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Zambia Buyin

THE VALUE OF NON-TIMBER FOREST PRODUCTS IN ZAMBIA: INDIRECT AND NON-USE BENEFITS

By

Hambulo Ngoma, Paul Samboko, Chewe Nkonde, and Davison Gumbo

Food Security Policy *Research Papers*

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EXECUTIVE SUMMARY

The potential of a sustainable forest resource base to contribute to improved livelihoods is central in the development discourse. In sub-Saharan Africa and Zambia in particular, the missing piece in this narrative has been the availability of reliable data estimates of the extent to which forests contribute to key economic indicators such as gross domestic product (GDP). In this paper, we augment recent empirical strides that have been made in Zambia to estimate direct use values of non-timber forest products (NTFPs) by estimating the indirect and non-use values of these products.

Our data are drawn from a primary contingent valuation survey of 352 households randomly selected from seven rural districts of Zambia. The survey elicited households' willingness to pay (WTP) to preserve NTFPs for their indirect and non-use benefits (mostly ecosystem services) using the double bounded dichotomous question format. The current study addresses the following key questions: 1) What are the key indirect and non-use benefits for NTFPs in Zambia? 2) What is the economic value of the indirect and non-use benefits for NTFPs in Zambia? 3) What drives WTP to preserve NTFPs in Zambia? We highlight the key findings, conclusion and policy implications in turn.

Key Findings

- Among interviewed households, about 60 and 30 % consider erosion control and climate regulation, respectively, as the two most important indirect-use benefits of, or ecosystem services associated with NTFPs in Zambia. On the other hand, pollination and water purification are correspondingly ranked third and fourth. We find similar results even after disaggregating the data by district and sex of the household head, and whether or not the household is environmentally aware, i.e., willing to pay to preserve NTFPs.
- About 60% of the respondents consider preservation of natural resources for future generations (bequest value) as the most important non-use benefit of NTFPs. The other non-use benefits of NTFPs—existence and altruistic values—are considered paramount by about 30 and 10% correspondingly of the surveyed households, respectively. These results are consistent at district level.
- Over time, NTFPs have become more difficult to collect or extract due to increased walking distances to points of extraction, with a marked increase in the effort and labour required to collect even small usable quantities.
- About 70% of the households in the sample were willing to pay to preserve NTFPs for their indirect and non-use benefits, suggesting that incentive based schemes may still have a role in conservation.
- Our empirical estimates of factors conjectured to drive WTP suggest that landholding size and the utilization of NTFPs are negatively associated with WTP to preserve NTFPs. Thus, non-binding land and access constraints may stifle conservation if considered in their own silos. Conversely, education level of the household head, household income, adult equivalents, distance from the homestead to the nearest main source for NTFPs, and considering the presented contingent valuation method (CVM) scenario as realistic, increases the WTP amount. Equally, considering bequest and altruistic values as most important non-use NTFP benefits relative to existence value is positively associated with the WTP amount.

These findings suggest that education and environmentally friendly pro-social behaviors may be good levers for conservation.

- Overall, we estimate that households in the survey areas are willing to pay about ZMW164 (USD18) per hectare per year or ZMW485 (USD54) per household per year to preserve NTFPs. This translates to about USD48 million (using 2010 constant prices) at national level, giving an indicative total economic value of NTFPs of USD73 million in real terms (if we account for the direct-use benefits estimated by Dlamini and Samboko (2017)) at national level.

Conclusion and Policy Implications

Our main conclusion is that NTFPs have great potential to contribute to the economic wellbeing of rural households and the country in general. After accounting for the direct, indirect and non-use benefits, our conservative estimates suggest that NTFPs can potentially contribute about 0.3% to the gross domestic product in Zambia. This estimate is higher than previously thought and demonstrates, in line with extant literature, that considering only the direct use benefits underestimates the economic value of natural resources.

Three main implications are as follows:

- Household and community engagements in natural resource management should be strengthened through education and awareness campaigns on the threats to forest resource use and how these can (should) be minimized in Zambia. This is necessary to promote environmentally friendly pro-social behavior and to create a citizenry that is environmentally aware—a necessary condition for sustainable natural resource use and management.
- The 0.3% potential contribution of non-timber forest products to gross domestic product should raise the impetus and fast-track implementation of sustainable forest management in Zambia, and should inform forestry policy more broadly.
- Because the majority of the households in the sample were willing to pay to preserve non-timber forest products implies that conservation can be enhanced with the 'right' incentive structures such as payments for ecosystem services. Questions on designs and *modus operandi* of such incentive schemes are empirical and remain the t-rex in the room.

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LIST OF ACRONYMS AND ABBREVIATIONS

CV	Contingent Valuation
CVM	Contingent Valuation Method
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GRZ	Government Republic of Zambia
IAPRI	Indaba Agricultural Policy Research Institute
NTFP	Non-timber Forest Products
RP	Revealed Preference
SP	Stated Preference
TEEB	The Economics of Ecosystem Services and Biodiversity
TEV	Total Economic Value
USD	United States Dollar
WTP	Willingness to Pay
ZMW	Zambian Kwacha

1. INTRODUCTION

The lack of adequate and effective forestry policy and regulatory framework pose significant challenges to the sustainable management of forest resources in the tropical dry forest countries. This is more evident in Africa where population growth, agricultural land expansion, urbanization, and the associated rise in the demand for wood fuel are often perceived to spur deforestation (Angelsen and Kaimowitz 1999).

On the one hand, forest loss contributes to global warming: it accounts for about one-third of the accumulated greenhouse gases (GHG), and contributes about one-tenth of the current emissions (IPCC 2013). On the other hand, forest resources are vital for livelihoods: they account for more than 20% of total household incomes across the tropics (Fisher 2004; Lwaila and Gumbo 2012; Angelsen et al. 2014; Mulenga et al. 2014). Thus, conserving the natural resource base is a necessary moral imperative to sustain rural livelihoods and for the global climate objectives.

Conservation efforts, however, face several challenges since the true economic value of forest resources remains largely unknown, and therefore unaccounted for in national economic accounts in many countries. This dearth of knowledge on the economic value of natural resources does not only lead to undervalued national wealth, it also stifles efforts to implement sustainable natural resource management policies. For example, Turpie, Warr, and Ingram (2015) posit that the contribution of the forest sector to national income in Zambia is undervalued by between 40 and 60%, and the 2014 National Forestry Policy recognizes that the true economic value of forest resources remains unknown in Zambia (Lwaila and Gumbo 2012; GRZ 2014; Turpie, Warr, and Ingram 2015).

One category of forest products that has been the subject of several studies are non-timber forest products (NTFPs). These include all biological products and services derived from forests that exclude wood in all its forms. NTFPs are important for rural livelihoods in Africa, where they directly constitute 20 - 35% of household incomes (Bishop, 1999; Jumbe, Bwalya, and Husselman 2008; Dlamini and Geldenhuys 2009; TEEB 2010; Bwalya 2013; Angelsen et al. 2014; Mulenga *et al.* 2014; Shackleton and Pandey 2014) and play important safety net roles (Shackleton and Shackleton 2004; Paumgarten 2005). NTFPs contribute between 25 and 96% of the total economic value of forest resources to livelihoods (MA 2005). [1] Notwithstanding, the indirect and non-use benefits of NTFPs remain poorly understood. Indirect use benefits refer to the economic life support or sustaining functions (or ecosystem services) of NTFPs such as pollination services, water purification and regulation, and carbon sequestration and storage, while non-use benefits reflect the satisfaction that individuals derive from knowing that the resource is available for current and future use and/or for other people to enjoy. This study focused on four indirect use benefits of erosion control, climate regulation, pollination and water purification and three non-use benefits related to existence, altruistic and bequest values based on literature (MA 2005; TEEB 2010) and the pilot survey. We return to these in section 2. While it is often difficult to ascribe indirect benefits or ecosystem services to NTFPs in particular, that NFTPs account for upto 96% of the total economic value of forest resources (MA 2005) validates our approach.

This paper contributes towards improving our understading of the benefits of NTFPs and, in particular, estimates their indirect and non-use values in Zambia. We test hypotheses on key drivers

[1] Forest resources include vegetation, wood and non-wood products and forest ecological services, including the maintenance of soil quality, control of erosion, provision of organic materials and regulating climate.

of willingness to pay along the needs versus means narratives—namely household income and endowment, share of forest income, use of NTFPs and environmental pro-social behavioral aspects. We focus on the indirect and non-use values because the direct use values are well understood and have been the focus of several studies (Shackleton and Shackleton 2004; Jumbe, Bwalya, and Husselman 2008; Bwalya 2013; Mulenga *et al.* 2014; Dlamini and Samboko 2017). Together with an earlier paper by Dlamini and Samboko (2017), this paper will contribute to a better understanding of the total economic value of NTFPs in Zambia. Ultimately, knowing the value of NTFPs could contribute to designing and implementing effective local-level poverty reduction strategies, and has implications for conservation and sustainable resource use. Further, this could justify/motivate the inclusion of the value of ecosystem goods and services in national accounts.

This study, in particular, attempts to answer the following key questions: 1) What are the key indirect and non-use benefits for NTFPs in Zambia? 2) What is the economic value of indirect and non-use benefits for NTFPs in Zambia? and 3) What drives willingness to pay to preserve NTFPs in Zambia?

The rest of the report is as follows. Section 2 gives a brief background on valuation and the NTFP sector in Zambia, while section 3 presents the conceptual framework. Data and context the empirical methods are presented in sections 4 and 5, respectively. Results are presented and discussed in section 6 and the paper concludes in section 7.

2. VALUATION AND THE NTFP SECTOR IN ZAMBIA

Zambia is endowed with vast forest resources covering an estimated 66% of the total land area (GRZ 2014; FAO 2015). The real economic value of forest resources to the Zambian economy remains unknown. Where attempts have been made to generate estimates, indications are that they have been undervalued, and therefore not included in national accounts (Puustjärvi, Mickels-Kokwe, and Chakanga 2005; Ngan'dwe et al. 2006). There are several reasons for this. On the one hand, a wide range of forest benefits and services, including the indirect and non-use benefits are un- or under-reported, partly because it is difficult to estimate the total economic value (TEV) of natural resources. In particular, the indirect and non-use values, which are not reflected in market transactions, are the most challenging to estimate (TEEB 2010).

Viewed from another perspective, this could reflect a failure in economic valuation, its application, or both. Inefficiencies characterize the provision of public goods and services. Providers of public goods (e.g., individual forest owners) are not paid for the services and neither are the victims of public bads (e.g., industrial pollution) compensated. This leads not only to an under appreciation of the economic significance of natural resources but potentially, ineffective management policies. Economic valuation can help address these gaps (Bishop 1999; MA 2005; TEEB 2010).

Even without accounting for indirect and non-use benefits, several studies show that forest resources are important for household income and livelihoods in Zambia (Shackleton and Shackleton 2004; Jumbe, Bwalya, and Husselman 2008; Mulenga et al. 2014; Dlamini and Samboko 2017) and more generally, in the developing world (Bishop 1999; Shackleton and Shackleton 2004; Angelsen et al. 2014).

