Environment for Development

Discussion Paper Series May 2019 ■ EfD DP 19-12

Factors Influencing People's Perceptions Towards Conservation of Transboundary Wildlife Resources

The Case of the Great Limpopo Trans-Frontier Conservation Area

Herbert Ntuli, Edwin Muchapondwa, Sverker C. Jagers, Amanda Linell and Martin Sjöstedt

The Environment for Development (EfD) initiative is an environmental economics program focused on international research collaboration, policy advice, and academic training. Financial support is provided by the Swedish International Development Cooperation Agency (Sida). Learn more at www.efdinitiative.org or contact info@efdinitiative.org.

Central America
Research Program in Economics and Environment for Development in Central America Tropical Agricultural Research and Higher Education Center (CATIE)

Chile
Research Nucleus on Environmental and Natural Resource Economics (NENRE)
Universidad de Concepción

China
Environmental Economics Program in China (EEPC)
Peking University

Colombia
The Research Group on Environmental, Natural Resource and Applied Economics Studies (REES-CEDE), Universidad de los Andes, Colombia

Ethiopia
Environment and Climate Research Center (ECRC)
Ethiopian Development Research Institute (EDRI)

India
Centre for Research on the Economics of Climate, Food, Energy, and Environment, (CECFEE), at Indian Statistical Institute, New Delhi, India

Kenya
School of Economics
University of Nairobi

South Africa
Environmental Economics Policy Research Unit (EPRU)
University of Cape Town

Sweden
Environmental Economics Unit
University of Gothenburg

Tanzania
Environment for Development Tanzania
University of Dar es Salaam

USA (Washington, DC)
Resources for the Future (RFF)

Vietnam
University of Economics
Ho Chi Minh City, Vietnam

The Environment for Development (EfD) initiative is an environmental economics program focused on international research collaboration, policy advice, and academic training. Financial support is provided by the Swedish International Development Cooperation Agency (Sida). Learn more at www.efdinitiative.org or contact info@efdinitiative.org.

Contents

Factors Influencing People's Perceptions Towards Conservation of Transboundary Wildlife Resources: The Case of the Great Limpopo Trans-frontier Conservation Area

Herbert Ntuli, Edwin Muchapondwa, Sverker C. Jagers, Amanda Linell and Martin Sjöstedt*

Abstract

Local people's perceptions about protected areas are important determinants of the success of conservation efforts in Southern Africa, as their perceptions affect their attitude and behaviour towards conservation. As a result, the involvement of local communities in transboundary wildlife conservation is now viewed as an integral part of regional development initiatives involving several countries. Building on unique survey data and applying regression analysis, this paper investigates the determinants of the perceptions of local communities around the Great Limpopo Trans-frontier Conservation Area in Zimbabwe and South Africa. Our results show that the perception that management of the park is good positively affects the perceptions of benefits from the park, rules governing the park, and how people perceive wildlife in general. Household expertise in environmental resource extraction positively affects the perception that it is wrong to commit environmental crime. Our results show that, if people perceive the rules of the park in a negative way, then they are less likely to conserve wildlife. Receiving benefits from the park seems to have a positive effect on perceptions of the rules governing the park and wildlife, but not the perception that it is wrong to commit environmental crime. Surprisingly, high levels of corruption positively affect people's perception of wildlife benefits and that it is wrong to commit environmental crime. There is a lack of evidence of the role of socioeconomic variables in people's perceptions towards wildlife. However, our data suggest that unobservable contextual factors could explain part of the variation in people's perceptions. Our results have implications for large-scale collective action, because perceptions of wildlife benefits, corruption, environmental crime, park management and rules governing the parks affect people's ability to self-organize. These variables are interesting because they can be influenced by policy through training and awareness campaigns.

Keywords: perceptions, attitudes, behaviour, collective action, transfrontier conservation area

JEL Codes: Q28 Q56 Q57 Q58

---

*Ntuli (corresponding author: ntlher001@myuct.ac.za), School of Economics, University of Cape Town, Private Bag, Rondebosch, Cape Town, 7701. Jagers, Linell, and Sjöstedt: Centre for Collective Action Research (CeCAR), University of Gothenburg, Sweden. Muchapondwa: Environmental Policy Research Unit, University of Cape Town, South Africa. This paper is a product of a research project on large-scale collective action that is collecting data in local communities around the Great Limpopo Trans-frontier Conservation Area. The authors gratefully acknowledge funding by the Swedish International Development Cooperation Agency (Sida) through CeCAR.

1. Introduction

The study of people's perceptions towards conservation of natural resources such as wildlife, forests and water resources is a popular vehicle for understanding the complex relationship between human beings and nature in the context of social-ecological systems (SES) (Allendorf et al. 2012; Allendorf 2007; Holmes 2003; Infield and Namara 2001). We define perception as what people know or understand (Huong and Lee 2017; Fischer and van der Wal 2007; Ingold 2000; Mansfeld and Ginosa 1994) and attitude as how they think or feel (Ashok et al. 2002). Sociologists theorise that perceptions translate into attitudes and then behaviour (Beedell and Rehman 2000; Fisbien and Ajzen 1985). Therefore, understanding people's perceptions can help us understand their attitude and behaviour towards conservation.

To a great extent, the success of Integrated Conservation and Development Projects (ICDPs) in many developing countries depends on the participation of local people living adjacent to protected areas. The main aim of these ICDPs is to balance conservation and development goals in rural areas characterised by conflict between people and wildlife (Ntuli and Muchapondwa 2017a). The creation of Trans-frontier Conservation Areas (TFCAs) involving several countries has increased conflict between people and wildlife, as their ancestral land, on which they reside, becomes a corridor facilitating the movement of wildlife between parks.

This study used purposefully collected primary data and instrumental variables estimation with heteroscedasticity-based instruments[1] to examine factors which influence local people's perception towards wildlife conservation in adjacent communities sharing a transboundary resource in South Africa and Zimbabwe. The people included in the study reside in communities located within the Great Limpopo Trans-frontier Conservation Area (GLTFCA). Viewed as an emerging way of managing transboundary resources, the GLTFCA is an interesting case study because wildlife, e.g., elephants, roams freely within the TFCA; the area is shared by different local communities in three countries;[2] and these communities benefit from wildlife conservation in one way or another. As a result, if a fugitive (mobile) species is threatened in one country, say through poaching, then all communities are affected since we are dealing with a common pool resource (CPR).

The main contribution of this paper is the comparison of perceptions among indigenous communities between countries. To date, there are few studies that compare perceptions of local people across countries, due to data limitations. As a result, the literature

[1] We employed instrumental variables estimation with heteroscedasticity-based instruments because of endogeneity issues. The endogeneity problem and this technique are discussed in more detail in the methodology section.

[2] Local communities around the Limpopo National Park (LNP) in Mozambique are also part of the GLTFCA and we are planning to collect data in these communities in the future.

is populated with single or localized case studies of a national park done in a single country. In contrast, this paper contributes to the study of complex SESs and the behavioural underpinnings of the link between human beings and nature in the context of a TFCA shared by multiple developing countries. Moreover, this study provides insights for large-scale collective action for managing transboundary resources between countries. We believe that local communities will protect wildlife if they perceive that the benefits from conservation are greater than the costs of conservation, i.e., if the design of the conservation scheme is incentive-compatible.

Understanding the determinants of people's perceptions becomes imperative from a policy perspective because it provides information about the behaviour of resource users to both policymakers and development practitioners, who in turn will be able to interrogate their wildlife management and conservation strategies. This will also allow the managers of the TFCA to harmonize their policies and strategies in order to cater to local communities that are seemingly identical, yet diverse in many attributes.

With this background, we ask the following questions i) Is there a significant difference in perceptions towards wildlife management and conservation of local people between communities in South Africa and Zimbabwe? ii) What are the factors driving the observed variation in perceptions of local communities in these two countries?

This paper is divided into six sections as follows. Section 2 provides a review of literature and the theoretical framework of this study. Section 3 presents information about the study site, nature of the data collected, sampling techniques and the empirical model specifications. Section 4 presents the results, while Section 5 provides a discussion of these results. Finally, Section 6 concludes.

