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Effects of Wildlife Resources on Community Welfare

Income, Poverty and Inequality

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Herbert Ntuli and Edwin Muchapondwa

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 consume more wildlife products in total than do relatively poor households. However, poorer households derive greater proportional benefit than wealthier households from the consumption of wildlife resources. Excluding wildlife understates the relative contribution of environmental resources while at the same time overstating the relative contribution of farm and wage income. Environmental income has more impact in terms of poverty reduction in the lower income quintiles than in the upper quintiles. Wildlife income alone accounts for about a 5.5% reduction in the proportion of people living below the poverty line. Furthermore, wildlife income has 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 increases with an increase in environmental income. As expected, household wealth significantly and positively affects 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 restraints on the use of capital investments by well-off households to harvest wildlife.

Key Words: wildlife, environmental income, poverty, inequality, Zimbabwe

JEL Codes: D63, I32, I38, Q22

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Effects of Wildlife Resources on Community Welfare

Herbert Ntuli and Edwin Muchapondwa*

1. Introduction

There is increasing consciousness among policymakers, development practitioners and academic scholars about the importance and value of environmental resources¹ in the livelihoods of poor rural communities, including the Southern Africa region (e.g., Cavendish 2000; Fisher 2004; Shackleton and Shackleton 2004; Lopez-Feldman et al. 2007; Thondhlana et al. 2012; Uberhuaga et al. 2012; Fonta and Ayuk 2013; Thondhlana and Muchapondwa 2014). All these studies demonstrated considerable economic contribution made by environmental resources to rural livelihoods. However, based on the studies done in the Southern Africa region so far, it is still not clear how the analysis of environmental income and welfare² is altered when wildlife and 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. This paper argues that wildlife conservation is an important component of environmental income generation for communities living adjacent to the Gonarezhou National Park in Zimbabwe that are participating in the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), a program that seeks to balance both conservation and development goals by including local communities in wildlife management.

Therefore, the purpose of this study is to examine the economic contribution of wildlife resources (as part of the portfolio of environmental income) to household welfare and incentives

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¹ We define environmental resources in this paper as goods that are freely provided by nature or “nature’s bounty” (Cavendish 1999), accessible to everyone in the community, and which community members can collect without incurring any other cost except their own time. Ownership of assets such as carts and dogs helps in the process of collecting environmental resources.

² Household welfare is measured in terms of three dimensions: total household income, poverty and income inequality.

to conserve resources. This study seeks to fill an important gap in the literature. For instance, little is known about the effect of wildlife income on household welfare, i.e., total income, poverty and inequality. It is unquestionable that unequal utilization of wildlife resources results in different contributions to livelihoods among the users of such resources. The different channels through which wildlife contributes to livelihoods need to be investigated in order to inform rural development and conservation policy in Southern Africa.

In addition, little is known about the relative contribution of environmental income (with and without 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; 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 that measures of poverty and inequality are overstated in conventional studies. As a result, such measures do not reflect the true picture on the ground and policies 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 and Campbell et al., 2002; Cavendish 2000). To overcome this challenge, this study made use of purposely-collected survey data capturing both economic and environmental aspects from local communities around the Gonarezhou National Park in Zimbabwe.

In light of the policy issues discussed above, a number of questions arise. How does the utilization 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 toward total household income, reduction in rural poverty and reduction in 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 is organized as follows. Section 2 provides the background and reviews the literature while Section 3 discusses data issues, defines key variables and gives an outline of the research methods, analytical framework and empirical model specifications. We then proceed to discuss the results in Section 4 and end with conclusions and policy implications in Section 5.

2. Background and Literature Review

Poor rural households in Southern Africa depend heavily on the natural capital base to sustain their welfare through the provision of both consumptive and non-consumptive goods (Cavendish 2000; Fisher 2004; Shackleton and Shackleton 2004; Thondhlana et al. 2012; and Thondhlana and Muchapondwa 2014). 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 and Mashinya 2006).