Forest resources overall and NTFPs in particular directly contribute about 20 - 35% of rural household income in Zambia (Jumbe, Bwalya, and Husselman 2008; Bwalya 2013; Angelsen et al. 2014; Mulenga et al. 2014). More recently, Dlamini and Samboko (2017) estimated the direct use values of NTFPs in Zambia to be about USD14 and USD28 per household per year in 2012 and 2015, respectively. In a large-scale study across 24 tropical countries including Zambia, Angelsen et al. (2014) found that (the direct use) environmental income (of which, 77% came from natural forests (including NTFPs)) contributed an average of 28% to total household income, with larger shares for low-income households. However, the omission of indirect and non-use benefits from these studies suggests that they underestimate the aggregate value of forest resources.

The TEV of natural resources, e.g., NTFPs, derive from direct, indirect and non-use values (Bishop 1999; TEEB 2010).[2] Direct use values may be extractive, i.e., from the direct use of resources for consumption or production (e.g., crops, livestock and wild fruits) or non-extractive or non-consumptive (e.g., for aesthetic, landscapes, recreational and spiritual well-being).

Indirect use values are related to the economic life support or sustaining functions such as pollination services, water purification, and regulation, carbon sequestration, and storage, erosion and sedimentation control etc. These are also called ecosystems services. The indirect use benefits are typically public goods, which are not reflected in market transactions.

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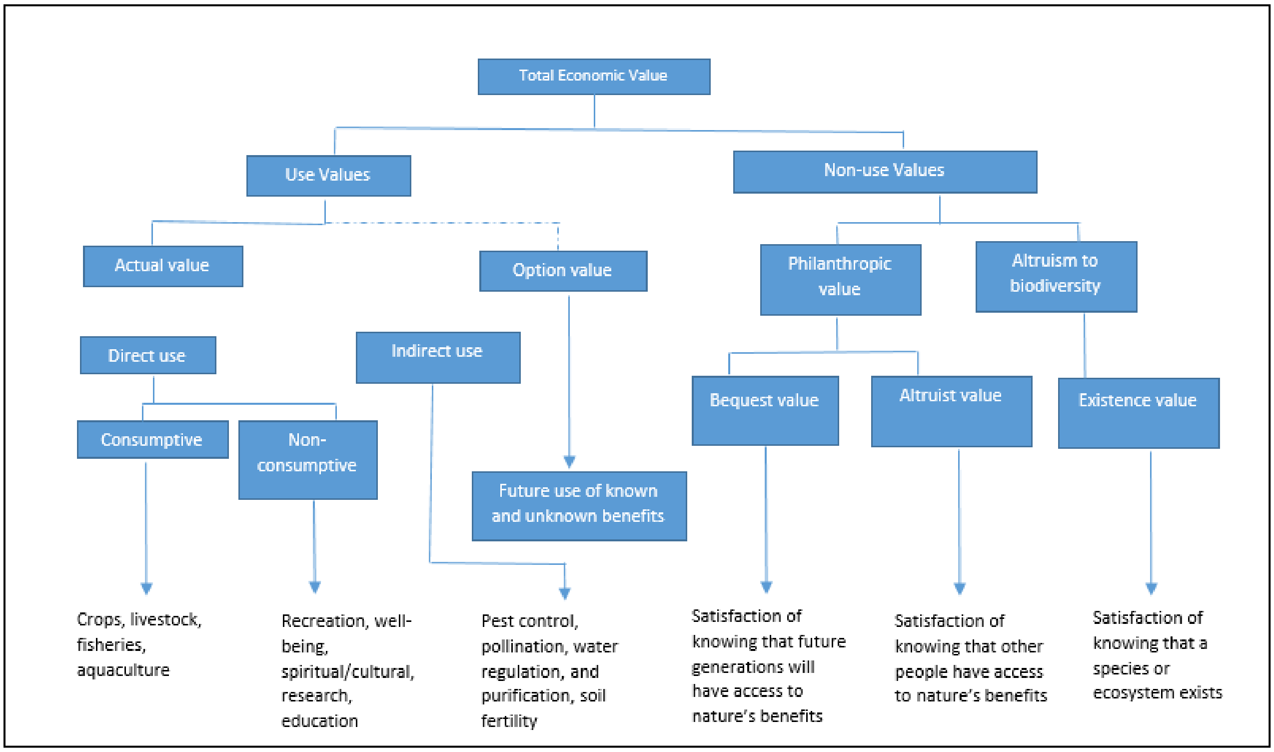
[2] The classification of economic values differs across disciplines, see for example Dlamini and Geldenhuys (2009). We adopt the classification commonly used in economics and advocated for by The Economics of Ecosystems and Biodiversity (TEEB).

Unlike use values, non-use values do not involve the direct or indirect use of the resource in question. They reflect the satisfaction that individuals derive from knowing that the resource is available for other people to enjoy. Non-use values can be classified as existence, which capture individuals' satisfaction from having natural resources preserved. They could be altruist or bequest, highlighting intra- and inter-generational equity concerns, respectively. Figure 1 presents a classification of natural resource values commonly used in economic valuation (Barbier 1994; Bishop 1999; TEEB 2010).

Figure 1. Types of Values Used in Economic Valuation



Source: TEEB (2010).

3. CONCEPTUAL FRAMEWORK

The value of NTFPs to livelihoods can be estimated based on their current and future use, and non-use values to humans. These values, also known as the Total Economic Value (TEV) are based on service flows either directly or indirectly and not necessarily on the intrinsic value of NTFPs. Thus, the value of NTFPs is a reflection of what society is willing to trade off to conserve these scarce natural resources. Economic valuation can make explicit the benefits and costs under the assumption that society can assign values to natural resources only to the extent that these fulfill felt needs or confer satisfaction (utility) to people either directly or indirectly (TEEB 2010).

Three main approaches are used to value natural resources: direct market valuation, revealed preferences (RPs), and stated preferences (SPs). Direct market valuation approaches use market prices and costs from actual markets to infer individual preferences and valuations. As the name suggests, this approach is most useful for marketed goods. RP approaches are based on observing individual choices in existing markets related to the subject of valuation. In making their choices, individuals 'reveal' their preferences and hence valuations. Classic examples here are the travel cost and hedonic pricing methods commonly used for valuing recreation and housing properties, respectively. Like direct methods, RP methods are based on existing markets and are therefore less useful for non-marketed goods and services like the indirect and non-use values of NTFPs.

SP methods simulate a market using a hypothetical scenario that depicts policy-induced changes in the provision or availability of a good or service. These methods create a surrogate market and ask individuals to state their preferences. Contingent valuation method (CVM) and Choice modeling are typical examples. SP methods are appropriate for valuing the non-marketed indirect and non-use benefits of NTFPs. In particular, this study used CVM. More recent approaches apply experimental methods such as randomized control trials (Jayachandran et al. 2017) and framed field experiments (Handberg and Angelsen 2015) to assess conservation motives.

To motivate the CVM, let the current stream of benefits from NTFPs to a representative household be given by b_0. Unsustainable extraction and harvest of NTFPs (a non-marketed natural resource) threaten to reduce these benefits to b_1, such that $b_1 - b_0 < 0$. Household derive utility (satisfaction) from NTFPs (***b**$_i$*) and from a vector of marketed goods ***q***: $U_i = U(b_i, \boldsymbol{q}) \ \forall i = 0,1$. Maximizing this household utility subject to a budget constraint $\sum p_i q_i \leq m$ yields the usual optimal factor demands. Using these optimal factor demands, we can define an indirect utility (*V*) as a function of NTFP benefits (***b***), the market price for marketed goods (*p*) and income (*m*): $V = V(b_i, p, m)$.

The loss of NTFPs due to unsustainable management implies a potential welfare loss equivalent to $C = V(b_1, p, m) - V(b_0, p, m) < 0$.[3] CVM creates a surrogate market and asks how much households are willing to pay (WTP) to avoid this welfare loss. The elicited WTP amount equivalent to *C* ensures parity between the pre- and post-NTFP-induced utility changes so that $V(b_1, p, m - C) = V(b_0, p, m)$ or $V(b_1, p, m) = V(b_0, p, m + C)$.

[3] We assume no changes in *p* and *m* to simplify the exposition, but still capture the essential elements.

Because of the duality between indirect utility functions (*V*) and expenditure functions (*E*), WTP can also be defined as

$$WTP = E\left(b_1, p, U_0 : \boldsymbol{h}\right) - E\left(b_0, p, U_0 : \boldsymbol{h}\right) \tag{1}$$

where $\boldsymbol{h}$ captures the household socioeconomic characteristics and all other variables summarized in Table 2. Equation (1) suggests that household WTP will be a function of the perceived NTFP benefits (*b*), market prices (*p*) and utility, which can be proxied by income (*m*), and other household socioeconomic, behavioral, and demographic characteristics (*h*).

One of the major challenges with implementing CVM is hypothetical bias. This is a tendency by survey respondents to give answers they consider socially acceptable or simply the tendency to give answers that do not reflect the actual decisions they would make in real life. Hypothetical bias is caused by various factors including strategic behavior and cognitive dissonance, which is the emotional discomfort people feel if asked to reveal their real values, especially if these values are socially undesirable. We followed Loomis (2014) and attempted to minimize hypothetical bias in the following ways. First, we used a hypothetical scenario that had consequences on the everyday lives of respondents. Second, we included follow up CV questions. Third, we ensured that the payment vehicle was compulsory, and Lastily, the survey included debriefing questions on the hypothetical scenario.

4. DATA AND CONTEXT

This study used mainly primary data collected from a detailed contingent valuation (CV) survey conducted in seven of the eight districts covered by Dlamini and Samboko (2017). These include Mumbwa and Serenje in Central Province, Luanshya and Mpongwe in Copperbelt Province, Mwinilunga and Zambezi in North Western Province, and Choma in Southern Province. Two villages, one from a high-forested area and another from a low-forested one, were purposively selected per district using 2016 district forest cover maps generated from Landsat satellite imagery (Figure A8). Selecting study sites from a high-forested area and low-forested area was meant to capture how and if resource availability (scarcity) influences willingness to pay. About 25-26 households per village were randomly sampled for interview for a total sample of 50-52 households per district and 352 households overall.

In eliciting households' willingness to pay (WTP) for the preservation of NTFPs, the questions following the hypothetical scenario in the CV survey attempted to only tease out the indirect and non-use benefits, which are a focus of this study. We elicited WTP following Hanemann, Loomis, and Kanninen (1991) and used the more efficient double bounded dichotomous question format. The double bounded CVM question format provides more information than the single dichotomous question format by asking follow up questions depending on the response to the first binary WTP question. This means that if a household answers yes to the first binary WTP question, a follow-up question elicits WTP for a higher amount. If the answer to the first question is no, the follow-up question offers a lower amount. Unlike the single dichotomous questions, the double bound question format allows construction of upper and lower bound intervals within which the true WTP lies.

We used four initial bid values of ZMW 100, 200, 400, and 800 per hectare per year. These bids were validated during a pretest survey conducted with rural households from outside the final sample. The initial bids were randomly distributed across respondents during the actual CV survey. The following hypothetical scenario was presented to respondents prior to eliciting WTP.