2. Literature Review and Theoretical Framework

There is a tremendous amount of literature that seeks to enhance our understanding of the SES by focusing on the link between people and nature (Thondhlana and Muchapondwa 2014; Lindahl et al. 2012; Ntuli and Muchapondwa 2018; Ostrom 2007; Shackleton and Shackleton 2006; Agrawal 2001). As many natural resources often share two common attributes – jointness of supply and difficulties in excluding outsiders – the management of natural resources often produces so-called collective action dilemmas (Becker and Ostrom 1995). This means that, even though the rational behaviour would be to act in the interest of the collective, when resource users cannot be excluded from enjoying the benefits provided by others, resource users instead tend to freeride on the efforts of others (Ostrom 1990). This could have immense consequences for the environment, because the expectations that others will overexploit the resource creates incentives for every resource user to overexploit the resource (Ostrom 1998). Nevertheless, recent decades of research indicate that many

resources actually can be governed sustainably through self-governing institutions of trust, reputation and norms of reciprocity (Ostrom et al. 1994; Baland and Platteau 1996; Gibson et al. 2005).

Several strands of the literature come from the field of behavioural economics and these studies use both lab and framed field experiments to examine the link between human behaviour and the ecological system. These include studies on the role of trust (Johnson and Mislin 2011; Cox 2004), monetary and non-monetary punishment (Masclet et al. 2003) and social ostracism (Akpalu and Martinsson 2011) in stabilizing large-scale collective action in natural resource management. There has also been an increase in experimental studies focusing on behavioural responses to latent endogenously driven regime shifts in ecosystems (Lindahl et al. 2016; Schill et al. 2015; Crépin et al. 2012) – described as endogenous because they are caused by the actions of the resource users and as latent because the possibility of the regime shift may not be obvious to resource users. Resource economists are currently focusing on endogenously driven regime shifts because these can be avoided when people coordinate their actions, as opposed to exogenously driven regime shifts that are caused by nature (Crépin et al. 2012).

Human behaviour has also been at the centre of empirical studies that focus on the role of institutions in cooperation and conservation of natural resources such as forest (Agarwal 2009; Agrawal and Chhatre 2006), wildlife (Ntuli and Muchapondwa 2018; Frost and Bond 2008; Murphree 2004), rangelands (Woods and Ruyle 2015) and water (Maganga 2002; Pollard and du Toit 2011). These studies link institutions to conservation through collective action and its role in curbing illegal harvesting of natural resources (Ntuli and Muchapondwa 2018), since institutions are devices meant to constrain human behaviour (North 1990). Regionally, poaching is a major challenge in the management of common pool resources (CPR) such as wildlife because of poor local institutions. Environmental crime[3] in developing countries is caused by many factors, ranging from poverty to selfishness. Critics of conservation projects attribute failure or limited success of these initiatives to the design of most ICDPs, which is not incentive-compatible (Ntuli and Muchapondwa 2017a). Other scholars attribute failure of ICDPs to lack of capacity to self-organize by communities managing a CPR, and hence they recommend the use of coercion by the state (Romero et al. 2012; Adams and Hutton 2007). Recent evidence reveals that some communities, particularly in Asia, have been able to develop robust CPR institutions in order to manage their resources (Ostrom 2007).

There is also a huge body of literature focusing on the role of people's perceptions and attitudes in natural resource management and conservation in the context of the

[3] Environmental crime includes all human activities that are classified as illegal, e.g., poaching, harvesting firewood in protected areas, gold panning.

developing world (Ciocăneaa et al. 2016; Bennett and Dearden 2014; Ebua et al. 2011; Lia et al. 2010; Newmark 1993). Perceptions and attitudes form the basis of behaviour that will in turn affect the possibility of collective action (Karanth 2008). Perceptions and attitudes are in turn shaped by people's experiences with CPRs, i.e., ownership of the resource, fairness in terms of institutions governing resource access, whether a household receives benefits from the resource, and whether they suffer loss through interaction with the resource. Perceptions and attitudes towards conservation of CPRs are also influenced by socioeconomic characteristics such as age, gender, level of education, training related to natural resource management and the type of resource in question (Mutanga 2017; Levitt 2013; Ebua et al. 2011; Lia et al. 2010; Allendorf 2007; Mansfeld and Ginosar, 1994; Newmark 1993). Interventions such as training and benefit sharing can influence the way people think about wildlife, which in turn affects conservation and welfare in the latter case. The role of information provisioning on community wildlife conservation should not be underestimated, as this has potential to transform the way people think about a resource (Ntuli and Muchapondwa 2017a).

This paper takes existing literature on perceptions towards wildlife as a starting point and sets out to investigate their determinants empirically. While most studies have been conducted at the local level, studying a small number of resource users (see Agrawal 2001), the empirical investigation conducted here focuses on large-scale social-ecological systems, i.e., transfrontier conservation areas. Together, local people's perceptions affect the possibility of collective action (Kelly 2001), which is essential for the management and exploitation of CPRs in a sustainable manner.

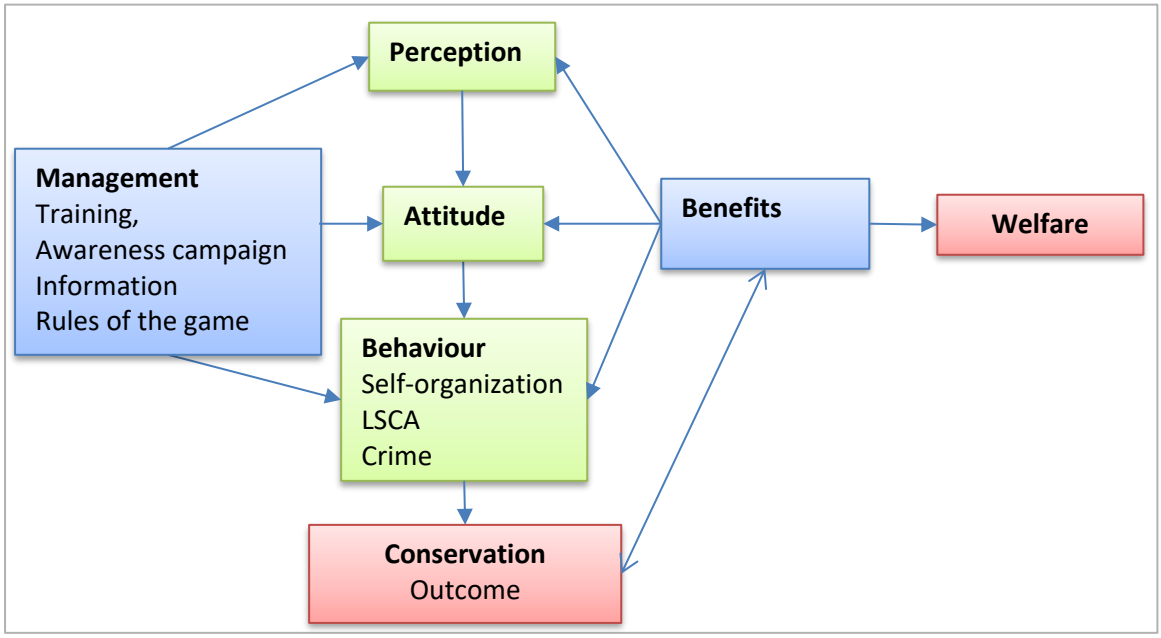
While transboundary conservation of natural resources and wildlife has the potential of increasing conservation effectiveness, these conservation arrangements could also face challenges in terms of reaching collective action because of their increased scale and complexity (see Death 2016; Petursson et al. 2011). Considering fugitive resources such as wildlife straddling across borders, the possibility of large-scale collective action is, for example, complicated by different institutions and settings in different countries. These different contexts affect the perceptions and attitudes of local people about a resource. The interaction between wildlife and local communities around GLTFCA yields different experiences. For instance, CAMPFIRE[4] communities in Zimbabwe lose livestock and suffer crop damages from wildlife intrusion on a regular basis, yet the benefits from conservation are negligible. In Mozambique, there are no institutional arrangements to facilitate the flow of benefits from wildlife conservation to local communities and as a result they resort to poaching (Whande and Suich 2009). The South African case is unique, since the Makuleke

[4] The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) is discussed in more detail in Section 3.1.

community generates revenue from land owned inside the Kruger National Park, which is managed by a safari operator on their behalf (Reid, H. 2017). These different contexts affect and shape perceptions and attitudes of local communities in the three different countries towards conservation.

Our argument is that if we understand the determinants of perceptions in different contextual settings, then we will be able to develop sound policies promoting CPR institutions that will change people's attitudes, thereby incentivising them to behave in a way that is consistent with sustainable development. Thus, we contribute both empirically and theoretically to the field by studying the foundations for collective action in a large-scale setting. The conceptual framework is shown in Figure 1.

