Zimbabwe's CAMPFIRE public investments: Impact on education, adaptation and preferences

By

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Declaration and copyright

I Collen Matema declare that this thesis is my own unaided work, both in concept and execution, and that apart from the normal guidance from my supervisors, I have received no assistance.

Signature	Signed by candidate	Date	09/02/2020

Abstract

The thesis investigates household economic and behavioural implications of public investments funded by communal based wildlife management programmes, such as Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe. The thesis focuses on household education and adaptive capacity production. It further investigates determinants of programme stated preferences and behaviour thereof in communal areas of Zimbabwe, using the case of Dande communal area in Mbire district. Since its inception in the late 1980s, there has been debate over the adequacy of the implementation of the CAMPFIRE programme in effecting economic and behavioural change in the respective communities. However, most of the assessments focused on household financial gains, poverty reduction and inequality. Results show that little financial gains accrue to the respective households, with poverty and inequality remaining high. This thesis argues that the main development trajectory in communities implementing communally based wildlife programmes such as CAMPFIRE is biased towards public capital investment; in the form of infrastructure development and respective support for the related services. By design therefore, the programme will have positive impact on access to publicly provided goods and services rather than private goods. By implication, the study further argues that the programme will therefore have varied implications on households' adaptive capacity components that are closely linked to the investment trajectory. Furthermore, there has been mixed feelings regarding the CAMPFIRE programme at the local level, varied to mixed decision outcomes regarding stated preferences on whether to continue the programme or not. The study attempts to decipher this by investigating whether feelings are driven by past wild animal encounters and whether the stated programme preferences are in turn driven by the reported feelings or perceptions of benefit (utility). The study uses posttest data collected through survey-method-choice-experimental design complemented by qualitative data collection from wildlife producer communities and non-wildlife producing communities in Mbire rural district. I present the exploration on each of the issues in three papers included in the chapters herewith.

The first paper investigates effects of the Communal Area Management Programme for Indigenous Resources (CAMPFIRE)'s public investment on education production. The objectives are to estimate the average treatment effect of the programme on children's participation in formal education and identify the socioeconomic inputs that influence education production. The study uses the post-test only control group design and Average Treatment Effect on the Treated (ATET) in estimating the impact of CAMPFIRE programme

induced changes on participation in formal education of children of school going-age. I use propensity score estimation to correct for confounding factors, and to allow for comparison of units with similar background characteristics.

Results show that education production improves by 12 per cent when children are under the CAMPFIRE programme than when they are not. However, results from education production function show that socio-economic inputs or characteristics are significant factors in explaining variation in education production in CAMPFIRE implementing areas than in non-programme implementing areas. This indicates that the programme design is does not remove education disparity between better and less resourced households. Therefore, while public investments for the programme improves education production it needs to be re-configured to address the skewedness.

The second paper investigates the average treatment effects on the treated, ATET of community based wildlife management programme on resilience, specifically household adaptive capacity and its different components. Adaptive capacity denotes the ability of a system to adjust, modify or change its characteristics or actions to moderate potential damage, take advantage of opportunities or cope with the consequences of shocks or stresses. I use Regression Adjustment and Potential Outcome Means (POM) procedures to estimate ATET.

Results show that the programme's effect is negative on social, economic and human capacities while positive for transformative or physical capacity. The programme however, has a positive effect on the overall adaptive capacity. The average social capital index for example is 0.011 or 1.1 per cent less when households implement CAMPFIRE programme than the average of 0.061 or 6.1 per cent that would have occurred or obtain if these households were not implementing the programme. The human capital capacity index for programme implementing households is 0.006, less than 0.076, if they were not implementing the programme. The economic capacity index is 0.008 less when treated than the average of 0.068 that would have occurred if the programme-implementing households were not under the programme. However, on physical capacity the potential outcome would be 0.038 higher than 0.183 if the programme-implementing households were not implementing. On the overall household adaptive capacity index, the potential outcome is 0.012 higher than 0.388 that would obtain if the programme-implementing households were not implementing the programme. The results reflect the investment trajectory in the area; a higher proportion of income from the

conservation programme has been directed towards public goods provisioning, improving the physical capacity of the respective households. Lessons from the results are that impacts of investments are a result of the investment portfolio configuration.