Hypothetical Scenario

Forest resources including non-forest timber products like wild fruits, mushrooms, and honey, and wild animals, ornamental and medicinal plants are important to the well-being of humanity. Households and individuals derive various direct and indirect benefits from forest resources. Direct benefits are from the direct use of forest resources for food and in production, and for spiritual or cultural well-being. Indirect benefits come from the life support and regulation functions of forest resources, e.g., climate regulation, pollination, carbon sequestration (climate mitigation), water regulation, and purification.

In addition, forest resources also confer other non-use benefits including the satisfaction that individuals derive from knowing that forest resources will be preserved and not depleted (existence value), that other people will have access to the forest resources (altruistic value) and that future generations will have access to the same forest resources (bequest value). We will now focus on the indirect and non-use benefits of NTFPs to assess their value to human welfare.

The rise in population, urbanization, industrialization and the demand for food has necessitated clearing forest resources for alternative land uses. While important, conversion of forests to alternative use implies that there is an increased risk that you may no longer be able to access the forest resources such as NTFPs (e.g., mushrooms, wild *honey, fruits and animals, thatching grass etc.) in this area. This may or may not be happening in this village yet, but you may have heard of cases where mining companies are displacing villages to set up mining operations, or government grabbing customary land to setup farming blocks for agricultural production or indeed, cases where residential property developers clear forests and displace villages. Besides the possibility of not having access to the NTFPs now and in the future, the loss of forest resources causes climate change, which negatively affects agricultural production.*

[Enumerator: Pose and ask the respondents if anything is unclear? Explain where you can and tell them you are not sure if in doubt.]

In order to reverse this increasing trend of forest loss, the government needs to understand the importance of forest resources to livelihoods. [Enumerator: remind the respondents that forest resources provide direct, indirect and non-use benefits]. One way to do this is to estimate how much individuals would be willing to pay so that forest resources are preserved for current and future use. (This, in essence, captures the satisfaction that people get from knowing that the forest resources will be preserved). In practice, this could be done by local forest management teams (e.g., neighborhood watch) or by the local leadership in this village. The payment modality could be in cash or in kind per household and per year. The income realized could support the work of local authorities to develop policies and programs aimed at averting conversion of forestland to alternative uses and promote sustainable management of forests.

Local forest management initiatives may or may not be there in this area yet, but there are places within Zambia and elsewhere in the world where such activities are taking place and are helping preserve forest resources. If such initiatives are not yet present here, they may soon be expanded to this area. With this background, please help us answer the following questions.

Data were collected through face-to-face interviews using a semi-structured questionnaire (available on request). Table 1 characterizes our sampled households in terms of their willingness to pay using the double bounded question format. Column (1) shows the WTP intervals with lower and upper bounds given in columns (2) and (3), respectively. The frequency and percentage responses are given in columns (4) and (5). About 48% of the respondents said no to both the first and second bids while 20% answered no to bid one and yes to bid two. About 14% answered yes to bid one but no to bid two, but those saying yes to both bids were 17%.

Table 1. Characterization of Willingness to Pay Using the Double Bound Question Format

	(1)	(2)	(3)	(4)	(5)
Outcome responses	WTP interval	Low WTP	High WTP	Freq.	Percent
Yes to bid 1 and 2	bid1<WTP>∞	bid1	.	61	17.33
Yes to bid 1 and no to bid 2	bid1≤WTP<bid2	bid1	bid2	49	13.92
No to bid 1 and 2	-∞<WTP>bid1	.	bid1	170	48.30
No to bid 1 and yes to bid 2	bid2≥WTP<bid1	bid2	bid1	72	20.45
Total				352	100

Source: 2017 IAPRI NTFP Survey that was conducted for the data used in that paper.

5. EMPIRICAL STRATEGY

Since our survey used the double bounded dichotomous question format, we can parametrize Eq. (1) using the interval data model of Haab and McConnell (2002) given in a general form as:

$$\boldsymbol{WTP}_i = \boldsymbol{x}_i \beta + \mu_i \tag{2}$$

$\boldsymbol{WTP}$ is a vector of two continuous dependent variables *wtp1* and *wtp2*[4], β captures estimable model parameters, $\boldsymbol{x}$ is a vector of covariates influencing WTP, including binary responses to bids 1 and 2. μ is the idiosyncratic normally distributed error term with zero mean and constant variance $\left(\mu \sim N(0,\sigma^2)\right)$. How households answered to the two bid questions determines their contribution to the likelihood function that is maximized to estimate β and σ—the two parameters needed for WTP. Readers are referred to Haab and McConnell (2002) and Lopez-Feldman (2012) for an elaborate exposition on the likelihood functions for such models.

We estimated the interval data model using Lopez-Feldman's (2010) *doubleb* Stata command that is customized to analyze the Hanemann, Loomis, and Kanninen (1991) type—double bounded CVM model. For robustness checks, we also estimated the same model using the interval regression estimator following Wooldridge (2010).

We estimated the following empirical model:

$$\begin{aligned} WTP_j = {} & \boldsymbol{h}_i \beta_1 + ntfpuse\beta_2 + likntfpused\beta_3 + realcvm\beta_4 + \boldsymbol{wtp}_i\beta_5 + hhinc\beta_6 \\ & + finc\%\beta_7 + \boldsymbol{d}\beta_8 + land\beta_9 + asset\beta_{10} + tenure\beta_{11} + \boldsymbol{v}\beta_{12} + \mu \end{aligned} \tag{3}$$

where *j* indexes the two WTP bids one and two (*wtp1* and *wtp2* in Table 2). These averaged ZMW346 and ZMW236 per ha per year.[5] ***h*** is a vector of household-demographic variables—age, education level and gender of the household head in years, and adult equivalents. On average, 81% of the households were male headed, with five adult equivalents on average. Household heads were about 47 years old and spent about 6 years in school.

The dummies *ntfpuse, liknftpused* and *realcvm* capture whether the household uses NTFPs (99%), consider NTFP likely to be depleted under business as usual (50%) and whether the CVM scenario presented was realistic with the potential to address the loss of NFTPs (81%). *liknftpused* and *realcvm* are measures of environmental awareness and we hypothesize that these are positively correlated with conservation. *wtp* indexes the responses to the binary WTP bids one and two. About 32 and 38% of the respondents answered yes to bid one and two, respectively.

Total household income (*hhinc*) averaging ZMW5,195 captures all incomes from agricultural production (subsistence and from sales), off-farm work, forest income, business activities and remittances. The share of forest income (f*inc%)* to total household income averaged 4% per household.

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[4] or *wtplo* and *wtph* for the interval regression estimator
[5] Note, however, that the mean WTA for double-bounded questions is estimated differently (see section 3).

Land averaging 4 ha captures the total landholding per household, *asset* is a measure of household asset index computed using principle component analysis and takes into account all productive assets owned by the household during the survey period. Considered together, household income, landholding size (a proxy for wealth) and asset index measure households' *means* versus *needs* to extract NTFPs. The means argument suggests that wealthier households with the means to extract natural resources are responsible for resource depletion while the needs argument posits that poor households in need of natural resources are responsible for resource depletion (Babigumira et al. 2014). Thus, for conservation, a positive correlation between WTP and our wealthy measures renders support to the needs narrative while a negative correlation supports the means narrative. We expect ambiguous effects *a priori*.

Tenure is a dummy = 1 if the household has statutory tenure on part of their land. On average, 9% of the respondents had some form of secure tenure on their land. Distances from the homestead to the main NTFP source, district center, and protected forest, averaged respectively 2, 34, and 7 km are captured in the vector ***d***. These have ambiguous effects on conservation *a priori*.

We used household beliefs towards the main non-use benefits of NTFPs to infer pro-socio behavioral attitudes. For example, households that said the main non-use NTFP benefit were altruistic values were considered 'altruistic'. These attitudes are captured in the vector ***v***. By this measure, about 9% of the respondents were altruistic, 60% were more concerned with intergenerational equity (bequest) and 30% existential, and we hypothesized that being pro-environment increases WTP and conservation.

Table 2 presents further descriptions and summary statistics of all variables used in the regression. These variables were selected based on theory and literature.

Table 2. Description of the Main Variables

Name	Description	Mean	SD	Min	Max
Dependent variables					
wtp1	WTP bid 1	346.88	265.47	100.00	800.00
wtp2	WTP bid 2	236.08	221.47	50.00	1200.00
Independent variables					
wtp1_yn	Yes to WTP bid 1	0.32	0.47	0.00	1.00
wtp2_yn	Yes to WTP bid 2	0.38	0.49	0.00	1.00
ntfpuse	Household used NTFP (yes =1)	0.99	0.11	0	1
likntfpused	Likely NTFP depletion (yes =1)	0.50	0.50	0	1
realcvm	Realistic CVM Scenario (yes =1)	0.81	0.39	0	1
d	Distance to main NTFP source (km)	1.49	3.07	0	40
d	Distance, district center (km)	34.19	17.47	7.00	90.00
d	Distance, protected forest (km)	6.85	6.97	0.00	45.00
h	Age, household head (years)	46.97	14.76	0.00	117.00
h	Education, household head (years)	6.30	3.70	0.00	17.00
h	Male, household head (yes =1)	0.81	0.39	0.00	1.00
h	Adult equivalents	5.28	2.28	0.74	18.56
hhinc	Household income (ZMW)	5194.59	7718.71	0.00	69500.00
finc%	Share, forest income (%)	0.04	0.10	0.00	0.82

Source: 2017 IAPRI NTFP Survey. Note: N=352

6. RESULTS AND DISCUSSION

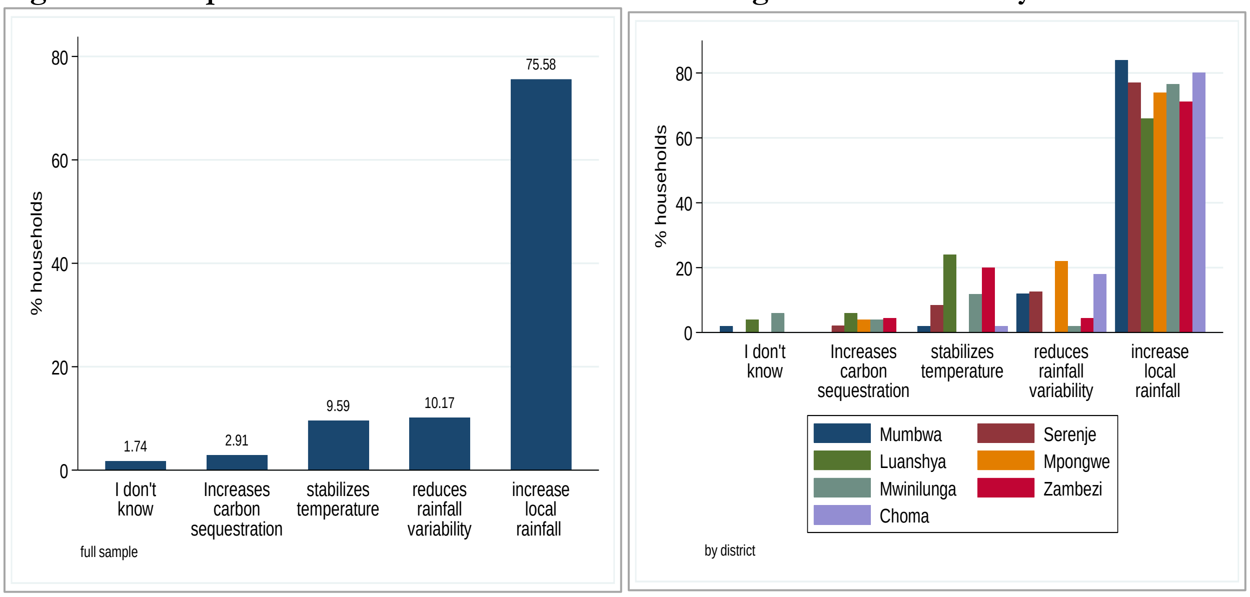
6.1. Local Knowledge on the Role of Forests in Climate Mitigation

As the first step, we assessed local knowledge on the role of local forest resources in climate mitigation.[6] From a sample of 352 households, almost all households (98%) perceived forests as important in reducing rainfall variability and global warming. Of these households, 75.6% felt that forests increase the amount of local rainfall received per annum while 10 % said that local forests stabilize temperature and contribute to reduced rainfall variability (Figure 2). Very few (2.9%) indicated that forests contribute to increased carbon sequestration. We find similar results at a more disaggregated district level (Figure 2).