Demonstrating the complementarity between development and conservation goals, which were previously thought to be incompatible, has been on the agenda of regional and international policy since the mid-1980s, when devolution started in Southern Africa (Dubois 2003; Shackleton and Shackleton 2006). Zimbabwe was among the first countries in the region to implement the so-called “people-oriented approaches” to natural resource management and the Communal Areas Management Programme for Indigenous Resources³ (CAMPFIRE) is one good

³ The CAMPFIRE programme was established during the mid-1980s to accommodate peasant farmers in communal areas that are located in the vicinity of national parks (Balint and Mashinya 2006). CAMPFIRE allows local communities to manage wildlife through their respective Rural District Councils and get income from wildlife conservation. It is expected that villagers carry out anti-poaching enforcement in their communal areas because they now benefit from conservation.

example of local communities that are managing natural resources to their own benefit (Murombedzi 1999; and Balint and Mashinya 2006). The livelihood of local communities that are 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 increase livelihood security and reduce rural poverty and inequality but will also provide incentives for conservation and sustainable utilization of resources (Wunder 2001; Thondlana et al. 2012).

Cavendish (2000) identified a number of channels through which environmental resources contribute to rural livelihoods. To begin with, a household 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 resources as inputs in another production activity, 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 talks about the three roles of environmental resources, i.e., preventing poverty by acting as insurance or safety nets (Shackleton et al. 2008; Thondlana and Muchapondwa 2014), reducing poverty via increased earnings (Fisher 2004; Vedeld et al. 2007), and, finally, playing a role in equalizing income (Cavendish 1999; Fonta and 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. Poor rural households use environmental income⁴ as a method of diversification to cushion themselves against shocks associated with illness, crop failure, loss of employment, changes in food prices or extreme weather conditions.

⁴ Environmental income is defined here as the sum of direct use values and cash income derived from environmental resources (Thondlana et al. 2012).

From the literature, a number of issues stand out with regard to the study of the human-environment relationship. 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.

Environmental resources offer goods to rural households that have considerable differentiation in terms of their economic characteristics and utilization (Cavendish (1999; 2000). Shackleton and Shackleton (2006) and Kar and 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 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.

In Southern Africa, poorer households depend heavily on environmental resources, which contribute about 40% to their incomes, although richer households use greater quantities of these resources in total (Cavendish 2000). Through a detailed examination of use and value of four non-timber forest products (NTFPs), Shackleton and Shackleton (2006) found evidence supporting Cavendish's claim that poorer households benefit more than wealthier classes from environmental resource utilization in proportional terms. In addition, wealthier households purchase more NTFPs, while a greater proportion of poor households were actually involved in selling NTFPs (McGregor 1995; and Shackleton and Shackleton 2006). Richer households generated more environmental income in total than poorer households because they have more man-made assets, which are helpful in collecting resources (Cavendish 1999; Uberhuaga et al. 2012; Ambrose-Oji 2003).

There are mixed results with regard 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 that such resources can mitigate poverty and at least make some households less poor. For example, Cavendish (1999) reported that environmental income is important in mitigating poverty but might not be responsible for lifting poor households out of poverty. In contrast, in a study of forest income and resource dependence in lowland Bolivia, Uberhuaga et al. (2012) reported that forest income has the potential to move households out of poverty provided environmental resources are fully commercialized and 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.

There is general consensus about the role of environmental income in reducing rural inequality (Cavendish 2000; Cavendish and Campbell et al., 2002; Fisher 2004; Vedeld et al., 2007; Fonta et al. 2011). For example, using a sample of 213 households from rural Zimbabwe, Cavendish and Campbell et al. (2002) found that environmental income is strongly and significantly equalizing⁵, 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. This paper fills in gaps in this literature by defining two categories of environmental income (with and without wildlife), whereas other studies concerned themselves with the broader environmental income category.

3. Research Methods

3.1 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°40'S and 31°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 5053 km² 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 499 mm, with a standard deviation of about 195 mm, 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

⁵ 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.

respectively (Gandiwa 2011). The vegetation of the Gonarezhou ecosystem is typical semi-arid savanna and is dominated by *Colophospermum mopane* woodlands (Gandiwa and 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; other ethnic groups such as the Venda, Ndau, Shona and Ndebele people are also found in the area. Apart from the CAMPFIRE programme (which accounts for over 90% of the local communities involved in wildlife conservation), there are also peasant farmers operating under resettlement schemes⁶ (slightly less than 10%) who are involved in wildlife conservation in the area. Comparing households in communal areas and those in resettlement schemes might be problematic because the sample for the latter tenure regime is quite small relative to the former⁷. The mode of production of peasant farmers in both communal areas and resettlement schemes is primarily subsistence 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, in 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 informant⁸. A simple random sample of households was then drawn using the list of households provided by the chairperson

⁶ The resettlement scheme is a product of the government of Zimbabwe's land reform program created after independence in 1980 when the country embarked on a land redistribution exercise, in which some of the land that belonged to large-scale commercial farmers was transferred to poor households from the overcrowded communal areas (Mushunje et al., 2003).