Figure 1: Conceptual Framework



Source: Own diagram

3. Research Methods

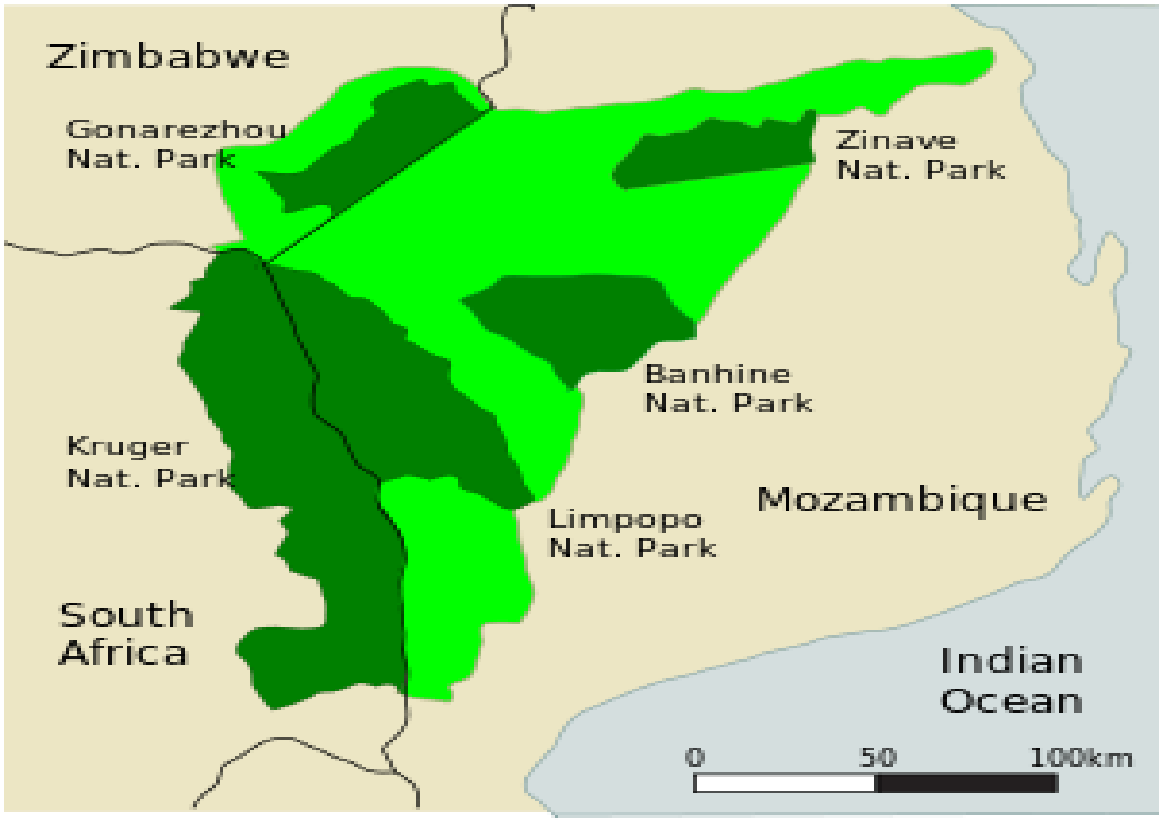
3.1. Study Area

In this study we focus on the Great Limpopo Trans-frontier Conservation Area (GLTFCA). Formally established in 2000, when a common treaty was signed, this is a collaboration between the governments of South Africa, Zimbabwe and Mozambique (Spenceley 2006). A new treaty was approved in 2002 recognizing the 'core protected areas' of the region and thereby establishing the Great Limpopo Transfrontier Park (TP). Today, the park stretches over an area of about 35.000 square kilometres including three national parks: the Kruger National Park in South Africa, the Limpopo National Park in Mozambique and the Gonarezhou National Park in Zimbabwe (SANParks 2018). The future plan is, however, for the trans-frontier park to become a trans-frontier conservation area, expanding into surrounding areas covering almost 100.000 square kilometres, thereby becoming one of the world's largest TFCAs.

The overall goal of GLTFCA is to foster transnational collaboration and increase the effectiveness of ecosystem management. Ideally, it was supposed to provide mobility of both people and wildlife within the TFCA. Another important purpose is for the local communities to receive economic benefits through increased eco-tourism in the region. The park further holds its own organizational structure with a Trilateral Ministerial Committee, a joint management board, and a management committee (SANParks 2018).

Figure 2 shows the map of the GLTFCA, where the national parks are shown in dark green and surrounding areas identified for future expansion in light green. The park is located between $22^0$22'S and $31^0$22'E, with arid conditions thus less suitable for rain-fed agriculture (Gandiwa 2017; Ntuli and Muchapondwa 2017a). The mode of production is predominantly subsistence agriculture, combining livestock and crop cultivation. Furthermore, the study area is dominated by Shangani-speaking people (approx. 95%) although other languages such as Shona, Ndau and Ndebele in Zimbabwe and Venda and Zulu in South Africa are also spoken.

Figure 2: Map of the Great Limpopo Trans-frontier Conservation Area



Source: Wikipedia, 21 January 2018

On the Zimbabwean side, local communities are organized into Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) projects, which are dotted around the Gonarezhou National Park, while in South Africa the Makuleke community owns land inside the Kruger National Park, but hires a safari operator to manage wildlife on the community's behalf. CAMPFIRE communities do not own land, but manage wildlife traversing the buffer zone through their respective Rural District Councils (RDCs). The proceeds from wildlife conservation are in turn shared between the RDC (47%) and the CAMPFIRE communities (50%), while the balance goes to the CAMPFIRE association.

3.2 Data and Sampling

This paper uses unique household survey data collected between May and September 2017 from local communities residing close to the Great Limpopo TP. The data is based on face-to-face interviews and includes 1351 respondents, with 769 respondents from the Zimbabwean side and 582 respondents from the South African side. The survey consists of questions on the respondents' socioeconomic conditions[5] and themes such as willingness to follow formal rules,

[5] The socioeconomic variables included the respondent's age, gender, level of education, employment status and household income.

corruption and law enforcement, the function and management of the park, poaching trends, and the respondent's attitudes towards different strategies and policies to combat poaching.

Simple random sampling was applied to select 11 out of 29 CAMPFIRE projects located near Gonarezhou National Park. These were all identified by the Rural District Council (RDC) in Zimbabwe. In South Africa, a full sample of 5 villages closely situated to Kruger National Park was identified by the local chief. Thereafter, the chairpersons of each CAMPFIRE project and each chief provided a list of beneficiaries in each project and community respectively. We then performed a simple random sampling procedure starting with a random household on the list. Each household was chosen after every *n* households where *n* is the sampling interval calculated as the total number of households in the project divided by the required sample size. The selection procedure continued until the required number of households in the sample was achieved.[6]

The enumerators were trained for two days during which they got the opportunity to go through the survey and get familiar with the questions. A pilot round was also carried out in one village before the data collection started, testing applicability of the questionnaire. This study does not, however, include a sample of respondents from the Mozambican side of the park. Even though this would be of high interest, this was not possible because of logistical aspects at the time the survey was conducted. Still, a project is now underway to collect data in communities located in Mozambique which could be used to supplement future studies in the research field.

3.3 Empirical Model Specification

In this study, we model the attitudes and perceptions of local people around the GLTFCA in South Africa and Zimbabwe towards the rules of the park. We cannot observe people's attitudes, but we can ask questions about their perceptions and infer their attitudes. Thus, we ask a number of questions for each of the different themes highlighted above and then use factor analysis to recover the latent variables measuring people's attitudes and perceptions.

We use instrumental variables estimation with heteroscedasticity-based instruments to model the determinants of people's perceptions. Consistent with theory and empirical literature, we assume that people's perceptions are linked to their attitudes and behaviour; if this is the case, then the same factors that influence perception also influence attitude, whether directly or indirectly (via the influence of perceptions on attitude). The dependent variables used in the regression models are related to people's perceptions of benefits from conservation, rules governing the GLTFCA, wildlife and environmental crime. Table A1 in

[6] If we reached the end of the household list before collecting the required number of households, we restarted the sampling process selecting a different starting point at random on the list. The target sample was exceeded in all communities except in three, i.e., Dopi, Gondweni and Mugiviza.

the annexes shows the types of questions that were asked under each theme. All categorical variables and variables that require respondents to rate from 1 to 5 were converted into binary variables and the computed index expressed as a fraction between zero and one for ease of interpretation. For instance, a question that asked respondents either to rate between 1 and 5 or to order categories was recorded as one of two values: zero if the response is negative and 1 if it is positive. Before the indices were computed, negative questions were re-coded to match questions that were asked in a positive sense, i.e., zero signifies a negative outcome or bad situation and one stands for a positive outcome.