Results of the education production function confirm that the CAMPFIRE programme affects the individual components of adaptive capacity variably; negatively on household social, economic capacities, and positively on household physical capacity, with no significant effect on human capacity and overall household adaptive capacity. Implementing the programme significantly improves access to public service for the poor: with no significant change in economic and social statuses. Furthermore, the results also show that there are other covariates that have significant influence on household capacities, such as having a household member out of the country, or in an urban area, being a widow, belonging to some ethnic groups such as Karanga, and religious affiliation, for example traditional religion. Having a household member in the diaspora for example improves household economic and human capacity, while traditional religion tends to have negative effect on all household adaptive capacities. The key lesson is that the programme is flexible; policy makers can reconfigure it to address critical livelihoods and capacity components as needed. With the active participation of local communities, it can therefore be directed to invest in livelihoods components that are more preferable.

In the third paper, I argue that heuristic theory can be used to explain some of the observed or stated human behaviour and stated preferences in communities implementing wildlife based programmes. Heuristics are feelings generated by encounters, painful or pleasurable, which triggers some behaviour traits in the future. The paper aims to determine whether subjects' past encounters with wild animals influence negative affect/feelings; and whether the negative affect leads subjects (1) to engage in self-reported behaviours such as poaching and killing of wild animals and (2) stated preferences towards community based wildlife programmes. I developed two models: a $encounter \rightarrow affect \rightarrow behaviour$ *model and a* $encounter \rightarrow affect \rightarrow preference$ *model. The premise is that subjects in wildlife areas experience negative encounters with wild animals that are likely to trigger emotions or negative affects. The affect likely influence stated or observed behaviour, and stated or revealed preferences for wildlife-based programmes. The argument is that affect, anchoring and availability heuristics interact to influence people's preferences of wildlife programmes and their behaviour towards wild animal resources in their area. Using both qualitative and survey methodologies subjects were asked to describe their feelings towards wild animals, how they relate especially with*

dangerous wild animals such as elephants, lions, buffaloes and their past encounters with the respective wild animals.

Logistic regression results point to encounters with wild animals being statistically significant predictors of negative affect; which in turn is a key determinant of resource degrading behaviours such as (self-reported) poaching and killing wild animals in revenge or as a deterrent from destroying fields, livestock, killing or injuring people. On the other hand, perceptions of benefit and employment in the wildlife industry influence stated preference for wildlife-based programmes: and not negative affect. The conclusion is that a considerable fraction of decisions by subjects in Community Wildlife-Based programmes can be attributed to heuristics; negative wildlife encounters and associated feelings. However, stated preferences for wildlife-based programmes are not influenced by negative affect, but by expected utility, in this case access to public goods and services. Heuristics can therefore compliment the understanding of some decision patterns and behaviour that are seemingly inconsistent with economic theories of logic and probability. I therefore propose that working towards generating positive markers or anchors about wildlife among subjects can increase tolerance of wildlife. This can be achieved for example by instituting wildlife management systems that cater for problem animal control to reduce negative encounters, reducing evocation of affect and the associated resource degrading behaviours. Furthermore, improving benefits or perceptions of benefits can increase preference or willingness to accept wildlife-based programmes by producer communal people.

There are many studies on the impact of community based natural resources management, including community based wildlife management programmes. However, these tend to be limited to issues of household income and food poverty, governance and natural resource sustainability. Results of most of the studies show that the impact is largely negative. Nevertheless, there is little acknowledgement or reference to the investment trajectory in communities implementing the programme, and the associated implications. Furthermore, there is little reference to how the programme impacts household adaptive capacities, which has become an important tool to sustain livelihoods under changing environmental and economic conditions.