⁷ 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.

⁸ Local communities are required by the government to organize and form wildlife management committees in order to participate and to benefit from wildlife conservation. All the communities visited during the field work had committees in place; the only difference among them was the extent to which these committees are functional and involved in wildlife management.

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.

3.2 Empirical Strategy

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

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 all household economic activities (i.e., wage income, remittances, gifts and 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 household income is used as the baseline against 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).

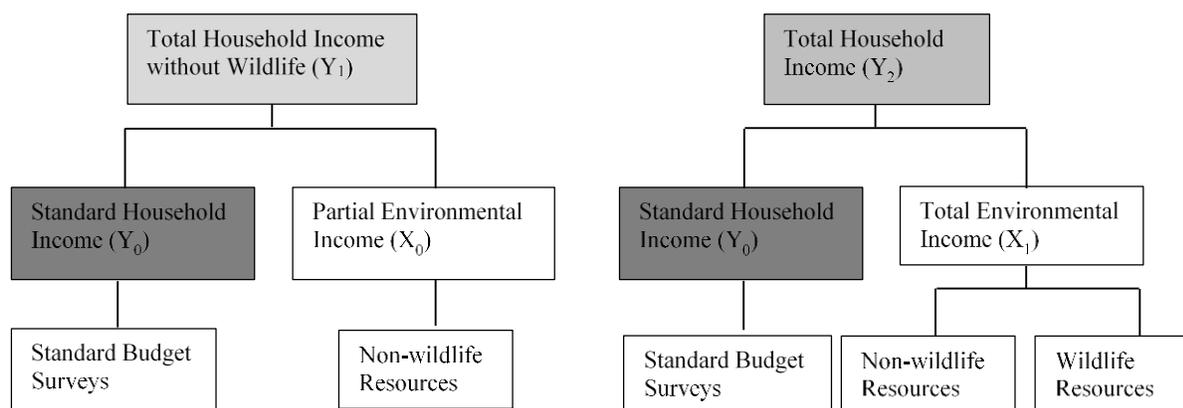
Because we are dealing with local communities living adjacent to a game park and whose livelihoods depend on wildlife conservation, the main goal of this paper is to examine the effects of wildlife resources on welfare. We are concerned with two scenarios, i.e., with and without wildlife. As a result, a distinction is made between non-wildlife and wildlife income. Wildlife income captures household consumption and sales of bush meat, small animals, fish and birds (illegal harvest), in addition to income generated from legal activities which include the money and meat from wild animals killed through trophy hunting⁹ in the community's conservation

⁹ Local communities get income from legal hunting activities by engaging a Safari operator or local professional hunter who utilizes the quota on their behalf.

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, to take care of 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 because 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.

Figure 1: Summary of Income Measures



Cavendish (1999) highlighted a number of controversies in poverty research when it comes to measuring poverty and the choice of a measure of welfare. Our study follows standard practice in poverty research, considers these issues, and chooses 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 poverty measures to different poverty lines is therefore more important than a point estimate of poverty. Following Cavendish (1999), this study uses 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 quintile¹⁰ 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 and their uses and values as part of household 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 prices¹¹ 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 in that 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

¹⁰ 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 the neighbourhood socio-economic status.

¹¹ Market prices are ideal because they represent clearing prices.

quantitative data was supplemented by qualitative data collected through key informant interviews.

The Foster-Greer-Thorbecke (FGT) poverty measure: The Foster-Greer-Thorbecke (FGT) metric¹² 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 making people less poor than they were without it? Hence the FGT metric measures the income shortfall expressed as a share of the poverty line and is weighted by a “sensitivity parameter” α (Donaldson and Weymark 1986). Algebraically, we have:

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

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 corresponds 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 Atkinson (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 the lowest incomes (i.e., furthest below z). A very high FGT statistic implies more poverty in the economy.