Table 1 shows the explanatory variables used in our regression models and their expected signs. Theoretical, empirical and experimental studies suggest that both socioeconomic variables and governance or management outcomes affect people's perception of natural resources (Agrawal et al. 2008; Ostrom et al. 2007; Kemp et al. 2005). However, the results are mixed because the effects of socioeconomic variables on perception depend on contextual factors and the type and size of resource under consideration (Ostrom 2007; Agrawal 2001). Empirical literature seems to suggest that livestock ownership, off-farm employment, and a larger size of the group that manages the resources are negatively associated with perceptions about the value of conservation. Women are more likely to perceive natural resources in a positive way than men since they are involved in harvesting resources such as firewood, insects, weaving material and wildlife vegetables on a daily basis (Ntuli and Muchapondwa 2017b; Thondlana and Muchapondwa 2015; Shackleton and Shackleton 2006).

Table 1: Explanatory Variables and Their Definition

Variable	Explanation	Expected sign
Gender	0 = Female, 1 = Male	-
Education	Number of years in School	+
Age	In years	+
Hholdsize	Number of household members	Undetermined
Employment	Is household head employed?	±
Electricity	Is your house electrified? 0 = No, 1 = Yes	+
Group size	How big is your community?	-
Livestock	Does household own livestock? 0 = No, 1 = Yes	-
Socialgrant	Does household receive a social grant?	Undetermined
Foodinsecure	Number of days household slept without eating	-
Sellassets	Has household been forced to sell assets? [0, 1]	Undetermined
Manageindex	Management index	±
Expetindex	Expertise	Undetermined
Benefitindex	Wildlife benefits	+
Rulesindex	Rule compliance	±
Corruptindex	Corruption	-

Source: Empirical literature and theory

Other studies demonstrated that education, age, employment and access to electricity have a positive effect on people's perception of natural resources (Pollnac, 2000; Nazarea et al., 1998; Samdahl and Robertson, 1989). Theoretical studies predict that benefits from conservation affect perception in a positive way (Marks and Davis 2012; Fisher et al. 2008; Ostrom et al. 2007), while corruption affects perception negatively (Sandker et al. 2009; Ostrom 2007; Smith and Walpole 2005). The effect of management outcomes and institutional variables such as rules is mixed since the impact of these variables also depends on the context (Kitthananan 2006; Kemp et al. 2005; Kellert et al. 2000). The effects of household size, social grants, whether household sold assets during difficult times and expertise in resource extraction could not be determined *a priori* from the literature.

We suspect the problem of endogeneity in our regression models. For instance, perceptions about wildlife benefits affect how people perceive the rules of the park, wildlife in general and environmental crime. On the other hand, these three variables also affect how people perceive wildlife benefits. Because of this problem, we employ instrumental variables estimation with heteroscedasticity-based instruments, which methodologically deal with the problem of endogeneity (Lewbel 2016; Prono 2014; Baum et al. 2013; Lewbel 2012; Hausman et al. 2012; Chao et al. 2012). This method estimates an instrumental variables regression model, providing the option to generate instruments and allowing the identification of structural parameters in regression models with endogeneity in the absence of traditional identification information such as external instruments (Chao et al. 2012; Lewbel 2012; Rigobon 2003). Identification is achieved in this context by having explanatory variables that are uncorrelated with the product of heteroscedastic errors (Lewbel 2016; Baum et al. 2013). Instruments may be constructed as simple functions of the model's data (Lewbel 2012). As a result, 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. Thus, Lewbel's approach can be a good substitute for the standard IV approach in terms of addressing the problem of endogeneity. The choice one uses depends on the availability of sound external instruments. If good external instruments are available, then the standard IV approach is superior. If external instruments are either weak or not available, then the method of heteroscedasticity-based instruments is superior to the conventional IV approach.

This technique is gaining popularity and is being used widely in many studies (e.g., Ntuli and Muchapondwa 2018; Mishra and Smyth 2015; Banerjee et al. 2013; Emran et al. 2012). Using two data sets from China to compare an identification strategy that utilises a heteroscedastic covariance restriction to construct an internal IV and the standard IV, Mishra and Smyth (2015) found that Lewbel's method provides plausible estimates in datasets in which conventional IVs are not available. The major drawback of Lewbel's approach is that identification relies upon higher moments, and therefore is likely to be less reliable than

identification based on coefficient zero restrictions. For a detailed description and the mathematics behind the method for constructing instruments as simple functions of the model's data, we refer the readers to Lewbel (2012) and Baum et al. (2013). We also checked for multicollinearity, under-identification, weak identification and over-identification of instruments using the VIF test, the Kleibergen-Paap test, the Cragg-Donald Wald F-statistic and the Hansen J statistic before proceeding with heteroscedasticity-based instruments in both models.

4. Results

Table 1 indicates that there is great variability between the two countries in terms of both socioeconomic characteristics and important policy variables. In both countries, there are more women than men in the samples, which is not surprising since most able-bodied males in both countries migrate from rural to urban areas in search of employment. Our results show that South Africa has household heads with more education and a higher employment rate, and a greater number of households with access to electricity and social grants. Hence the welfare of households on the South African side is much higher than on the Zimbabwe side. On the other hand, Zimbabwe has slightly more women-headed households, more livestock per household (suggesting a higher degree of agricultural orientation), slightly older household heads, households that are more prone to food insecurity, and households that frequently sell assets during shocks.

Table 1: Characterization of the Sample

Variable	Zimbabwe			South Africa			Total		
	Obs	Mean	Std	Obs	Mean	Std	Obs	Mean	Std
Gender	769	0.39	0.49	582	0.28	0.45	1351	0.34	0.48
Education	769	5.82	3.83	582	8.59	4.43	1351	7.01	4.32
Age	769	43.03	15.14	582	42.12	15.15	1349	42.64	15.14
Hhold size	769	6.21	2.53	581	4.63	2.12	1351	5.53	2.49
Employment	769	0.13	0.33	581	0.28	0.45	1351	0.19	0.39
Electricity	769	0.02	0.13	581	0.91	0.29	1350	0.40	0.49
Group size	769	60.20	53.22	582	937.19	208.28	1351	439.69	457.49
Livestock	769	0.72	0.72	582	0.15	0.21	1351	0.47	0.56
Socialgrant	768	0.10	0.30	581	0.76	0.43	1350	0.39	0.49
Foodinsecure	768	2.27	4.83	581	1.04	3.83	1351	1.73	4.47
Sellassets [0,1]	768	0.55	0.50	581	0.14	0.35	1351	0.37	0.48
Manageindex	768	80.57	7.13	581	81.88	5.21	1349	81.13	6.40
Expetindex	768	2.98	7.57	581	0.56	2.07	1349	1.94	5.98
Wildlifeindex	768	96.86	6.43	581	97.36	5.09	1349	97.07	5.90
Benefitindex	768	69.64	23.27	581	60.16	19.47	1349	65.49	22.18
Rulesindex	768	97.93	3.99	581	98.40	0.85	1349	98.13	3.07
Environindex	768	83.51	20.54	581	85.59	16.47	1349	84.40	18.92
Corruptindex	768	94.63	6.17	581	95.58	1.73	1349	95.04	4.82

Source: Survey data May – Sept 2017

When we consider important variables about people's perceptions towards wildlife that matter for conservation, we observe less variability across countries. Conventional tests using the standard t-test show significant differences between the two countries for expertise in resource extraction, benefits and environmental crime index. The environmental crime index measures the perception that environmental crime is morally acceptable. Nonparametric tests[7] suggest significant differences for the management index, expertise, wildlife, benefits, rule compliance, corruption and environmental crime index. Zimbabwe has slightly higher indices for resource extraction expertise and wildlife benefits, while South Africa has slightly higher indices for management, wildlife perception, rule compliance, environmental crime and corruption. We expected the index for environmental crime to be higher in Zimbabwe because the CAMPFIRE communities are relatively poor and thus rely more on less-valuable environmental resources such as firewood and wildlife vegetables. Poor people feel the need to illegally harvest fuel and vegetables. However, studies have shown that richer communities actually consume more environmental resources than relatively poor households because they have the means (Ntuli and Muchapondwa 2017b; Thondhlana and Muchapondwa 2014; Shackleton and Shackleton 2006).

We run four models, shown in Table 2, with perceptions of benefits, rules, wildlife and environmental crime as dependent variables. Our results show that perception of good management of the park positively affects the perception of benefits from the park, rules governing the park, and how people perceive wildlife. The results show that perception of good park management negatively affects people's perceptions of environmental crime, while resource extraction expertise positively affects people's perception of environmental crime. Perception of benefits positively affects how people perceive the rules governing the park and wildlife. Our results show that if people perceive the rules of the park in a negative way, then they are less likely to conserve wildlife, which at the same time will increase the likelihood of environmental crime.