6.2. Household Reliance on Non-timber Forest Products

Overall, 99% of households in our sample relied on NTFPs for some aspect of their livelihoods, mostly for consumption purposes. The main NTFPs used by at least 20% of the respondents include wild mushrooms, wild fruits, fencing/thatching grass, firewood from dead wood, and edible insects (Figure 3 on following page). Other common NTFPs include Chikanda (*Eulophia schweinfurthii*), Incha (*Parinari curatelifolia*), Mooma (Bark hive) Mada (*Vangueria infausta*), Inshindwe (*Aframomum africanum*), Tuda (*Kigelia africanum*), Nyilun'i (*Rhynchosia insiginis*), and Monzhi (Rattan) Katona (*Strychnos Spinosa*) (Figure A 9).

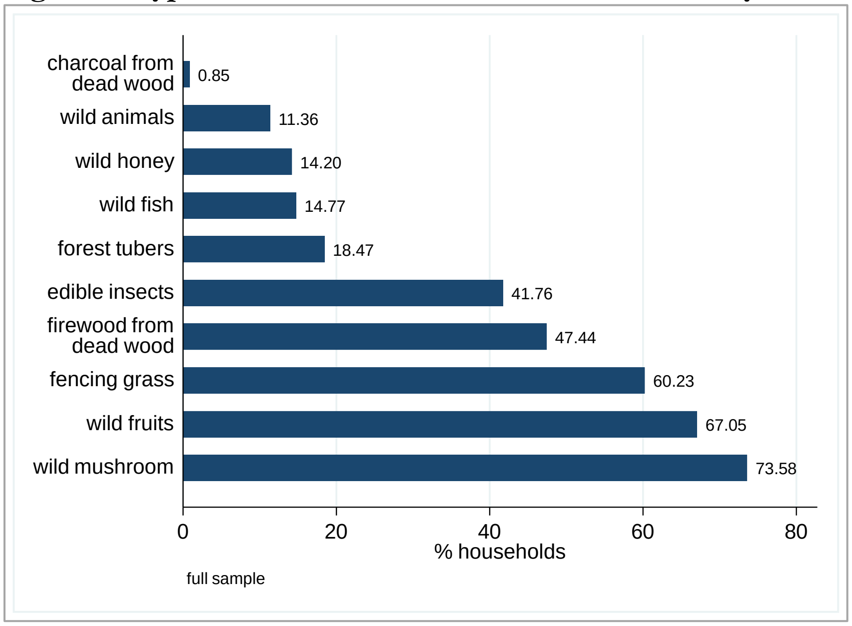
Figure 2. Perceptions on the Role of Forests in Reducing Rainfall Variability



Source: 2017 IAPRI NTFP Survey.

[6] NTFPs are an important component of forest resources.

Figure 3. Types of Non-timber Forest Products Used by Households in the Survey Areas



Source: 2017 IAPRI NTFP Survey.

These results are fairly consistent across districts especially for the top three main NTFPs, but there are differences in the ordering of the NTFPs. For example, while wild mushrooms were the main NTFP product used in Mwinilunga, Luanshya, Serenje and Zambezi districts, wild fruits were the most prevalent in Choma and Mumbwa districts, and fencing/thatching grass in Mpongwe district (Figures A 4-A 7). Figure A 9 presents pictorial examples of NTFPs common in survey areas. These results are similar to findings in Shackleton and Shackleton (2004) which show that about 85% of households in South Africa relied on NTFPs in one way or another.

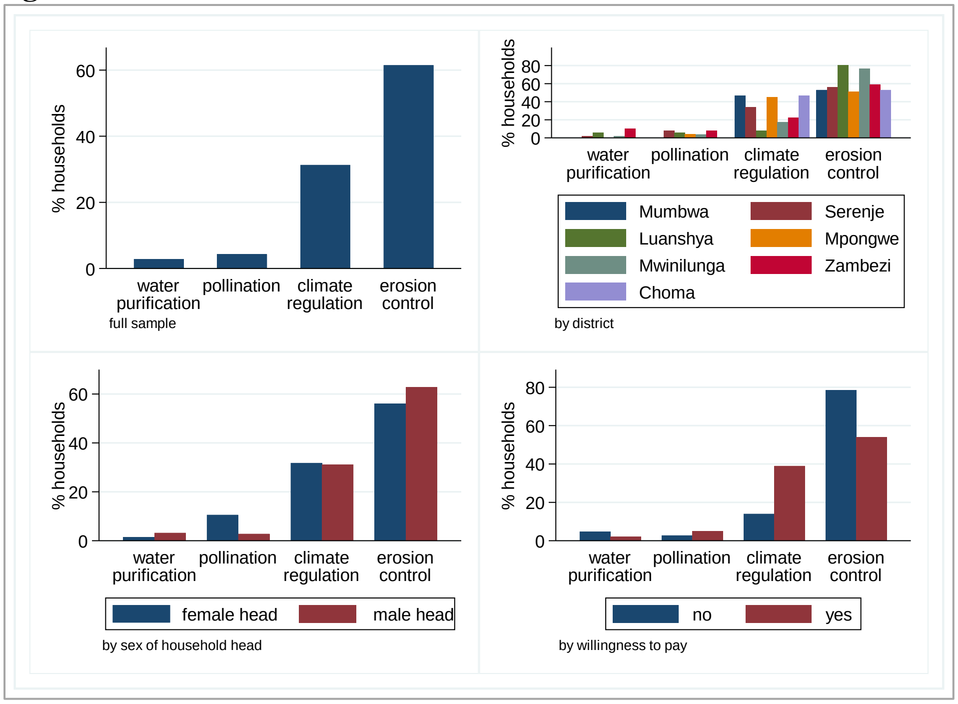
6.2.1. Indirect Use Benefits of NTFPs

Out of the four main indirect use benefits of NTFPs considered in this study, the majority of the respondents (61%) said that NTFPs were most important for erosion control. Climate regulation was the second most prevalent indirect use benefit, followed by pollination and water purification (Figure 4 following). We find similar results when the analysis is disaggregated by district, the gender of the household head, and whether a household is willing to pay for the preservation of NTFPs or not (Figure 4).

6.2.2. Non-use Benefits of NTFPs

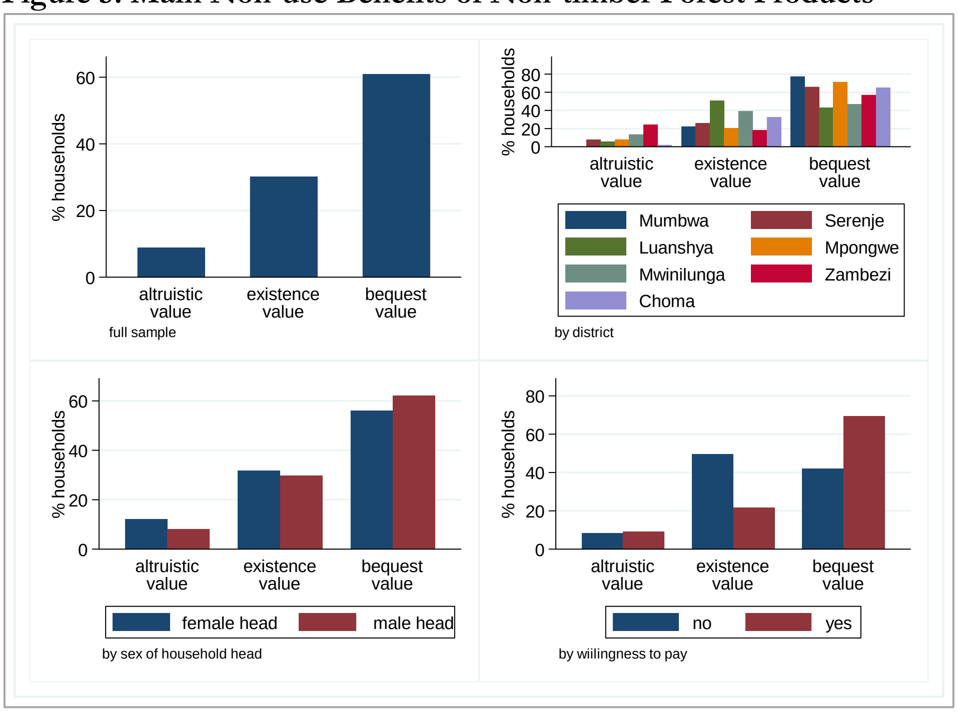
Most households (60.2%) in the survey areas consider that bequest value—the preservation of natural resources for future generations—is the most important non-use benefit of NTFPs (Figure 5 following). Existence value—the satisfaction from the existence of the natural resource base was second most important mentioned by 29.8% of households while, altruistic value—the satisfaction from knowing that other people will have access to NTFP resources was third most important non-use benefit mentioned by 10% of the respondents (Figure 5).

Figure 4. Main Indirect Use Benefits of Non-timber Forest Products



Source: 2017 IAPRI NTFP Survey.

Figure 5. Main Non-use Benefits of Non-timber Forest Products



Source: 2017 IAPRI NTFP Survey.

Table 3. Main Changes to the Ease with which NTFPs are Extracted/Accessed

% Responding Yes	
Walking longer distances to find NTFPs	95.67
More time to extract even small usable quantities of NTFPs	90.91
More labor to access and extract a variety of NTFPs	89.18
Walking shorter distances to find forest resources	5.19
Less time to extract even small quantities of NTFPs	9.96
Less labor to access and extract a variety of NTFPs	9.09
Total number of households	231

Source: 2017 IAPRI NTFP Survey.

6.2.3. Perceptions on the Ease of Extraction and Access to NTFPs

We asked respondents if there were any changes in the ease with which they extracted or accessed NTFPs over the past five years. Two-thirds of the households agreed: compared to the past five years, the majority of households (89%) indicated that household members walk longer distances, spend more time and use up more labor to extract/access even small useable quantities of NTFPs. Very few households indicated otherwise (Table 3).