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

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

¹² The FGT class of decomposable poverty measures discussed in this sub-section was first introduced by Foster et al. (1984).

If $\alpha = 1$, then the FGT metric reduces to the average poverty gap¹³, that is, the average amount of income required to move those in poverty up the poverty line. Thus, we have:

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

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

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

Using such a tractable form, the statistic combines information on both poverty and income inequality¹⁴. Rewriting the FGT statistic, we obtain:

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

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

Gini coefficient analysis: To establish whether environmental income reduces rural inequality, the Gini coefficient method is employed. The Gini index is a summary statistic that measures how equitably or inequitably 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.¹⁵ Therefore, the Gini coefficient can be thought of as

¹³ This is equivalent to the amount an average person in the economy would have to contribute in order for poverty to be barely eliminated. The poverty gap index estimates the depth of poverty by considering how far, on average, the poor are from that poverty line.

¹⁴ The FGT also considers inequality among the poor, but, as the proper amount for α is not defined (i.e., it is a normative question), we are not able to say that the Gini coefficient is part of the FGT.

¹⁵ By definition, the Lorenz curve shows the distribution of a quantity in a population. For a resource Q , the Lorenz curve 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 ,

the ratio of the area that lies between the line of equality (i.e., the 45⁰ 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 equity, i.e., the 45⁰ line, as follows:

$$G = 2 \int_0^1 [P - L(p)] dp \dots (6)$$

where the factor 2 scales the area in such a way that the Gini index varies between 0, perfect equity 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:

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

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 analysis: In this study, we expand the six variables used in Leibbrandt et al. (2000) and include environmental income. By going deeper into each and every component, we ask whether there are any policy interventions that can either increase or decrease income generation.

Following Leibbrandt et al. (2000) and Shorrocks (1983), we assume n households deriving income from K different sources. Let y_i represent the total household income $i = \{1, \dots, n\}$ and y_{ik} represent total income for household i and source $k = \{1, \dots, K\}$; hence, $y_i = \sum_{k=1}^K y_{ik}$. Assuming that the distribution of household income and the income components are represented by $\gamma = \{y_1, \dots, y_n\}$ and $\gamma_k = \{y_{1k}, \dots, y_{nk}\}$ respectively, the Gini coefficient for the distribution of total income within the group can be defined as:

then the order of our imaginary line-up would be completely arbitrary and $L(p) = p$, the curve of perfect equilibrium.

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

where μ represents mean household income, $F(\gamma)$ is the cumulative distribution of total household income, i.e., $F(\gamma) = f(y_1), \dots, f(y_n)$, 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:

$$G = \sum_{k=1}^K R_k G_k S_k \dots(9)$$

where S_k denotes the share of income source k in total group income, i.e., $S_k = \mu_k / \mu$, G_k represents 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:

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

To check for robustness of our results, we consider results from the Gini decomposition using the analytical approach of Rao's (1969) method, 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. First, does environmental income affect households in various income quintiles in the same way? Second, 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 these assertions are 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 restraints 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 poorer than households in a higher quintile. Algebraically, we can write the following model.

$$Y_i = \beta_0 + \beta_1 Age + \beta_2 Areacult + \beta_3 EI + \beta_4 Hhsize + \beta_5 Employ + \beta_6 Lhead + \beta_7 Educ... + \xi_i \dots (11)$$

where the explanatory variables in equation 11 are defined as follows: age of household head (Age), area under crop cultivation (Areacult), environmental income (EI), household size (Hsize), household head employed (Employ), number of years living in the area (Lhead), and number of years of school of the household head (Educ).

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

$$EI_i = \beta_0 + \beta_1 S_i + \beta_2 W_i \dots + \mu_i \dots (12)$$

where EI_i represents environmental income, S_i denotes household characteristics, W_i indicates household wealth and μ_i is the error term. As is common in the economics literature, the wealth variable is recovered from household assets, livestock ownership and agricultural implements (Shackleton and Shackleton 2006). In this study, it is assumed that, as household wealth increases, people invest in technology such as carts and draught power to harvest more environmental resources. Conversely, as households obtain 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 that endogeneity is an issue in this relationship. In such a case, the most appropriate way forward is using an instrumental variables regression model. However, because it is difficult to find sound external instruments for use in traditional instrumental variables estimation, this study makes use of instrumental variables estimation with heteroskedasticity-based instruments that methodologically deal with the endogeneity problem (Lewbel 2012; and Baum et al. 2013).