Benefits seem to have a positive effect on people's perception of the rules governing the park and wildlife, but not on their perception that environmental crime is acceptable. Surprisingly, higher corruption levels positively affect people's perception of wildlife benefits and perception that environmental crime is justified. Communities in Zimbabwe value benefits from wildlife conservation more than communities in South Africa, are more compliant to the rules of the GLTFCA (view the rules as fair), while at the same time they are the ones who engage in environmental crime. This might be true given that CAMPFIRE communities are very poor and more dependent on the environment. Although they might value wildlife more than communities in South Africa, they are more likely to be caught loitering (trespassing) and harvesting firewood and certain food items from the park.

[7] The Mann-Whitney U test was used to test for significance differences between two medians.

In our regression models, we also controlled for other socioeconomic characteristics of the respondent. Most socioeconomic variables were insignificant, suggesting that they are not important in explaining variation in people's perceptions. Thus unobservable contextual factors could be responsible for explaining part of this variation. These contextual factors are absorbed by the constant in models 2, 3 and 4, thereby making the intercept large and highly significant. There is therefore a need to interpret our results with caution. We interpreted only those variables that are significant. Although the significance level is low or approaching insignificance, the age of a person positively affects his or her perception of the benefits of conservation. The variable 'age' seems not to affect a person's perception of the rules governing the park, wildlife and environmental crime. The size of the group has a negative effect on people's perceptions that the benefits are fair and that environmental crime is acceptable.

Table 2: Results of IV Estimation with Heteroscedasticity-Based Instruments

Explanatory variables	Benefits Index	Rules index	Wildlife Index	Environmental Crime index
Number of obs	1,316	1,316	1,316	1,316
Prob>F	0.0000	0.0001	0.0000	0.0000
F-statistic	232.45	320.20	160.71	92.23
Centred R2	0.122	0.0314	0.0586	0.0619
Uncentred R2	0.134	0.0451	0.0590	0.0727
Management index	0.288**	0.0522***	0.190***	-0.110**
	(0.0926)	(0.0136)	(0.0264)	(0.0859)
Expertise index				0.407***
				(0.0866)
Benefits index		0.00732*	0.0170**	-0.00546
		(0.00407)	(0.00763)	(0.0241)
Rules index			-0.0045**	0.753***
			(0.0593)	(0.187)
Corruption index	0.301**			2.433**
	(0.121)			(1.150)
Country	32.87***	2.410**	1.531	8.374**
	(7.088)	(1.048)	(1.294)	(4.099)
Gender	-0.852	0.123	0.174	-1.036
	(1.255)	(0.183)	(0.349)	(1.110)
Education	0.0899	0.0244	-0.00779	-0.0045
	(0.178)	(0.0260)	(0.0496)	(0.158)
Age	0.0909*	-0.00421	-0.00965	-0.00563
	(0.0487)	(0.00716)	(0.0136)	(0.0432)
Groupsize	-0.00851**	-0.000600	-0.00172	-0.0082**
	(0.00404)	(0.000595)	(0.00114)	(0.00361)
Electricity	-3.322	0.446	0.425	0.0976
	(2.650)	(0.389)	(0.740)	(2.336)
Livestock	-2.190	0.116	-0.293	-0.121
	(1.661)	(0.244)	(0.465)	(1.471)
Employment	0.592	0.0591	0.149	-0.674
	(1.535)	(0.225)	(0.427)	(1.350)
Social grant	-7.639***	-0.180	-0.0993	-1.267
	(1.630)	(0.241)	(0.457)	(1.447)
Food insecurity	-0.0306	0.00523	-0.0938**	0.447***
	(0.133)	(0.0196)	(0.0372)	(0.117)
Sell assets	2.892**	-0.341*	0.367	1.135
	(1.365)	(0.201)	(0.380)	(1.200)
Constant	1.843	1.89***	4.73***	1.79***
	(14.10)	(1.396)	(5.579)	(18.88)
Underidentification LM test	82.208	56.450	139.319	95.452
$\chi2(10)$ P-val	0.0001	0.0000	0.0000	0.0000
Weak identification F-test	18.373	26.281	25.420	31.568
Over-identification test	11.574	8.584	6.0430	7.561
$\chi2(9)$ P-val	0.2308	0.2623	0.8352	0.543
Breusch-Pagan test	18.543	29.172	21.954	19.753
Prob> $\chi2$	0.0000	0.0000	0.0000	0.0000

Source: survey data May – Sept 2017

Our results show that social grants negatively affect people's perceptions about wildlife benefits, suggesting that households that receive grants value wildlife benefits less

than non-beneficiary households. This result is strongly driven by one country, since social grants are only administered by the government of South Africa. Food insecurity at household level negatively affects people's perception about wildlife, while positively affecting perception of environmental crime. Although people might value wildlife benefits, households that have sold assets in the past year because of a shock have a negative perception of the rules of the GLTFP.

5. Discussion

Following the results of our regression analysis, several points can be discussed. The fact that appropriation rights belong to the RDC makes CAMPFIRE communities weaker in terms of their bargaining power and, as a result, they are viewed as mere beneficiaries by other stakeholders. In South Africa, we identified five communities, namely, Makuleke, Mabilikwe, Makahlule, Kombo and Humula. Out of these five communities, only Makuleke is directly involved in wildlife management through its community board and hiring a safari operator. Although the main language used in the study area is the same (i.e., we are dealing with Shangani-speaking communities in both countries), our study shows that people may have different perceptions both within and across communities and countries. These differences in perceptions could be driven more by policy and by unobserved contextual factors other than socioeconomic variables.

Our results show that positive perceptions about the management of the park positively affect perceptions of benefits from the park, rules governing the park, and how people perceive wildlife. Positive perceptions about the management of the park negatively affect the perception that it is morally acceptable to commit environmental crime; in other words, people who perceive that the park is well-managed are less likely to believe that environmental crime is acceptable. There is a very strong policy message behind this result, which calls for park management and other stakeholders to respect the perceptions of local communities and to increase dialogue with communities in order to improve their perceptions about wildlife management (Mutanga et al. 2017; Teferra and Beyene 2014).

We find that household expertise in resource extraction actually increases the likelihood that people will engage in environmental crime.[8] If households are able to harvest environmental resources illegally and at the same time are able to pay bribes to cover their tracks, then they can benefit from conservation efforts by other people, while 'free-riding' on

[8]This is consistent with Mukul et al. (2014), who reported that households with knowledge of environmental resources have greater incentives to engage in illegal harvesting of such resources. From a moral point of view, people do not feel ashamed when they harvest firewood and do not even consider it as an environmental crime (Ntuli and Muchapondwa 2017b). Wildlife benefits can influence rule compliance and improve the way communities view wildlife, but might not stop people from illegal harvesting of less valuable resources like firewood.

those efforts. Rule compliance and conservation attitudes in Integrated Conservation and Development Projects depend on whether people perceive benefits as fair (Arias et al. 2015), which is strongly tied to incentives. Child and Child (2015), Goldman (2011), Muchapondwa (2003) and Songorwa et al. (2000) argue that wildlife benefits create the necessary incentives for wildlife conservation through their role in promoting and shaping the way people view wildlife and rules governing the park. However, Balint and Mashinya (2006) argue that wildlife benefits derived by local communities in Southern Africa are too little to achieve such impacts, suggesting that there is a threshold that is unknown to authorities and, if benefits were to increase or reach this point, then people's perceptions would change.

Different sources of income were identified in the study area, including agriculture, employment, wildlife, environmental income and social grants. Most rural households in South Africa are eligible for different types of social grants including disability, old age, and benefits for children under the age of five (Maitra and Ray 2003). If social grants contribute significantly towards total household income, then this may greatly affect household perception of wildlife benefits. Studies done in South Africa reported that social grants support well over 33% of the population in the country, and the majority of the beneficiaries are found in rural areas (Du Toit and Neves 2009; Booysen and van der Berg 2005). Furthermore, most communities on the South African side do not have direct access to wildlife benefits, as this privilege is monopolized by only one community, namely, Makuleke. Wildlife and tourism activities on the land inside Kruger National Park that belongs to the community are managed by the state agency and a private company respectively, while the board responsible for administering and managing wildlife benefits is based in Makuleke. Key informant interviews revealed that wildlife benefits are not fairly distributed across communities, and some community leaders were disgruntled by the status quo. As the analysis revealed, this might have serious consequences on how the communities perceive wildlife and their attitude towards conservation in general.