A number of policy implications can be drawn from results of this study. At the onset community, based wildlife programmes are demonstrably important in the livelihoods of the respective communities. However, programme impact can be enhanced for specific livelihoods

or well-being components if there is a deliberate effort to direct the investment in the direction of the intended components. For example, an improvement in education production is a result of deliberate investment towards education infrastructure and support system. A similar result was obtained with reference to adaptive capacity. The programme demonstrably improved household physical capacity, which illustrates results of deliberately investing in public capital or infrastructure. For example, the district council's policy is that at least 70 per cent of the conservation income goes to infrastructure or public capital development. In view of this, the policy has yielded positive results in relation to the policy objective. Other welfare dimensions have low ratings because investments by the programme towards the dimensions are negligible. Approximately 30 per cent of wildlife income remains to be invested, inconsistently towards all the other critical livelihoods dimensions and adaptive capacities such as social support, human wildlife conflict mitigation, wildlife protection and other income generation investments. Therefore, policy decisions about how income from wildlife business is utilised have implications on specific livelihoods or welfare components. This demonstrates that policy makers can make deliberate decisions to influence specific livelihoods and welfare components through structuring wildlife programmes investment portfolios accordingly.

Acknowledgements

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I am also grateful for the comments that I received from a number of conferences, especially Environment for Development (EfD) organized conferences where different papers of the thesis were presented. These include the '11th EfD Annual Meeting held on October, 27-30 2017 in Addis Ababa, Ethiopia'; '12th EfD Annual Meeting held on November 1-5 2018 in Hanoi Westlake, Vietnam'; Community Voices: Local Perspectives on International Responses to Illegal Wildlife Trade held on October 10th 2018 at the Zoological Society of London, United Kingdom', and the PhD Brown Bag Seminars at the University of Cape Town.

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Dedication

I dedicate this thesis to my wife Bella Nyamukure, my late mother and mother in law who both passed on during the study period, and my children Tanatswa, Tavongaishe and Taonanyashadzashe.

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Abbreviations

ACI	Adaptive Capacity Index
ATE	Average Treatment Effect
ATET	Average Treatment Effect on the Treated
ATETND matching	Average Treatment Effect on the Treated using nearest neighbour
AWF	African Wildlife Foundation
CAMFED	Campaign for Female Education
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CAs	Communal Areas
CBNRM	Community Based Natural Resources Management
CBWM	Community Based Wildlife Management
EfD	Environment for Development
ENSO	El Nino Southern Oscillation
FGLS	Feasible Generalised Least Squares
GEF	Global Environmental Facility
IPCC	Intergovernmental Panel on Climate Change
MDGs	Millennium Development Goals
NGOs	Non-Governmental Organisations
POMs	Potential Outcome Means
PPP	Public-Private partnerships
RA	Regression Adjustment
RD	Regression Discontinuity
SDGs	Sustainable Development Goals
SIG	School Improvement Grant
UN	United Nations
UNEP	United Nations Environment Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Education Fund
USAID	United States AID
USD	United States Dollar
WWF	World Wide Fund
ZIMVAC	Zimbabwe Vulnerability Assessment Committee

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1. Chapter 1: An overview

1.1 Introduction

In Southern Africa, a significant proportion of rural communities live around wildlife-protected areas, which are vulnerable to adverse climate variability, and more recently climate change. In addition, the communities experience livestock predation and crop raids by wild animals (Loveridgea *et al.* 2020, Chigonda 2018, Gandiwa *et al.* 2013a), over and about the countrywide economic challenges (Macheka *et al.* 2020, Mudzerengi *et al.* 2020, Makina 2010). In recognition, and as early as the 1980s 'communal' based wildlife management programmes or policies have been proposed and implemented in different forms in Zimbabwe, southern Africa and beyond to allow for local participation in and benefit from wildlife management (Tchakatumba *et al*. 2019, Taylor 2009, Chhatre and Agrawal 2008, Hutton *et al.* 2005,). During the initial stages of the communal based wildlife programmes development partners trained and reorganized local communities to manage wildlife and income generated thereof. In Zimbabwe, National Parks and development partners such as Centre for Applied Social Sciences department at the University of Zimbabwe, ZIMTRUST and World Wide Fund for nature (WWF) trained and advised resident communities on how to implement the programme (Tchakatumba *et al*. 2019, Jones and Murphree 2004, Child B. 1996). They also showed how the programme would improve livelihoods and their capacity to deal with recurrent droughts through generating income from wildlife (Murphree 2009, Murombedzi 1999). This enticed a wider range of communities to accept and implement the programmes across Zimbabwe and in other countries (Hutton *et al.* 2005).