Based on Lewbel (2012), this method estimates an instrumental variables regression model that provides 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 are a key feature of models where the correlations in the error terms are due to an unobserved common factor (Baum et al. 2013). Because 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 may be used to supplement weak external instruments in order to improve the efficiency of the instrumental variables estimator (Lewbel 2012).

4. Results and Discussion

4.1 Household Characteristics

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 dogs¹⁶ owned for the sampled population are 48.9 years, 5.52 years, 36.6 years, 6.4, 2.7 ha, 65.5 km and 1.1 respectively. The proportion of household heads born in the area is about 70.8% while the proportion of household heads who are Christians is 59.2%. Using a scale from zero to one hundred, the mean wealth index (31.8) shows that the average household in the sampled population is generally poor, i.e., the index lies below half (50.0).

¹⁶ The number of dogs owned by a household matters in this analysis because dogs are used by local people for hunting purposes.

Table 1: Household Characteristics by Tenure Category

Variables	<i>N_i</i>	<i>Mean</i>
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

Households were categorized in terms of income quintiles. Five categories of income corresponding to the 1st, 2nd, 3rd, 4th and 5th 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 makes use of two poverty lines widely used 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, 2013). 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.

Table 2: Income Quintiles

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

Source: survey results 2013

4.2 Utilization of Environmental Resources

There are a number of resources from which communities living adjacent to the Gonarezhou National Park derive their livelihoods; these include 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 keep¹⁷ the land which usually lies 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 only as a community, through trophy hunting and tourism activities conducted 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 categorized 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 over time. If such institutions are not in place, then the resource system is subject to an open access regime.

¹⁷ Local communities are allowed to manage the conservation land to their own advantage in accordance with CAMPFIRE.

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
Mushrooms	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)

* A nest built by a colony of termites underground or above ground (usually as a mound). Poor rural households in Southern Africa use the soil from this nest to improve the soil nutrients in their fields.

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), Cavendish (2000), Shackleton and Shackleton (2006), and Thondhlana and Muchapondwa (2014). In line with the study of Twine et al. (2003), richer households consume more of valuable resources such as 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 motivations of this paper, our results reveal that relatively wealthier households consume more wildlife products in the aggregate than do relatively poor households.

Table 4: Quantity Consumed by Income Quintile (kgs)

Variables	Income quintiles					Total
	1 st quintile	2 nd quintile	3 rd quintile	4 th quintile	5 th quintile	
<i>Quantity of major wild foods items consumed</i>						
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
<i>Wildlife products only</i>						
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
<i>Quantity of major non-food items consumed</i>						
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
<i>Total consumed</i>						
Total	786.794	809.522	817.535	881.062	982.235	855.437

Source: survey results 2013

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 did poorer households, while poorer households sold more environmental resources.

Table 5: % Household Purchased or Sold Environmental Resources by Income Quintile

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

Source: survey results 2013

4.3 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. Environmental income is made up of environmental-based labour income¹⁸, wildlife income and other environmental resources, each contributing 7.8%, 6.2% and 14.7% respectively to total household income.

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

¹⁸ Environmental-based labour income includes labour income derived from harvesting and processing environmental resources, such as digging termitaria, thatching, brick moulding, etc.

To examine the contribution of environmental income to total household income, the paper used income quintile analysis. Three definitions of income are used to accomplish this objective: standard household income, total household income without wildlife (including standard household income and non-wildlife income), and total household income (including standard household income, non-wildlife income and wildlife income). 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 and illegal hunting activities (game meat consumed by the household out of its own production and income realized from selling game meat).

In the aggregate, non-wildlife environmental 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 and Shackleton (2006) and Thondhlana and Muchapondwa (2014) that poor households derive greater relative benefits than richer households from utilizing environmental resources. Our contribution is to show that, in particular, poorer households derive greater benefit from the consumption of wildlife resources than wealthier households.