Ntuli and Muchapondwa (2018) reported a negative relationship between group size and wildlife benefits or conservation. The negative relationship between group size and environmental crime is not surprising since extensive resources such as wildlife need a larger group for easy monitoring. However, enforcement is still a challenge for both small and large group sizes because of poor institutions in local communities (Ostrom et al. 2007). Along these lines, previous studies have demonstrated that external monitoring and enforcement by the state is much worse compared to the case when it is done by local communities, due to limited state resources (Ostrom 2007; Murphy and Cardenas 2004). It is worthwhile to invest in local common pool resource institutions in order to strengthen the capacity of communities so that they are able to achieve effective monitoring and enforcement.

Thus, the most important determinants of people's perceptions towards transfrontier conservation areas are related to their perception of park management, benefits, crime, and institutional rules, as well as unobservable contextual factors. All these factors are interwoven and should not be considered in isolation, but as part of the bigger picture. Theory and empirical evidence suggest that these variables are important for stabilizing large-scale cooperation in the management of common pool resources that involves indigenous communities. When we compare our results, looking from a broader lens of large-scale conservation activities in the GLTFCA, to the results of other studies on collective action involving individual case studies, we observe striking similarities in terms of the influence of these key variables, which could be a target of policy interventions.

Our results speak to both large-scale collective action and wildlife conservation in the GLTFCA in different ways. Theory and empirical evidence seem to suggest that people's perceptions and attitudes affect collective action, which in turn influences behaviour towards conservation (Ostrom 2000). From a policy perspective, both park management and the distribution of benefits are critical to conservation and deserve to be executed in a manner that people perceive as fair. Furthermore, variables such as household expertise, group size and people's perception of the park, wildlife and rules governing the park should be given priority in future policy reforms, since they have bearing on local community involvement. Wildlife management training and awareness campaigns might play an important role in changing people's perceptions towards conservation, and thus influencing large-scale collective action. Ntuli and Muchapondwa (2018) found a positive and significant effect of training on cooperation in local communities around the Gonarezhou National Park (GNP) in Zimbabwe. Understanding the circumstances under which wildlife conservation occurs in the GLTFCA is of prime importance, since this has a bearing on perceptions and attitudes, which in turn are essential for stabilizing large-scale collective action.

6. Conclusion

The paper set out to examine the determinants of the perceptions in local communities sharing a transboundary wildlife area around the Great Limpopo Trans-frontier Conservation Area bordering South Africa, Zimbabwe and Mozambique. Our study is important because perceptions shape people's attitudes in the short run and behaviour in the long run. This study further contributes to the literature by focusing on people's perceptions towards conservation in a larger socio-ecological system, in contrast to the majority of studies within the field, which often study a small number of resource users within a geographically well-defined and comparatively small area. As perceptions translate into attitudes and then behaviour, this study investigates the foundations for collective action in a large-scale setting.

Our results show that positive perception of management of the park positively affects the perception of benefits from the park, rules governing the park, and how people perceive wildlife. Positive perception of park management negatively affects people's belief that environmental crime is acceptable, while expertise in extracting resources positively affects their tolerance of environmental crime. Positive perception of benefits positively affects how people perceive the rules governing the park and wildlife. Our results suggests that, if people perceive the rules of the park in a negative way, then they are less likely to conserve wildlife, which will increase the likelihood of environmental crime. Benefits seem to have a positive effect on people's perception of the rules governing the park and wildlife, but not on environmental crime. Surprisingly, corruption positively affects people's perception of wildlife benefits and environmental crime.

Most socioeconomic variables were insignificant, suggesting that they are not important in explaining variation in people's perceptions. Thus unobservable contextual factors could be responsible for explaining part of this variation. These contextual factors are absorbed by the constant, thereby making it large and highly significant. Consequently, there is a need for further studies to recover unobservable contextual factors in order to fully understand the determinants of perceptions towards wildlife across time and space in larger socio-ecological systems.

Acknowledgements

We thank the communities around the Gonarezhou in Zimbabwe and Kruger National Park in South Africa for their willingness to participate in the surveys. We also thank Sida (Swedish International Development Cooperation Agency) through the Centre for Collective Action Research (CeCAR) at the University of Gothenburg. Last but not least, we thank both friends and colleagues for their useful comments.

References

Adams, W., and Hutton, J. (2007). People, parks and poverty: Political ecology and biodiversity conservation. *Conservation & Society*, *5*(2), 147–183.

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development, 29*(10), 1649–1672

Agarwal, B. (2009). Rule making in community forestry institutions: The difference women make. *Ecological Economics, 68,* 2296–2308.

Agrawal, A., Chhatre, A., and Hardin, R. (2008). Changing governance of the world's forests. *Science, 320,* 1460–2.

Agrawal, A., and Chhatre, A. (2006). Explaining success on the commons: Community forest governance in the Indian Himalayas. *World Development, 34*(1), 149–166.

Allendorf, T. D. (2007). Residents' attitudes toward three protected areas in southwestern Nepal. *Biodiversity and Conservation, 16,* 2087–2102.

Allendorf, T. D., Aung, M., and Songer, M. (2012). Using residents' perceptions to improve park-people relationships in Chatthin Wildlife Sanctuary, Myanmar. *Journal of Environmental Management, 99,* 36–43.

Arias, A., Cinner, J. E., Jones, R. E., and Pressey, R. L. (2015). Levels and drivers of fishers' compliance with marine protected areas. *Ecology and Society*, *20*(4), 19. http://dx.doi.org/10.5751/ES-07999-200419.

Ashok, K., Dillon, W. and Yuan, S. (2002). Extending discrete choice models to incorporate attitudinal and other latent variables. Journal of Marketing Research 39, 31-46.

Baland, K., and Platteau, J. P. (1996). Halting degradation of natural resources: Is there a role for rural communities? Oxford: Clarendon Press.

Balint, P. J., and Mashinya, J. (2006). The decline of a model community-based conservation project: Governance, capacity, and devolution in Mahenye, Zimbabwe. *Geoforum, 37*(5), 805–815.

Banerjee, S., P. Chatterji, and K. Lahiri. 2013. Effects of Psychiatric Disorders on Labor Market Outcomes - A Latent Variable Approach Using Multiple Clinical Indicators. CESifo Working Paper Series No. 4260.

Baum, C. F., Lewbel, A., Schaffer, M. E., and Talavera, O. (2013). Instrumental variables estimation using heteroskedasticity-based instruments. United Kingdom Stata User's Group Meetings, Stata Users Group.

Becker, C. D. and E. Ostrom, 1995. Human Ecology and Resource Sustainability: The Importance of Institutional Diversity. Annual Review of Ecology and Systematics 26(1):113-133

Beedell, J., and Rehman, T. (2000). Using social-psychology models to understand farmers' conservation behaviour. *Journal of Rural Studies, 16*, 117–127.

Bennett, N. J., and Dearden, P. (2014). Why local people do not support conservation: Community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy, 44*, 107–116.

Booysen, F., and Van der Berg, S. (2005). The role of social grants in mitigating against the socio-economic impact of HIV/AIDS in two Free State communities. *South African Journal of Economics, 73*, 545–563.

Chao, J. C., Swanson, N. R., Hausman, J. A., Newey, W. K., and Woutersen, T. (2012). Asymptotic distribution of JIVE in a heteroskedastic IV regression with many instruments. *Econometric Theory, 28*, 42–86.

Child, G., and Child, B. (2015). The conservation movement in Zimbabwe: An early experiment in devolved community based regulation. *African Journal of Wildlife Research, 45*, 1–16.

Ciocăneaa, C. M., C. Sorescub, M. Ianoși, and V. Bagrinovschia, 2016. Assessing public perception on protected areas in Iron Gates Natural Park. *Procedia Environmental Sciences, 32*, 70–79.

Crépin, A.-S., R. Biggs, S. Polasky, M. Troell, and A. de Zeeuw. 2012. Regime shifts and management. *Ecological Economics* 84:15-22.

Death, C. (2016). Green states in Africa: Beyond the usual suspects. *Environmental Politics, 25*(1), 116–135.

Du Toit, A., and Neves, D. (2009). Trading on a grant: Integrating formal and informal social protection in post-apartheid migrant networks. Manchester: Brooks World Poverty Institute. (BWPI working paper no. 75).

Ebua, V. B, Agwafo, T. E., and Fonkwo, S. N. (2011). Attitudes and perceptions as threats to wildlife conservation in the Bakossi area, South West Cameroon. *International Journal of Biodiversity and Conservation, 3*(12), 631–636.

Emran, M. S., V. Robano, S. C. Smith. 2012. Assessing the Frontiers of Ultra-Poverty Reduction: Evidence from Targeting the Ultra-Poor (CFPR/TUP) program in Bangladesh. IIEP Working Paper IIEP-WP-2009-06.