6.3. Willingness to Pay to Preserve NTFPs in Zambia

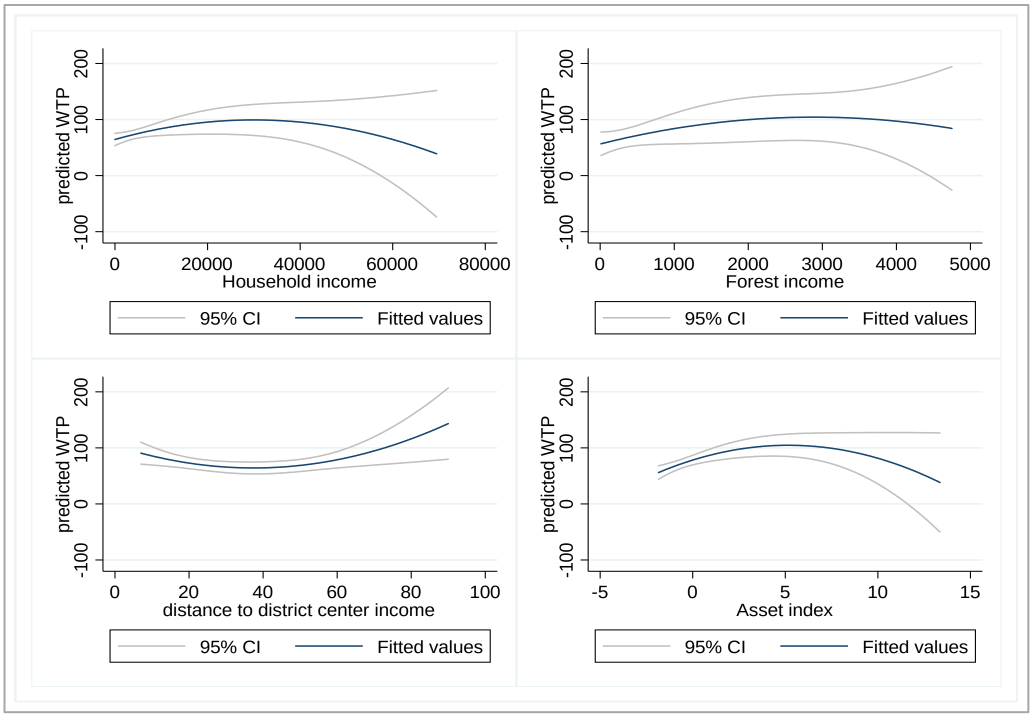
As a prelude to the fully robust results, we checked for bivariate relationships between WTP and four key variables—household income, forest income, distance from the homestead to the district center and household assets. Overall, about 70% of the respondents were willing to pay to preserve NTFPs for the indirect and non-use benefits in Zambia. Without controlling for other confounding variables, WTP has a U-shaped relationship with distance and more of an inverse U-shaped relationship with the income and asset index variables (Figure 6 following). These results, however, do not give a full picture. The next section present results from a multivariate framework.

6.3.1. Drivers of Willingness to Pay to Preserve NTFPs in Zambia

As usual, the first step before estimating drivers of WTP and mean WTP using CVM is to assess the credibility of the hypothetical scenario. This can be done by asking respondents if the presented CV scenario is likely to occur or already occurring, and realistic, i.e., if the proposed solutions are considered effective in addressing the loss of NTFPs. Our CV scenario passed both of these tests. About half of the respondents (much more in some districts) felt that the hypothetical CV scenario was likely to occur or was already occurring, while more than 80% said the proposed policy instrument and the payment vehicle would be effective in addressing the loss of NTFPs (Figure A 3).

Another logical test for CV surveys assesses whether WTP declines as the initial bid amount increases, as would be expected for a rational economic agent (Carson 2000). Figures A 1 and A 2 show that this holds for our data—WTP declines with the bid amount. For example, while 54% of the respondents were willing to pay ZMW100 per hectare per year to preserve NTFPs, only 15% were willing to pay ZMW800. This and the foregoing logical test results render credence to the credibility of the CV survey used in this study.

Figure 6. Bivariate Relationships between Willingness to Pay, and Household and Forest Income, Wealth Index, and Distance from the Homestead to the District Center



Source: 2017 IAPRI NTFP Survey.

6.3.2. Empirical Results on Drivers of WTP

We used the double bound maximum likelihood estimator of Lopez-Feldman (2010) to estimate Eq. (3). Model 1 results are from the fully robust specification, while model 2 results are from a specification that omits the potentially endogenous income variables. Because the two sets of results are very similar, we will use those from model 1 for interpretation and discussion, unless stated otherwise. We also estimated Eq. (3) using the interval regression estimator for robustness checks. Results in Table A 1 are qualitatively similar to those in Table 4.

Focusing only on statistically significant results in Table 4, following, landholding size and using NTFPs are associated with reduced WTP, while the education level of the household head, household income, and adult equivalents are associated with higher WTP.

Distance from the homestead to the nearest main source for NTFPs, and considering the presented CVM scenario as realistic increased WTP. Equally, considering bequest and altruistic as most important NTFP benefits relative to existence value significantly increased WTP

.

Table 4. Double Bound Regression Estimates of Factors Influencing Willingness to Pay to Preserve Non-timber Forest Products in Zambia

	Model 1		Model 2	
	Coefficient	T-statistic	Coefficient	T-statistic
Household uses NTFPs (yes=1)	-498.68**	-2.41	-577.07***	-2.93
Likely NTFP depletion (yes=1)	-38.00	-0.72	-40.33	-0.75
Realistic CVM scenario (yes=1)	329.08***	4.26	338.48***	4.33
Distance, main NTFP source	17.09*	1.71	16.24	1.64
Distance, district center	-2.81	-1.32	-2.73	-1.27
Distance, protected forest	3.52	0.47	2.72	0.36
Age, household head	-0.31	-0.21	-0.43	-0.28
Education, household head	19.21***	2.88	18.56***	2.73
Male, household head	34.74	0.59	50.06	0.84
Adult equivalents	20.72*	1.93	20.21*	1.85
Household income (ZMW)	0.01*	1.88	-	-
Share, forest income (%)	-227.12	-1.00	-	-
Total landholding size	-8.39**	-1.98	-7.93*	-1.84
Asset index	-11.86	-1.06	-10.90	-0.96
Statutory land tenure for some land (yes =1)	40.65	0.47	41.67	0.47
Bequest value (yes =1)	213.68***	4.08	212.50***	3.99
Altruistic value (yes =1)	189.00**	2.16	186.25**	2.09
Village fixed effects	*Yes*		*Yes*	
Sigma	297.01		303.06	
Constant	-264		-186	
Log likelihood	-396		-398	
AIC	855		857	
Observations	352		352	

Source: 2017 IAPRI NTFP Survey.
Notes: Dependent variables, WTP1 'first bid' and WTP2 'second bid'; estimation included binary response variables to bid value 1 'WTP1_yn' and bid value 2 'WTP2_yn'; *** p<0.01, ** p<0.05, * p<0.1.

6.3.3. Mean Willingness to Pay to Preserve NTFPs in Zambia

The mean WTP in Table 5 was calculated as a post estimation, nonlinear combination of the parameter estimates and the mean values for covariates in Eq. (3). On average, households in the survey areas were willing to pay an average of ZMW164 (or USD18) per hectare per year to preserve NTFPs.

Table 5. Overall Mean Willingness to Pay to Preserve Non-timber Forest Products in Zambia

	Coefficient	Standard error	[95% confidence interval]
Mean WTP	164.25	153.82	-137.23 - 465.72

Source: 2017 IAPRI NTFP Survey.
Notes: The calculated mean WTA from the interval regression estimator was ZMW200 per hectare per year. District and province level mean WTP values were also calculated but are not reported here because they are based on smaller samples.

When we adjust for the average forestland under each household in the survey villages, this translates to about ZMW485 or USD54 per household per year (Table 5).[7] The mean WTP of USD18 per hectare per year in this study is USD10 less than the mean willingness to accept (WTA) to conserve forests in a randomized control trial in Uganda (Jayachandran et al. 2017) and far less than a mean WTA to conserve forests of USD 837 per hectare per year in Zambia (Ngoma et al. forthcoming). This is not surprising; WTA tends to be larger than WTP.

So far, we have not answered the question on the total economic value of the indirect and non-use benefits of NTFPs in Zambia. Using the calculated mean WTP per household per year, and the total number of rural agricultural households (CSO/MAL/IAPRI 2015), conservatively, the indirect and non-use value for NTFPs in Zambia would be worth about USD48 million using 2010 constant prices. This is about 92 % higher than the 2015 direct NTFP benefits in Dlamini and Samboko (2017). Adding the two estimates brings the indicative total economic value of NTFPs in Zambia to about USD73 million in real terms. The national level estimates should, however, be taken with caution because they are extrapolated from CVM surveys that are not statistically representative at national level.

6.4. Discussion

The differences in the types and extent of use of NTFPs found in the study districts are not surprising. These districts vary in size, population density, and forest cover (Table A 2 and Figure A 8). Of the seven districts, Choma and Luanshya with the highest population densities of about 40 and 186 persons per km^2, respectively, show the highest pressure on forests cover (Figure A 8). This signals heightened resource abstraction and raises red flags on availability of NTFPs and perceptions of forests. The rest of the districts have low population densities, which may suggest less pressure on forests, but where charcoal production and trade (incompatible with NTFP) is carried out, the threat to NTFPs stands and this has a bearing on how the people view the forest.

While most of the rural households in Zambia derive the lion's share of their incomes from subsistence agriculture (crops and livestock), our findings that nearly all households in the sample rely on NTFPs in some ways is in line with the literature (Angelsen et al. 2014; Babigumira et al. 2014; Bwalya 2013; Cavendish 2000; Mulenga et al. 2014) and suggest that income from agriculture is insufficient to support household food, income, and nutrition security objectives (see Table A 2). This is especially true for rural households who continue to derive larger shares of their incomes from the sale of forest products such as charcoal, timber and edible caterpillars (Angelsen et al. 2014).

The empirical results in this paper are illuminating. Using NTFPs reduces the WTP amount perhaps because households that have access might not consider the imminent threat of depletion. To such households, NTFPs are *de facto* open access and changing their attitudes towards such resources may require command and control or the so-called 'carrot and stick' policy instruments such as regulation and enforcement, which are effective in some contexts (Handberg and Angelsen 2015). However,

[7] Uses USD/ZMW rate of 9 at the time of the survey, and the mean forest land (virgin forest) controlled or that each household had access to, was 2.96 ha on average.

how such instruments perform in the current context is an empirical question and requires further study.

Having larger land parcels is associated with reduced WTP because it presents households with more options from which to source NTFPs. Because NTFPs are wild products, having larger landholding size relaxes the land constraint, which would otherwise limit accessibility.

Although the distance from the homestead to the main NTFP source is expected to be negatively related to WTP due to distance decay, our finding of a positive relationship is intuitive. The further away the main source of NTFPs is from the homestead, the more difficult it will be for household members to access the resource. This, in turn, would bid up their WTP to preserve NTFPs and consequently improve access. The overall logic may be similar to the effect of adult equivalents; households with higher adult equivalents may have more need for NTFPs, and this could drive up WTP.

