head born in area	-0.0158	0.0333
religion of household head	0.00954**	0.0295
tenure	-0.126**	0.0565

Source: survey results 2013

Figure 2: Lorenz curves for standard income and total household income with and without wildlife



Source: survey results 2013