Fisbien, M., and Ajzen, T. (1985). Belief, attitudes, intension and behaviour: An introduction to theory and research reading. Philippines: Addison Wesley Publishing Co.

Fischer, A., and van der Wal, R. (2007). Invasive plant suppresses charismatic seabird – the construction of attitudes towards biodiversity management options. *Biological Conservation, 1*(35), 256–267.

Fisher, R., Magginis, S., Jackson, W., Barrow, E., and Jeanrenaud, S. (2008). Linking conservation and poverty reduction: Landscapes, people and power, *Earthscan.*

Frost, P. G.H. and I. Bond, 2008. The CAMPFIRE programme in Zimbabwe: Payments for wildlife services. Ecological Economics 65: 776 – 787

Gandiwa, E., 2011. Preliminary assessment of illegal hunting by communities adjacent to the northern Gonarezhou National Park, Zimbabwe. *Tropical Conservation Science* 4 (4), 445–467 (Mongabay.com Open Access Journal).

Gibson, C. C., Williams, J. T., and Ostrom, E. (2005). Local enforcement and better forests. *World Development, 33*(2), 273–284.

Goldman, M. (2011). Strangers in their own land: Maasai and wildlife conservation in Northern Tanzania. *Conservation and Society, 9*(1), 65–79.

Hausman, J. A., Newey, W. K., Woutersen, T., Chao, J. C., and Swanson, R. (2012). Instrumental variable estimation with heteroskedasticity and many instruments. *Quantitative Economics, 3*, 211–255.

Holmes, C. M. (2003). The influence of protected area outreach on conservation attitudes and resource use patterns: a case study from western Tanzania. *Oryx, 37*, 305–315.

Huong, P. M., and Lee, J. H. (2017). Finding important factors affecting local residents' support for tourism development in Ba Be National Park, Vietnam. *Forest Science and Technology, 13*(3), 126–132.

Infield, M., and Namara, A. (2001). Community attitudes and behaviour towards conservation: An assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx, 35*, 48–60.

Ingold, T. (2000). The perception of the environment: Essays on livelihood, dwelling and skill. New York.

Johnson, N. D., and Mislin, A. A. (2011). Trust games: A meta-analysis. *Journal of Economic Psychology, 32*(5), 865–889.

Karanth, K. K., Kramer, R. A., Qian, A. A., and Christensen, N. L. (2008). Examining conservation attitudes, perspectives, and challenges in India. *Biological Conservation 141*, 2357–2367.

Kellert, S. R., Mehta, J. N., Ebbin, S. A., and Lichtenfeld, L. L. (2000). Community natural resource management: Promise, rhetoric, and reality. *Society & Natural Resources, 13*(8), 705–715.

Kelly, C. (2001). Group identification, intergroup perceptions and collective action. University of London, London.

Kemp, R., Parto, S., and Gibson, R. (2005). Governance for sustainable development : Moving from theory to practice. *International Journal Sustainable Development, 8*(1/2), 12–30.

Kitthananan, A. (2006). Conceptualizing governance: A review. *Journal of Societal & Social Policy, 5*(3), 1–19.

Levitt, M. (2013). Perceptions of nature, nurture and behaviour. *Life Sciences, Society and Policy, 9*, 13.

Lewbel, A. (2016). Identification and estimation using heteroscedasticity without instruments: The binary endogenous regressor case. *Economics Letters, 165*, 10–12.

Lewbel, A. (2012). Using heteroskedasticity to identify and estimate mismeasured and endogenous regressor models. *Journal of Business and Economic Statistics, 30*(1), 67–80.

Li, L., J. Wang, J. Shia, Y. Wangc, W. Liud, and X. Xu, 2010. Factors influencing local people's attitudes towards wild boar in Taohongling National Nature Reserve of Jiangxi Province, China. *Procedia Environmental Sciences, 2*, 1846–1856.

Lindahl, T., A.-S. Crépin, and C. Schill. 2016. *Potential disasters can turn the tragedy into success*. Environ Resource Econ, Volume 65, Issue 3, 657–676.

Lindahl, T., A.-S. Crépin, and C. Schill. 2012. *Managing resources with potential regime shifts: using experiments to explore social ecological linkages in common resource system*. Beijer Discussion Paper Series 232. Beijer Institute of Ecological Economics, Stockholm, Sweden.

Maganga, F. P. (2002). The interplay between formal and informal systems of managing resource conflicts: Some evidence from South Western Tanzania. *European Journal of Development Research, 14*(2), 51–70.

Maitra, P., and Ray, R. (2003.) The effect of rransfers on household expenditure patterns and poverty in South Africa, *Journal of Development Economics, 71*(1), 23-49.

Mansfeld, Y., and Ginosar, O. (1994). Determinants of locals' perceptions and attitudes towards tourism development in their locality. *Geoforum*, 25(2), 227–248.

Marks, S. J., and Davis, J. (2012). Does user participation lead to sense of ownership for Rural Water Systems? Evidence from Kenya. *World Development, 40*(8), 1569–1576.

Masclet, D., Noussair, C., Tucker, S., and Villeval, M. C. (2003). Monetary and nonmonetary punishment in the voluntary contributions mechanism. *American Economic Review, 93*(1), 366–380.

Mishra, V. and R. Smyth. 2015. Returns to Schooling in Urban China: New Evidence From Two Datasets Using Conventional and Heteroskedasticity-Based Instruments. *Economic Modelling* 47: 166 - 173.

Muchapondwa, E. (2003). The economics of community-based wildlife conservation in Zimbabwe. PhD dissertation, Göteborg University, Sweden.

Murphy, J. J., and Cardenas, J. C. (2004). An experiment on enforcement strategies for managing a local environmental resource. *Journal of Economic Education, 31*(1), 47–61.

Murphree, M. (2004). Communal approaches to natural resource management in Africa: From whence to where? *Journal of International Wildlife Law and Policy, 7*, 203–216.

Mutanga C. N., Muboko, N., and Gandiwa, E. (2017). Protected area staff and local community viewpoints: A qualitative assessment of conservation relationships in Zimbabwe. PLoS ONE 12(5): e0177153. https://doi.org/10.1371/journal. pone.0177153.

Nazarea, V., Rhodes, R., Bontoyan, E., and Gabriela, F. (1998). Defining indicators which make sense to local people: Intra-cultural variation in perceptions of natural resources. *Human Organization, 57*(2), 159–70.

Newmark, W. D., Leonard, N. L., Sariko, H. I., and Gamassa, D. G. M. (1993). Conservation attitudes of local people living adjacent to five protected areas in Tanzania. *Biological Conservation*, *63*(2), 177–183.

North, D. C. 1990. Institutions, Institutional Change, and Economic Performance. Cambridge: Cambridge University Press.

Ntuli, H., and Muchapondwa, E. (2018). The role of institutions in community Wildlife Conservation in Zimbabwe. *International Journal of the Commons, 12*(1), 134–169.

Ntuli, H. and E. Muchapondwa, 2017a. A Bioeconomic Analysis of Community Wildlife Conservation in Zimbabwe. *Journal for Nature Conservation* (37) 106 – 121.

Ntuli, H., and Muchapondwa, E. 2017b. Effects of wildlife resources on community welfare in Southern Africa. *Ecological Economics, 131*, 572–583.

Ostrom, E. 2007. A Diagnostic Approach for Going beyond Panaceas. Centre for the Study of Institutions, Population & Environmental Change. *PNAS* 104(39).

Ostrom, E. (2000). Collective action and the evolution of norms. *Journal of Economic Perspectives, 14(*3), 137–158.

Ostrom, E. (1998). A behavioural approach to the rational choice theory of collective action: Presidential Address, American Political Science Association, 1997. *American Political Science Review, 92*(01), 1–22.

Ostrom, E. (1990). Governing the commons: The evolution of institutions for collective Action. Cambridge, England: Cambridge University Press.

Ostrom, E., M. A. Jansses, and J. M. Anderies. 2007. Going beyond Panaceas. *PNAS* 104(39).

Ostrom, E., Gardner, R., and Walker, J. (1994). Rules, games, and common-pool resources. Ann Arbor: University of Michigan Press.

Petursson, J. G., Vedeld, P., and Kaboggoza, J. (2011). Transboundary biodiversity management: Institutions, local stakeholders, and protected areas: A case study from Mt. Elgon, Uganda and Kenya. *Society & Natural Resources, 24*(12), 1304–1321.

Pollard S., and du Toit, D. (2011). Towards adaptive integrated water resources management in Southern Africa: The Role of self-organisation and multi-scale feedbacks for learning and responsiveness in the Letaba and Crocodile Catchments. *Water Resource Manage,* doi 10.1007/s11269-011-9904-0.