Our findings suggesting that the education level of the household head, considering the CVM scenario as realistic and household income are positively correlated to WTP are in line with *a priori* expectations. More educated household heads may better understand the threats of NTFP depletion and may, therefore, be willing to pay more to preserve these resources. Environmental awareness (considering the CVM scenario as realistic) is expected to increase WTP and conservation. The overall negative correlation between our wealthy measures (household income and landholding size) and WTP suggests that the means narrative is more relevant for our study areas. Wealthier households with the means to extract NTFPs are willing to pay less to preserve them. This could be driven by the fact that rich households may have multiple other livelihood options or are capable of relocating their operations to other areas where NTFPs are still abundant. The latter would amount to leakage, in the conservation jargon.

The results on the 'behavioral' factors are interesting. While admittedly, these are not perfect measures of household behavior, they are intuitive. Households that are altruistic (i.e., consider altruistic values as the main non-NTFP benefit and are more concerned with intragenerational equity) and those more concerned with intergenerational equity (i.e., consider bequest values as most important) are predisposed to pay more to preserve NTFPs. These findings are important for two reasons. First, they demonstrate that beliefs about non-use benefits significantly affect WTP, and if these beliefs can proxy household behavior, we can surmise that behavioral factors influence WTP. Second, while both people's attitudes towards intergenerational and intragenerational equity increase WTP, the former effect seems stronger than the latter. This may be indicative of the importance of prosocial behavior in conservation. Overall, these findings imply that behavioral factors may be good levers for conservation. (However, this conclusion should be taken with caution, as it requires further study).

Our estimated total value of NTFPs of USD73 million per year represents 0.3% of the country's 2016 Gross Domestic Product, and is 0.2 percentage points higher than the 0.1% estimate in the 2014 National Forestry Policy in Zambia (GRZ 2014). Our results are largely in agreement with the 2014 National Forestry Policy (GRZ 2014) and findgings in Puustjärvi, Mickels-Kokwe, and Chakanga (2005) and Turpie, Warr, and Ingram (2015) suggesting that forest resources and, in particular, NTFPs are undervalued in Zambia. As suggested in Shackleton and Pandey (2014), it is hoped that valuation studies like ours will help accelerate the integration of NTFPs in broader development and poverty alleviation programs at national and sub-national levels.

Some caveats in reading these results are in order. First, readers should bear in mind that what we call indirect-use benefits in this paper are also called ecosystem services more generally. We have attempted to delineate these in so far as they pertain to NTFPs, but overlaps with forest resources in general cannot be ruled out. Second, there is debate on whether non-use or passive use values should be included in economic valuation. The main argument is that these values do not generate utility to economic agents since they are not directly utilized. We followed the guide for CV studies in Carson (2000) and included non-use values and argue that non-use values confer utility to economic agents through vicarious enjoyment.

7. CONCLUSION

Forest resources including non-timber forest products are important in the global efforts to mitigate climate change and are central to rural livelihoods. However, these resources are increasingly under pressure from deforestation and forest degradation caused by agricultural land expansion, rising demand for woodfuel (charcoal and firewood), urbanization and industrialization. Forest conservation is thus crucial given the projected increases in the underlying drivers of forest loss such as population, per capita income, poverty and dietary diversity among others.

Conservation efforts have, however, stalled because governments and other stakeholders do not fully understand and perhaps recognize and appreciate the economic importance of forest resources. For example, the extent to which forest resources contribute to economic accounts such as gross domestic product remains largely unknown and/or grossly undervalued (Puustjärvi, Mickels-Kokwe, and Chakanga 2005). This study sought to contribute towards filling this gap. It determined the value of the non-use and indirect-use benefits of non-timber forest products in Zambia and augments previous studies on the direct use values of non-timber forest products (Dlamini and Samboko 2017). This study attempts to given a complete picture of the *true* economic value of non-timber forest products in Zambia.

Our results show that erosion control and climate regulation are the two most important indirect-use benefits of non-timber forest products in the survey areas, with pollination and water purification ranked third and fourth respectively. (Admittedly, these may conflate with forest resources in general.) These results are unaffected when data is disaggregated by gender of the household head and whether the household is willing to pay for the preservation of non-timber forest products. The bequest value (i.e., the preservation of natural resources for future generations) is the most important non-use benefit. This is followed by existence value (satisfaction from knowing that the natural resources base in preserved) and altruistic value (satisfaction from knowing that other people will have access to the resources).

Over-time, it is becoming more difficult to collect or extract non-timber forest products: this requires walking longer distances to points of extraction, with a marked increase in the effort and labour to collect even small usable quantities.

Households in the survey areas are willing to pay ZMW164 (USD18) per hectare per year or ZMW485 (USD54) per household per year to preserve non-timber forest products for the indirect and non-use benefits. Several factors drive the mean willingness to pay amount: it is positively correlated with the education level of the household head, distance from the homestead to the point of access, altruism and existence values, suggesting that education and prosocial behavior may be good levers for forest conservation. Willingness to pay is negatively correlated with landholding size and whether a household uses non-timber forest products or not. Thus, nonbinding land and access constraints may stifle conservation if considered in their own silos.

We estimate an indicative total indirect and non-use value of non-timber forest products in Zambia of about USD48 million and a total value of USD73 million at 2010 constant prices after accounting for the direct-use values estimated by Dlamini and Samboko (2017). This translates to about 0.3 % of Zambia's 2016 gross domestic product. This estimate is higher than previously thought and demonstrates that considering only the direct use benefits underestimates the economic value of natural resources.

Three main implications follow:

- There is need to strengthen household and community engagement in natural resource management by ramping up education and awareness campaigns on the threats to forest resources and how these can (should) be minimized in Zambia. This could be done via radio and other mass media campaigns and could be introduced in school curricula at early stages. Not only would such a move promote prosocial behavior, it would also go a long way in creating a citizenry that is environmentally aware – a necessary condition for sustainable natural resource use and management. Other methods to promote environmentally friendly prosocial behaviors such as nudging require further investigations.

- The 0.3% potential contribution of non-timber forest products to gross domestic product is not the lion's share but should raise the impetus and fast-track the implementation of sustainable forest management in Zambia and should inform forestry policy more broadly.

- That almost 70% of all households in the sample were willing to pay to preserve non-timber forest products implies that conservation can be enhanced with the 'right' incentive structures. Thus, incentive based efforts such as the reducing emissions from deforestation and forest degradation (REDD+) and payments for ecosystem services are still relevant. Questions on designs and *modus operandi* of such incentive schemes are empirical and remain the t-rex in the room.

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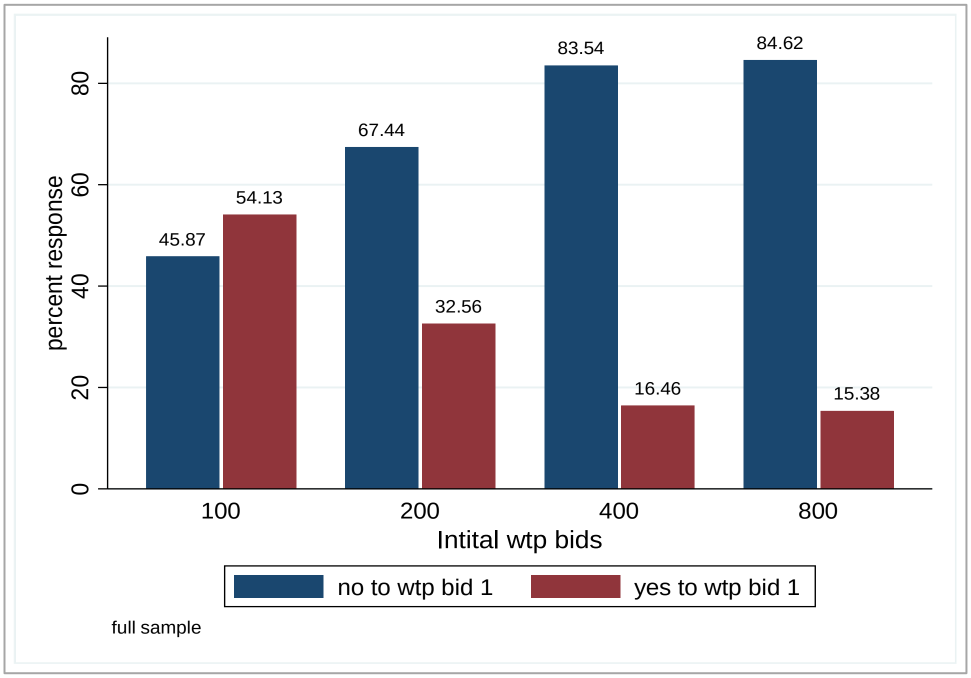
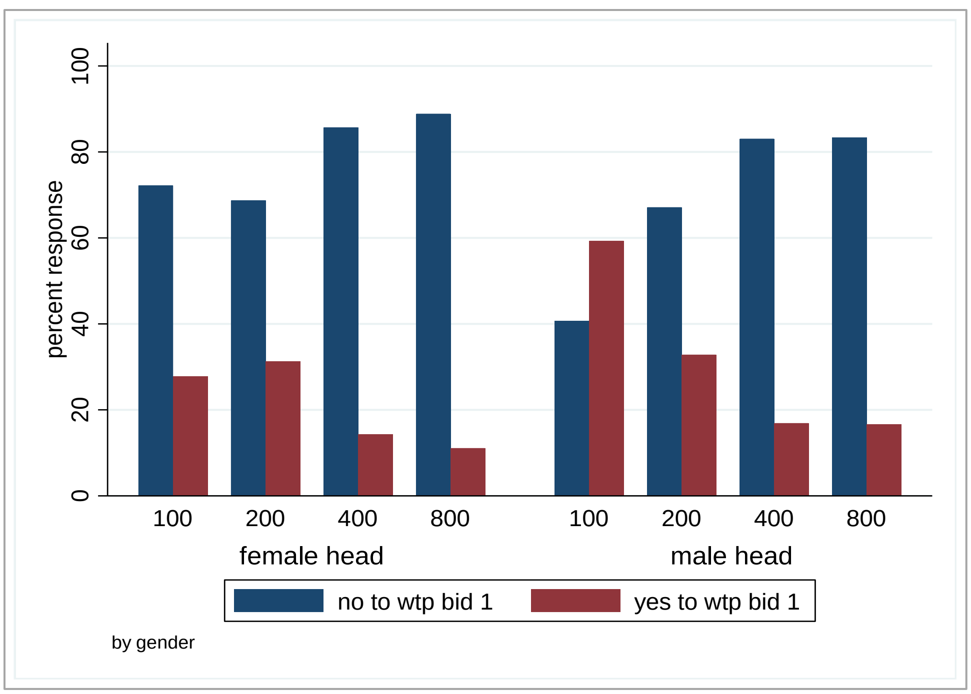
APPENDICES

Figure A 1. Distribution of Willingness to Pay to Preserve Non-timber Forest Products by Initial Bid Values