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
1 st quintile	204.6	279.9	36.9	300.1	45.7	7.2
2 nd quintile	301.1	405.6	34.7	432.6	45.0	6.6
3 rd quintile	367.8	502.4	34.6	542.8	43.6	6.5
4 th quintile	527.2	668.3	29.8	710.1	35.7	6.2
5 th 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

4.4 Environmental Income and Poverty

Table 8 below presents the results of the FGT poverty statistics. Three measures of poverty are used: the headcount ratio, the poverty gap, and the poverty severity measure. Overall, the results illustrate that the proportion of people in the full sample living below the poverty line is greatly reduced when we account for non-wildlife income initially and wildlife income later (i.e., from about 47.6% to 24.7% and then to 22.1%). 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 a 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 is reduced from 16.6% to 5.5% with non-wildlife income and then to 4.3% with wildlife income.

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

Source: survey results 2013

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 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 throughout 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.

4.5 Environmental Income and Inequality

This section discusses the sample estimates of measured inequality for Rao's (1969) approach, Shapley (1953) decomposition and 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 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 shows a significant reduction in measured inequality when environmental income is considered both with wildlife income (16.1%) and without wildlife (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 also has 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 Integrated Conservation and Development Projects might help reduce income inequality in rural areas. These results are also supported in Figure A.1 in the annexes.

Table 10: Gini Indices for Standard Income and Total Income With & Without Wildlife

Standard income		Total income (without wildlife)		Total household income	
<i>Estimate</i>	<i>Std. Error</i>	<i>Estimate</i>	<i>Std. Error</i>	<i>Estimate</i>	<i>Std. Error</i>
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

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 1st, 2nd, 3rd, 4th and 5th 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 for wealthier households. This might be true because the ratio of environmental income to total household income is very high for relatively poor households compared to richer households, implying 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.

Table 11: Comparison of the Gini Indices by Income Quintile

Group	Standard income	Total income (without wildlife)		Total household income		Effect of wildlife
	<i>Index</i>	<i>Index</i>	<i>% reduction</i>	<i>Index</i>	<i>% reduction</i>	<i>% reduction</i>
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

4.6 Contribution of Individual Income Sources to Total Household Income

Six income sources were considered: employment, agricultural income, capital, transfers, remittances and environmental income. As noted earlier, three different approaches were employed to check for robustness of our results, i.e., Rao's (1969) method, Shapley's (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 scarcer in rural Zimbabwe than in South Africa and because most households depend more heavily on agriculture (crop cultivation and livestock rearing) than on any other livelihood activities. Although employment is the second most important source of inequality in our study, 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, but wage income is quickly catching 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.

Table 12: Decomposition of the Gini Index by Income 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 (0.0169)	0.286 (0.0625)	0.0554 (0.0159)	0.145312 (0.0249)	0.2581 (0.0162)	0.328 (0.0580)	0.0632 (0.0155)	0.213219 (0.0449)
agriculture	0.401 (0.0153)	0.385 (0.0251)	0.155 (0.0131)	0.552284 (0.0429)	0.4093 (0.0146)	0.415 (0.0235)	0.166 (0.0124)	0.579487 (0.0409)
Capital	0.0732 (0.0034)	0.232 (0.0255)	0.0170 (0.0019)	0.062878 (0.0079)	0.0728 (0.0034)	0.263 (0.0255)	0.0192 (0.0019)	0.06460 (0.0077)
Transfers	0.0194 (0.0020)	0.00289 (0.0892)	0.0000056 (0.0017)	0.000208 (0.0064)	0.0193 (0.0020)	0.0450 (0.0920)	0.00087 (0.0017)	0.002935 (0.0059)
remittances	0.0580 (0.0044)	0.0675 (0.0404)	0.00392 (0.0024)	0.014503 (0.0088)	0.0577 (0.0046)	0.0152 (0.0439)	0.00088 (0.0025)	0.002965 (0.0086)
environmental	0.204 (0.0242)	0.0392 (0.0068)	0.254 (0.0111)	0.205232 (0.0520)	0.1827 (0.0068)	0.194 (0.0184)	0.0500 (0.0047)	0.168589 (0.0125)
Total	1.000 (0.0000)	--- ---	0.270 (0.0191)	1.000000 (0.0000)	1.0000 (0.0000)	--- ---	0.296 (0.0193)	1.000000 (0.0000)

Source: survey results 2013

Standard errors are shown in brackets

The use of the FGT decomposition approach brings 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 present 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 but the results remain the same under the other two measures of poverty.