After decades of the programme implementation questions have been raised about the programme impact on poverty and the natural resources (Jones and Murphree 2004, Murphree 2009, Taylor 2009, Hutton *et al.* 2005, Emerton 2001). Evidence show that poverty had remained relatively high, together with poaching and human wildlife conflict incidences (Gandiwa *et al.* 2013a & 2013b, Gandiwa 2011), which led Murphree (2009) to retract his earlier claim, and assert that the programme is not a 'panacea for poverty reduction'. However, in the majority of impact assessments focus is largely on household income, aggregate poverty and governance issues (Shereni and Saarinen 2020, Jones 2007, 2004 & Jones B. 2006), of which the results demonstrate little positive impact of the programme. While this is credible,

there seem to be no conscious effort in tracking the investment direction within communities to inform results of the assessments.

A series of the communal wildlife programme reviews in southern Africa show that the respective communities invest a larger proportion of their income on public goods, specifically public infrastructure development (Tchakatumba *et al*. 2019, Jones 2007, 2004). Inspite of this realisation, there has been few assessments directed towards public investment impact. Furthermore, there has been no focused assessment on livelihoods and capacity dimensions that are directly related to public investment such as education and health. More so none has been devoted to understand the nexus between the investment and resilience; specifically the transformative capacity dimension of households (Cai *et al*. 2018, Warrick *et al*. 2017). In addition, despite the benefits, households in wildlife programmes areas continue to experience human-wildlife conflicts, and in anecdotal reports, people have expressed disgruntlement about the programme (Shereni 2020, Rihoy 2009). In some cases, local communities express outright anger about the programme, while other people have reacted through revenge killing which degrades wildlife resource (Matema S. 2015, Rihoy *et al.* 2009). Rihoy *et al.* 2009 summed up that 'people are not happy' about CAMPFIRE. Yet at times, the same people speak highly of the programme (Tchakatumba *et al*. 2019), creating a complex scenario regarding programme preference; whether people still prefer the programme given their experience of it. This is a critical question as the sustainability of conservation programmes also depends on popular support (Shereni 2020, Bessette 2020), Dietz *et al*. 2003, Campbell and Shackleton 2001, Child and Graham 1996, Chambers 1983).

The study therefore attempts to do three things; firstly, to gather evidence on the relevance of the programme in relation to household education production. Secondly, gather evidence of the programme impact on household adaptive capacity dimensions. Lastly gather evidence to understand the nexus between human wildlife conflict and benefits (utility) with programme preference. It looks at how human wildlife conflict generates feelings ('*affect*'), and how this translate into behaviours such as poaching and revenge killing (self-reported). The thesis is that community based wildlife management programmes have made important public or infrastructural investments (Tchakatumba et al. 2019, Jones 2010, 2004, Hutton *et al.* 2005). This has the potential to improve specific welfare dimensions and specific household adaptive capacity components that are closely related to the programmes' investment trajectory, as opposed to aggregate household welfare or aggregate household adaptive capacity. Improvement in household education has been demonstrated to have the ability to pull

households out of poverty (Manjengwa *et al.* 2012) and adaptive capacity is viewed as critical in overcoming the challenges of climate variability and change as well as other shocks such as political and economic (Mayer 2019, Cinner 2018, Cai et al. 2018, Sen 2000). In addition, I conceptualise that there are specific programme features that become anchors or pillars for evaluation by lay people (Costa *et al.* 2017, Plott *et al.* 1987)). The proposition is that human wildlife conflict for example triggers negative feelings or *affect* that compete with expected utility (Schulan, A. (2019)) such as improved access to public goods, to influence people's stated preference of wildlife-based programmes and self-reported resource degrading behaviour such as revenge killing and poaching. The study draws its lessons from one of the community based wildlife management programme, Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), implemented over the past three decades in Mbire district, Zimbabwe.