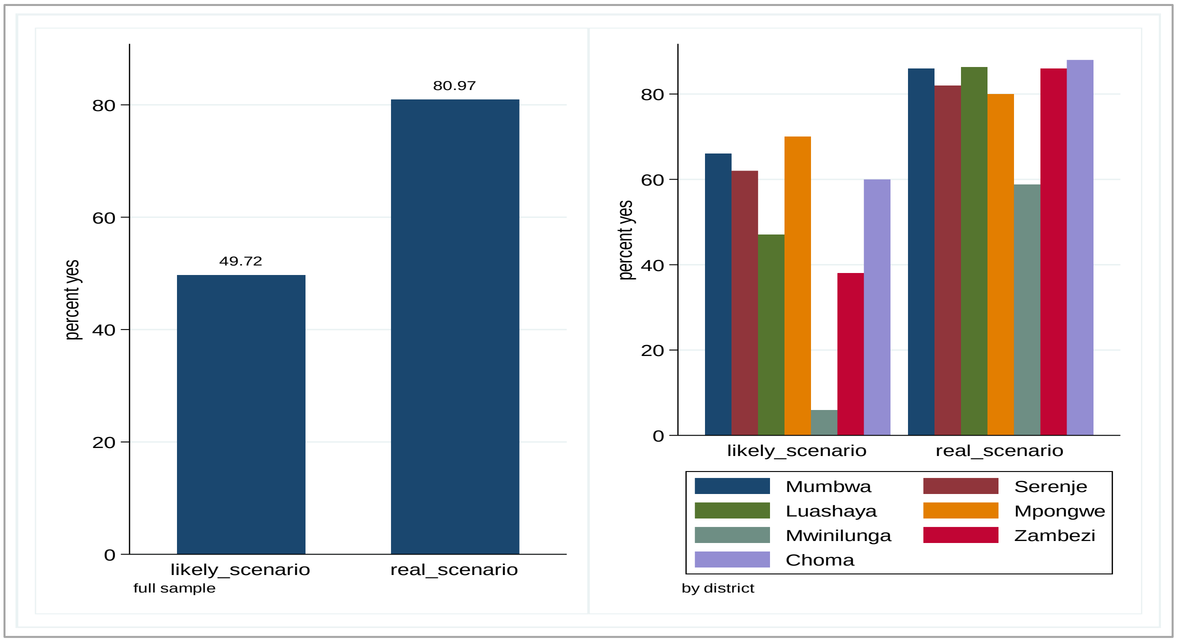
Source: Authors.

Figure A 2. Distribution of Willingness to Pay to Preserve Non-timber Forest Products by Initial Bid Values



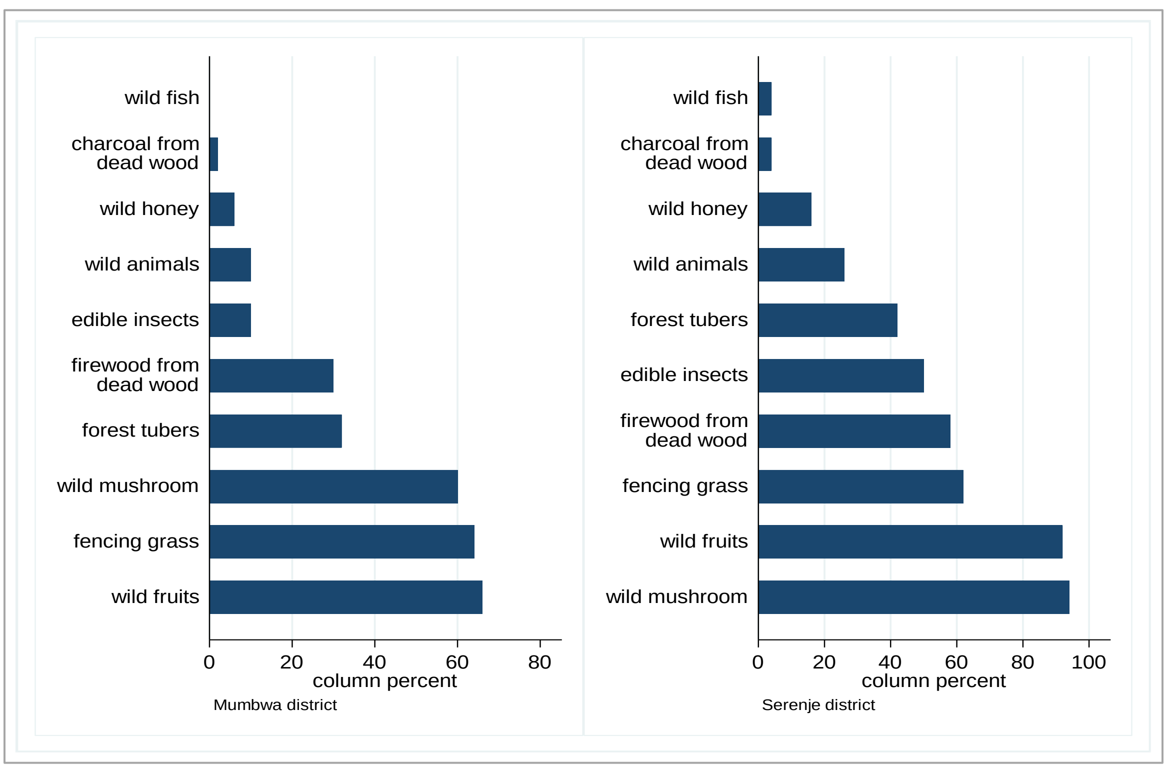
Source: Authors.

Figure A 3. Assessment of the Credibility of the Hypothetical Scenario Used in the Contingent Valuation Study by Full Sample and by District.



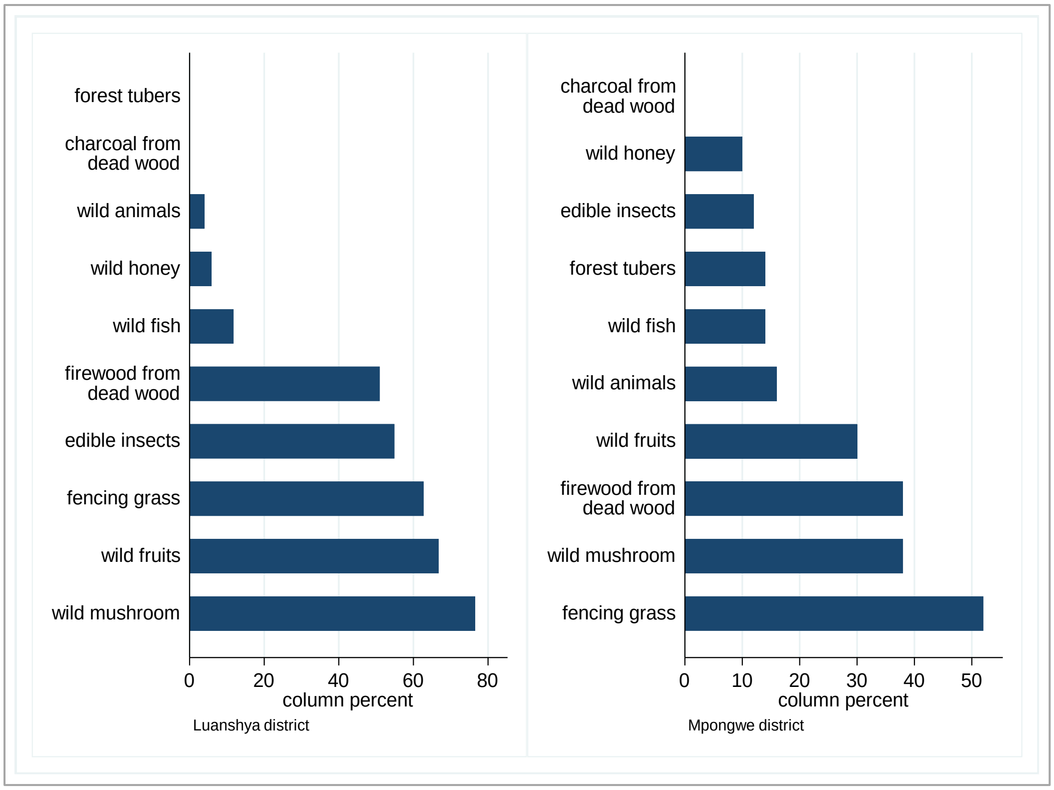
Source: Authors.

Figure A 4. Types of Non-timber Forest Products Used by Households in Mumbwa and Serenje Districts



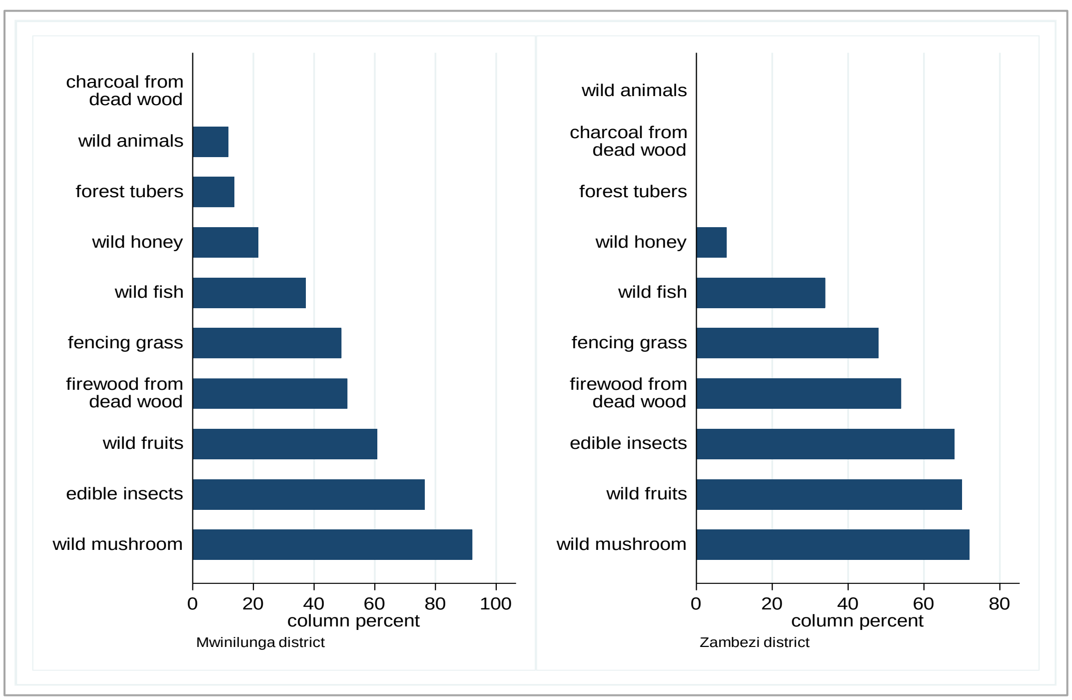
Source: Authors.