With the removal of wildlife, the relative contribution of agricultural income completely overshadows that of environmental income for all three measures of poverty. At the same time,

the relative contribution of farm income increases tremendously, while that of environmental income plunges to lower levels. The contribution of wage income is also increased, but only 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.

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)
<i>Headcount ($\alpha=0$)</i>					
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
<i>Poverty gap ($\alpha=1$)</i>					
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
<i>Poverty severity ($\alpha=2$)</i>					
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	0.113111	0.107878
environmental income	0.254	0.273870	0.282281	0.254104	0.257004

Source: survey results 2013

4.7 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 a differential impact on households in different income quintiles. To derive the dependent variable, sampled households were grouped into five categories of income: low income, lower middle income, middle income, upper middle income and higher income¹⁹. We can also think of these income categories in terms of relative poverty, i.e., households in the first quintiles are relatively poorer than households in the second, third, fourth and fifth income quintiles, 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, we use both the 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 that an endogeneity problem exists 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 purposes of comparison, we present the results of both models but do not interpret the OLS results. The VIF tests for the two models whose results are interpreted and discussed below rule out the possibility of multicollinearity 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 the 1% level) and tells us that the amount of environmental income generated by households, educational level of the household head, whether or not the household head is employed, household size, religion of the household head and tenure have an effect on households in the different income quintiles of relative poverty. There is no evidence of the effects on the dependent variable of the age of the household head and whether or not he or she was born in the area.

¹⁹ Note: The environmental income (EI) is excluded from the dependent variables because it also appears on the right-hand side of the equation.

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 increases 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 farther away from the boundary. Although environmental income might not be able to push households farther away from the boundary into the next income class, we argue that such households are better off in that they are less poor with environmental income than without it.

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

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 has a substantial positive impact on total household income, while educated household heads find it easier to secure employment than their 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 are households in the latter.

Table 15 present the results of the determinants of environmental income generated by households 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. Moreover, the number of explanatory variables that are significant increases, while the value of R-squared and the significance level also improve. All variables were significant except for area under crop cultivation, whether or not the household head lives on the farm and whether or not the household head was born in the area.

As expected, household wealth significantly and positively affects environmental income generated by households. The relationship between environmental income and wealth has some interesting policy implications given that wealthier households accumulate more assets that can be used 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 restraints on well-off households' use of capital investments to harvest resources. We also expect 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 because the number of people available 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 because the head of the household has more opportunities at his or her disposal due to this educational attainment. Employment reduces environmental income generated by the household *ceteris paribus*.

Table 15: Determinants of Environmental Income Generation

Environmental income	Ordinary Least Squares		IV Estimation	
	<i>Coef.</i>	<i>Std. Err.</i>	<i>Coef.</i>	<i>Std. Err.</i>
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 lives 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

Again, being a Christian reduces dependence on environmental resources. Blakemore (1975) established that Christian households in Ghana have better education and hence better employment opportunities than non-Christian households. The author argues further that allegiance to Christianity significantly reflects a shift toward the acceptance of formal education, suggesting that Christian households represent “family environments” generally oriented towards success norms and educational achievement to a greater degree than non-Christian homes. As discussed above, better education and more employment opportunities will in turn lead to less dependence on the natural capital base. In addition, by virtue of belonging to an organized group, there is more social cohesion among group members; also, when children leave the villages to find greener pastures elsewhere, they keep ties with their relatives and send back money in times of need.

Our results show that, as the distance to the market increases, environmental income generated by households also increases. This might be the case because rural households face fewer opportunities as we move farther 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 increases²⁰. This means that households generate more environmental income in areas with good biodiversity than in areas where there is an unhealthy population of wild animals (too few). Finally, our results also show that households in communal areas collect fewer environmental resources than do households in resettlement schemes. This might be the case because households in resettlement schemes are relatively wealthier compared to those in communal areas and, as a result, possess better technology and more assets (e.g., carts, draught power and guns) that are useful in harvesting 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 harvesting by well-off households in resettlement schemes.