Pollnac, R. B. (2000). Villagers' perceptions of aspects of the natural and human environment of Balikpapan Bay, Indonesia. *Journal of Pesisir & Lautan: Indonesian Journal of Coastal and Marine Resources 2000*, *3*(2), 19–29.

Prono, T. (2014). The role of conditional heteroskedasticity in identifying and estimating linear triangular systems, with applications to asset pricing models that include a mismeasured factor. *Journal of Applied Econometrics*, *29*(5), 800–824.

Reid, H. (2001). Contractual national parks and the Makuleke Community. *Human Ecology, 29*(2), 135–55.

Rigobon, R. 2003. Identification through heteroskedasticity. *Review of Economics and Statistics*, *85*(4), 777–792.

Romero, C., Athayde, S., Collomb, J. E., DiGiano, M., Schmink, M., Schramski, S., and Seales, L. (2012). Conservation and development in Latin America and Southern Africa: Setting the stage. *Ecology and Society, 17*(2), 17.

Samdahl, D. M., and Robertson, R. 1989. Social determinants of environmental concern: Specification and test of the model. *Environment and Behaviour, 21*(1), 57–81.

Sandker, M., B. M. Campbell, Z. Nzooh, T. Sunderland, V. Amougou, L. Defo, J. Sayer, 2009. Exploring the effectiveness of integrated conservation and development interventions in a Central African forest landscape. Biodiversity and Conservation, (18) 2875–2892.

Schill, C., T. Lindahl, and A.-S. Crépin. 2015. Collective action and the risk of ecosystem regime shifts: insights from a laboratory experiment. *Ecology and Society* **20**(1): 48.

Shackleton, C. M., and Shackleton, S. E. (2006). Household wealth status and natural resource use in the Kat River Valley, South Africa. *Ecological Economics*, *57*(2), 306–317.

Smith, R. J., and Walpole, M. J. (2005). Should conservationists pay more attention to corruption? *Oryx*, *39*(03), 251–256.

Songorwa, A. N., Buhrs, T., and Hughey, K. F. D. (2000). Community-based wildlife management in Africa: A critical assessment of the literature. *Natural Resources Journal*, *40*(3), 603–643.

South African National Parks (SANParks). (2018). Great Limpopo Transfrontier Park. Available from: https://www.sanparks.org/conservation/transfrontier/great_limpopo/ (Accessed 2018-04-26).

Spenceley, A. (2006). Tourism in the Great Limpopo Transfrontier Park. *Development Southern Africa*, *23*(5), 649–667.

Teferra, F., and Beyene, F. (2014). Indigenous claims and conflicts in managing the Abijata-Shalla Lakes National Park, Ethiopia, *International Journal of Biodiversity Science, Ecosystem Services & Management, 10*(3), 216-227, doi: 10.1080/21513732.2014.942372.

Thondhlana, G., and Muchapondwa, E. (2014). Dependence on environmental resources and implication for household welfare: evidence from the Kalahari drylands, South Africa. *Ecological Economics, 108*, 59–67.

Whande, W., and Suich, H. (2009). Transfrontier conservation initiatives in Southern Africa: Observations from the Great Limpopo Transfrontier Conservation Area, *Evolution and Innovation in Wildlife Conservation: Parks and Game Ranches to Transfrontier Conservation Areas* (eds. H Suich and B Child with A Spenceley), Earthscan, London, 373–91.

Woods, S. R., and Ruyle, G. B. (2015). Informal rangeland monitoring and its importance to conservation in a U.S. ranching community. *Rangeland Ecology & Management, 68,* 390–401.

ANNEXES

Table 3: Type of Question Asked by Theme

Theme	Type of questions
Dependent variables	
Perception of benefits	Do the rules from "the park" benefit you, for instance by generating income or employment? 0 = No 1 = Yes
	Does your community receive any income from recreational hunting in the area? 0 = No 1 = Yes
	To what extent do you believe that these economic benefits will be distributed fairly? 1 = Not at all 2 = To a limited extent 3 = To some extent 4 = To a great extent
Perception of rules	How willing are you to follow the rules of the park? 1 = Not at all willing 2 = Not willing 3 = Neither willing nor reluctant 4 = Willing 5 = Very willing
	To what extent do you consider violating the rules of the park? 1 = do not consider it at all 2 = do not consider it 3 = neither willing nor reluctant 4 = to some extent 5 = to a large extent
	In general, to what extent do you actually obey the regulations of the park? 1 = Not at all 2 = To a limited extent 3 = To some extent 4 = To a large extent 5 = To a complete extent
	Rules governing the park are clear and simple to understand 0 = No, 1 = Yes
	You are well informed about the park and its rules? 0 = No, 1 = Yes
	Rules governing the park intend doing the right thing 0 = No, 1 = Yes
	Rules governing the park are enforced fairly 0 = No, 1 = Yes
	There is a moral obligation to comply with the rules governing the park [0,1]
	A person would feel shame if caught for violating the rules governing the park
	Local communities are involved in the making of rules governing the park [0,1]
	Authorities listen to local communities when designing rules governing the park
Perception of wildlife	What the people and its livestock need is more important than saving plants and wild animals? 0 = No, 1 = Yes
	It is important to protect wildlife for our children 0 = No, 1 = Yes
	There are so many wild animals nowadays that the laws to protect them are no longer necessary 0 = No, 1 = Yes
	Wildlife and nature in the area of the park is in risk of being depleted
	Wildlife is nowadays more abundant than it used to be
	In recent time, the overall threats to wildlife and resources have increased
	Has your property or any person you know been damaged by wildlife? [0,1]

Perception of environmental crime	
	Collecting firewood in a protected area 1 = Not wrong 2 = Wrong but understandable 3 = Wrong and should be punished
	Shooting an animal that destroys your crops 1 = Not wrong 2 = Wrong but understandable 3 = Wrong and should be punished
	Fishing although there is a closed season 1 = Not wrong 2 = Wrong but understandable 3 = Wrong and should be punished
	Poaching inyalas or impalas for bushmeat 1 = Not wrong 2 = Wrong but understandable 3 = Wrong and should be punished
	Has illegal hunting increased or decreased during recent years? 1 = decreased 2 = not changed 3 = Increased
	How many poaching events have you heard about during the recent year? 0 if less than three and 1 if greater than 3
	Most poachers in this area never get caught
	It is sometimes justified to harbour a poacher in your house
	You would tell authorities if you had information that could send a poacher in front of the legal system to face sanctions
	Poaching for commercial use is morally wrong
	Poaching for subsistence use is morally wrong
	Collecting firewood, although illegal, is morally acceptable
	People engaged in poaching should face harder sentences
	If a poacher comes from another country then it is more acceptable to tell the police about this person
Explanatory variables	
Park management	What are your opinions about the current management of the park? 5 = Very good 4 = Good 3 = Neither good nor bad 2 = Bad 1 = Very bad
	How common is it that local communities are involved in monitoring rules governing the park? 1= Very rare 2 = Rare 3 = Common 4 = Very common
	How effective is enforcement to reduce violations? 1 = Not effective at all 2 = Somewhat effective 3 = Effective 4 = Very effective
	How much of illegal behaviour related to conservation in your area will the rangers generally be able to hinder? 1 = Nothing 2 = Hardly anything of it 3 = Some of it 4 = Most of it
	How often are you in contact with rangers or other state employees enforcing the park rules? 1 = Less than once a year 2 = On some occasions over a year 3 = Every month 4 = Every week 5 = Almost daily

	Rangers from your country are more efficient than rangers from neighbouring countries
	Help park rangers in their surveillance by telling them of suspicious activities
	A joint ranger force with staff from all the countries engaged in the TFCA
	Surveillance of poaching activities should be increased
	Are you ever in contact with enforcement officers from other countries? 0 = No 1 = Yes

Corruption	Offering a bribe to avoid being arrested by the police 1 = Not wrong 2 = Wrong but understandable 3 = Wrong and should be punished
	You personally know some of the rangers [0, 1]
	Rangers are on friendly terms with your community [0, 1]
	You can pay rangers to make them refrain from imposing sanctions for rule violations
	Rangers from your country are more easily bribed than rangers from neighboring countries
Expertise	Do you consider yourself or anyone else in the household to be a hunter? 0 = No 1 = Yes
	Do you consider yourself or anyone else in the household to be a fisherman? 0 = No 1 = Yes
	Do you consider yourself or anyone else in the household to be reliant on activities that consist of using natural resources? 0 = No 1 = Yes
	How many times have you eaten bushmeat within the previous month? (state a number) 0 if less than 5 times and 1 if greater or equal to five