Figure A 5. Types of Non-timber Forest Products Used by Households in Luanshya and Mpongwe Districts



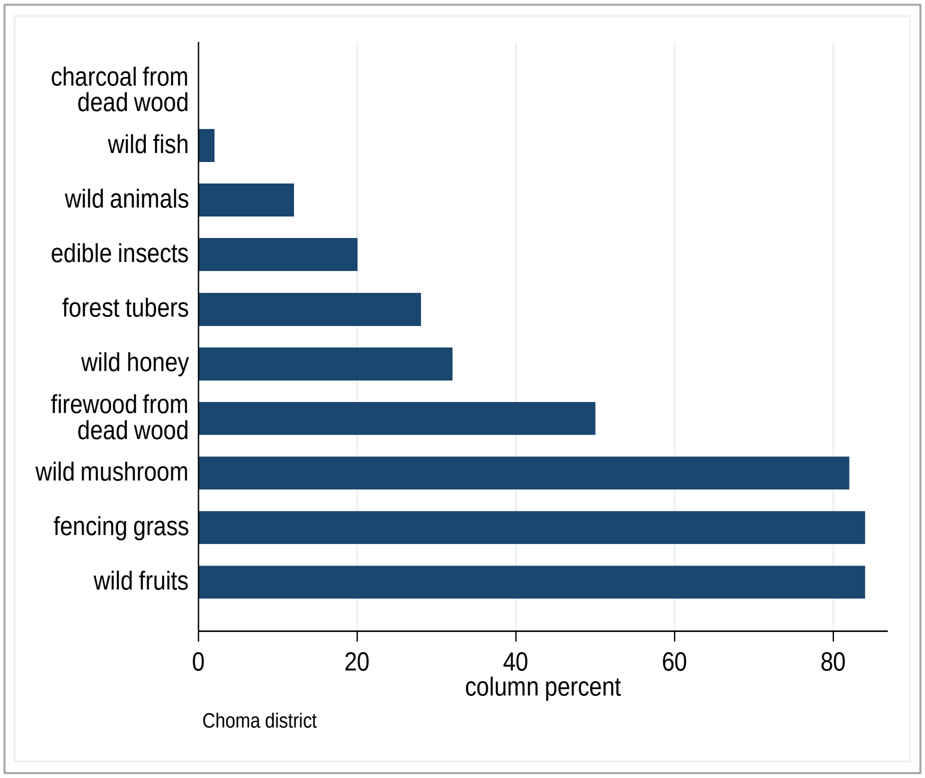
Source: Authors.

Figure A 6. Types of Non-timber Forest Products Used by Households in Mwinilunga and Zambezi Districts



Source: Authors.

Figure A 7. Types of Non-timber Forest Products Used by Households in Choma Districts



Source: Authors.

Table A 1. Interval Regression Estimates of Factors Influencing Willingness to Pay to Preserve Non-timber Forest Products

	Model 1	Model 2	Model 3
Willing to pay to preserve NTFPs (yes=1)	223.95***		234.93***
	(5.23)		(5.31)
Household used NTFP (yes=1)	-326.31***	-378.38***	-336.33**
	(-3.31)	(-4.43)	(-2.31)
Likely NTFP depletion (yes =1)	-66.19*	-33.04	-67.74*
	(-1.84)	(-0.96)	(-1.85)
Realistic CVM scenario (yes=1)	132.63**	200.85***	130.76**
	(2.05)	(3.11)	(2.00)
Distance, main NTFP source	13.94	14.13	13.16
	(1.43)	(1.39)	(1.39)
Distance, district center	-2.02	-1.42	-2.13
	(-1.33)	(-0.92)	(-1.42)
Distance, protected forest	0.82	2.27	0.14
	(0.10)	(0.26)	(0.02)
Age, household head	-1.14	-0.77	-1.22
	(-1.12)	(-0.75)	(-1.16)
Education, household head	6.99	10.47**	6.69
	(1.52)	(2.26)	(1.41)
Male, household head	5.73	9.21	10.86
	(0.14)	(0.22)	(0.25)
Adult equivalents	12.25	14.46	12.23
	(1.39)	(1.59)	(1.39)
Household income (ZMW)	0.00	0.00	
	(0.99)	(1.23)	
Share, forest income (%)	-255.54**	-288.78**	
	(-2.00)	(-2.11)	
Total landholding size	-6.12**	-6.89***	-5.78**
	(-2.41)	(-2.75)	(-2.27)
Asset index	-0.78	-4.06	-0.58
	(-0.09)	(-0.43)	(-0.06)
Secure land tenure for some land (yes =1)	19.01	22.63	21.60
	(0.38)	(0.41)	(0.42)
Bequest value (yes =1)	155.57***	175.32***	150.91***
	(4.69)	(5.06)	(4.51)
Altruistic value (yes =1)	131.83***	163.22***	126.31***
	(2.95)	(3.38)	(2.76)
Village fixed effects	yes	yes	Yes
Constant	-40.10	-1.39	-27.54
Sigma	187	195	190
Log likelihood	-301	-315	-304
AIC	667	695	669
Observations	352	352	352

Notes: Dependent variables, WTP low and WTP high; *** p<0.01, ** p<0.05, * p<0.1; 169 left-censored observations; 0 uncensored observation; 62 right-censored observations; 121 interval observations; T-statistics in parenthesis; AIC is Akaike's information criterion.

Table A 2. Social Economic and Demographic Attributes, and Woodland Types and Status of the Study Districts

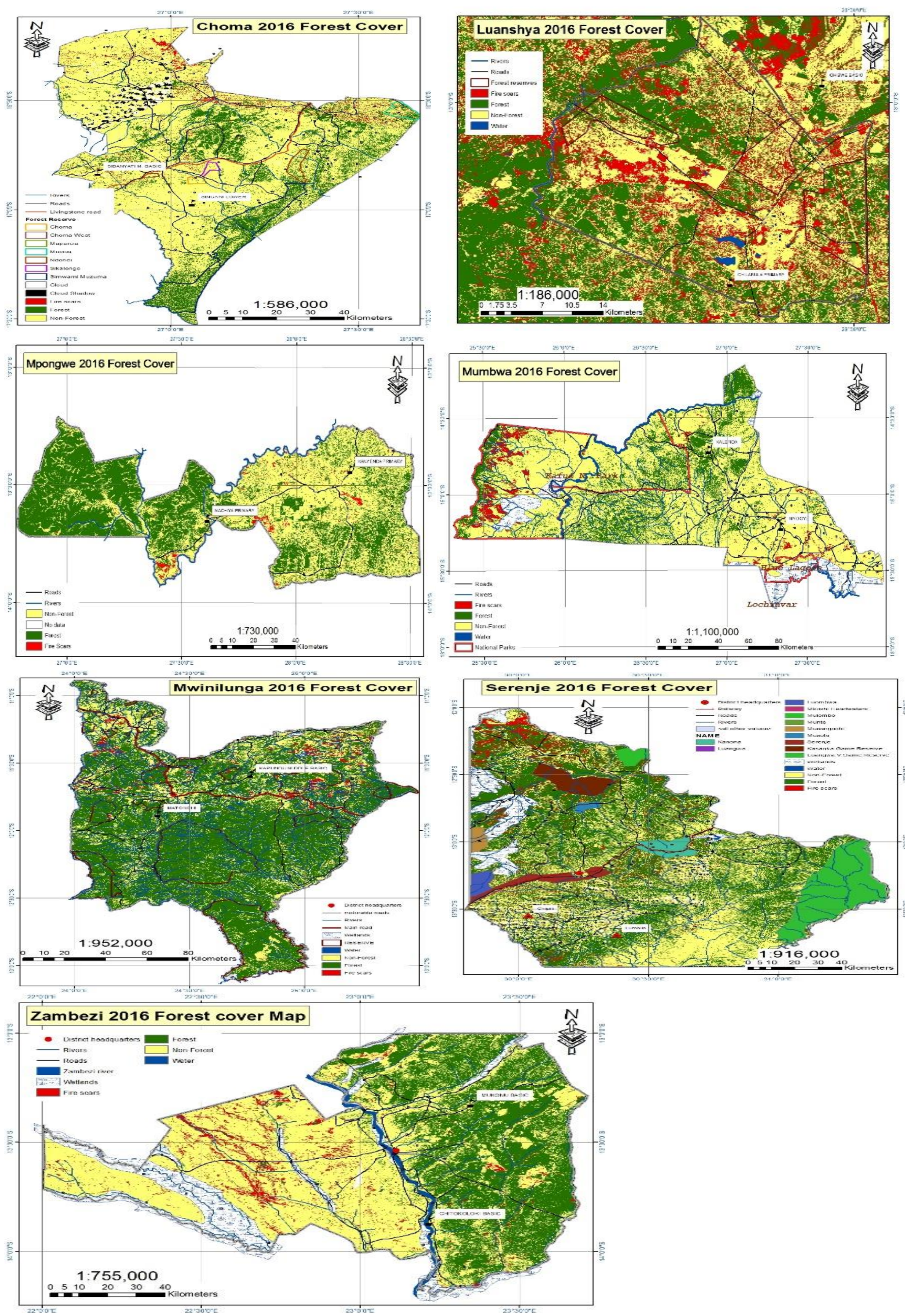
Key Attributes						
District	Size (Km^2)	Population Size[8]	Population Growth rate (2010-2017) % per annum	Population density (per km^2)	Main household income sources	Dominant woodland type and status
Choma	5,210	209,577	2.24	40.2	Subsistence and medium scale agriculture (crop and livestock) and charcoal production	Mainly Miombo with mixed dry forests (acacia, mopane, combtretum), threatened by agriculture expansion and charcoal production
Luanshya	938	174,497	1.68	186	Subsistence agriculture (including market gardening), small scale mining, trading, charcoal production and trade	Miombo woodland – very fragmented and further threatened by agriculture and settlements
Mpongwe	8,536	129,391	4.98	15.2	Medium scale (maize) and subsistence agriculture, beekeeping and horticulture	Miombo on high ground and acacias on low ground in some places– excellent cover threatened by in-migration and the associated opening up of new lands
Mwinilunga	18,542	123,672	2.57	6.7	Subsistence agriculture (including *chitemene*) and pineapples; small- and large-scale mining;	Predominantly miombo woodlands, threatened by agricultural expansion; *chitemene;* mining;

[8] Projected on the 2010 census count Source: http://www.citypopulation.de/php/zambia-admin.php

Key Attributes						
District	Size (Km^2)	Population Size[8]	Population Growth rate (2010-2017) % per annum	Population density (per km^2)	Main household income sources	Dominant woodland type and status
					charcoal and timber; *finkubala*; mushrooms and beekeeping.	charcoal production; unsustainable timber harvesting.
Mumbwa	19,783	225, 659	14.01	11.4	Subsistence and medium scale agriculture (maize, cotton and tobacco), charcoal trade as well as trade in other forests based products	Miombo on high ground and undifferentiated woodlands on lower altitudes threatened by agricultural expansion
Serenje	17,295	141,187	2.73	8.2	Subsistence and medium scale agriculture, charcoal and timber; *finkubala*	Miombo woodland threatened by agricultural expansion; charcoal production
Zambezi	14,076	96,436	2.77	6.9	Subsistence agriculture (including *chitemene*) and charcoal and timber; mushrooms and beekeeping.	Mainly Miombo woodlands threatened by agriculture expansion (including slash and burn) and slash

Source: Various, complied by authors.

Figure A 8. 2016 Forest Cover Maps for Non-timber Forest Products Survey Districts in Zambia



Source: Authors, processed from Landsat satellite imagery for May, June and /or July 2016 available at https://landsat.gsfc.nasa.gov/data/

Figure A 9. Examples of Non-timber Forest Products in Zambia

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Notes: Traditional and scientific or common names for non-timber forest products (NTFPs) in Zambia; Chikanda (*Eulophia schweinfurthii*), Incha (*Parinari curatelifolia*), Mooma (Bark hive) Mada (*Vangueria infausta*), Inshindwe (*Aframomum africanum*), Tuda (*Kigelia africanum*), Nyilun'i (*Rhynchosia insiginis*), Monzhi (Rattan) Katona (*Strychnos S)*