5. 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 utilization of wildlife has resulted in different contributions to livelihoods. 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 toward total household income and reduction in rural poverty and income inequality? ii) How does environmental income (specifically, wildlife income) compare with

²⁰ 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.

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 purposefully-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 the nexus between poverty and inequality and environmental income. 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.

The households sampled in this study harvested and used an enormous range of environmental resources which in turn provided a wide range of economic benefits. 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 do poorer households. However, poorer households derive proportionally greater benefits from the consumption of wildlife resources compared to wealthier households. Richer households consume more of valuable resources such as bush meat, fish, timber, firewood and livestock fodder, while poorer households consume more of the less-valuable resources, such as wild vegetables, wild fruits, insects and thatch grass. Furthermore, wealthier households purchase more environmental resources than poorer households, while poorer households sold more environmental resources.

Wage income, farm income and environmental income are the three most important sources of household income for the 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 when we account for non-wildlife environmental resource income initially and wildlife income later. The inclusion of non-wildlife resources accounts for approximately a 48.1% reduction in poverty, while the inclusion of wildlife resources accounts

for a 53.6% reduction in poverty. The net effect of wildlife income alone is about a 5.5% reduction in the proportion of people living below the poverty line. The separate consideration of wildlife and non-wildlife income is a key contribution of this paper.

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 for relatively wealthier households. Wildlife alone accounts for about 28.9%, 12.6%, 11.3%, 8.2% and 6.8% of the 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 for wealthier households. As a result, policies that seek to increase access to wildlife income by poor rural communities through IDCP might 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 in the area studied. 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 in the without-wildlife scenario while that of environmental income 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, suggesting that only households that are positioned on the boundary will be able to move to the next income quintile because of an increase in environmental income, while the impact of environmental income in general and wildlife in particular may be less pronounced for households that are located farther away from the boundary. As expected, household wealth significantly and positively affects environmental income generated by households.

Finally, 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.

All the results in this analysis speak to each other by addressing 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 a need to design policies that increase access to legal wildlife income by poor rural households living adjacent to national parks because 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 marginalization of the poor. Second, increased devolution of wildlife management into the hands of local communities could allow more access to wildlife income and potentially contribute toward reducing poverty and inequality. Finally, the relationship between environmental income and wealth has some interesting policy implications given that wealthier households accumulate more assets with which to harvest more environmental resources. Wildlife-based land reform also needs to empower poor households in the area of capital accumulation while imposing restraint on harvesting by well-off households.

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Annexes

Table A.1: Poverty Analysis Results

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

<i>Model 1 - Ordered logit regression model</i>			<i>Model 2 - Determinants of environmental income generation</i>		
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 lives 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

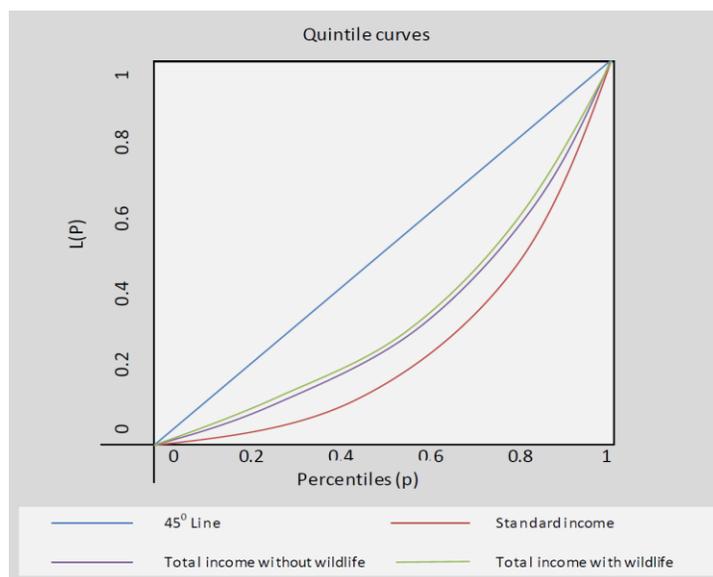
Source: survey results 2013

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	
	<i>dy/dx</i>	<i>Std.Err.</i>
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 A.1: Lorenz Curves for Standard Income and Total Household Income With and Without Wildlife



Source: survey results 2013