On the first issue, the study seeks to determine the programme treatment effect on poverty for households living in wildlife programme areas, with specific reference to education production. Poverty is usually measured using the Foster-Greer-Thorbecke (FGT) poverty measure (Villar 2017, Goerlich 2014, Foster *et al.* 1984). The approach is a generalised measure of poverty normally focusing on the value of consumed goods and services. However, poverty is multi-dimensional: encompassing education, health, nutrition, freedom, communication and energy among others, which are at times brought to a single metric measurement. The composite index hide a number of important aspects or linkages (Bessell 2020). However, the multi-dimensional approach to poverty allows for interrogation of the different dimensions' statuses and development of targeted strategies to address the respective dimensions (Bessell 2020, Weber 2011). This study uses education dimension to demonstrate that the CAMPFIRE programme is a relevant development instrument with respect to the investment direction on the ground. This is against a backdrop that the 'community' based wildlife programmes have invested substantial proportions of their public generated income into public infrastructure (Jones 2007, 2004), would have positive impact on education production. I introduced core infrastructure in the education production function based on the view that services it produces raises the education productivity of households. The study pursues education access and consumption effect of infrastructure provision and support services made by the CAMPFIRE programme.

Education is one key poverty dimensions that has long-term potential of moving people out of poverty (Boissiere 2004, Taubman 1975). Education has generally been promoted under community based wildlife management systems through infrastructure provision and related

support. Access to education takes the form of being located within acceptable distance from school infrastructure, affordable purchase price or user fees and associated costs to enable children to attend school (Coates 2003). Under the CAMPFIRE arrangement, user fees are either subsidised or fully met by the programme. In addition, the arrangement also subsidises or fully fund school related capital investments (Jones 2007).

Across the world, a significant proportion of children have been noted to experience different levels of education deprivation, locking families into a vicious circle of poverty (Shukla & Mishra 2020, Chevalier 2013, and Coates 2003). Research has shown that less educated parents for example are less likely to send their children to school, depriving the children of earning high incomes in the future (Shukla & Mishra 2020, Zhu 2020). The first paper thus attempts to measure the improvement in education production for children under the CAMPFIRE programme.

On the second issue, the study investigates the impact of community wildlife programmes on adaptive capacity dimensions, again based on public (infrastructure) investments made by the programme over the past three decades. With increased evidence of climate change in the past two decades, mitigation and later adaptation have been prescribed as the main panacea to deal with negative impacts of climate variability and change (Moreira *et al*. 2019, Warrick *et al*. 2017, Fussel and Klein, 2006). Following the third assessment report by the Intergovernmental Panel on Climate Change (IPCC), adaptation has become the more favoured approach in dealing with climate variability and change to improve and sustain livelihoods. Adaptation has become an 'urgent policy priority' mainly because most adaptation activities take effect almost immediately, while the effects of mitigation may take several decades to manifest (FAO 2019, Mayer 2019, and Parry *et al.* 2007). Adaptation measures are applicable at different scales and their effectiveness is less dependent on actions of others (Smith 1996).

Mitigation and adaptation strategies both require substantial public investments in the form of infrastructure to build community and household adaptive capacity (Jones et al. 2019, Parry *et al.* 2007). Meanwhile mainstream development sector has rekindled public investment approach owing to the evident failure of private led economic growth and welfare improvement in developing countries during the Millennium Development Goals (MDG) era (Baram 2019, Garcia-Milà 2018). However, marginal areas implementing community based wildlife management have consistently invested in public infrastructure (Jones 2007). The investment is more likely to have been building household adaptive capacity and improving specific

welfare dimensions that rely on publicly provided infrastructure. Public infrastructure is a development trigger as it lowers firms' and households' production cost and therefore increase profit and welfare respectively. Public investment improves welfare, for example through better employment opportunities and access to public services (Sustainable Development Goals 2019, Anderson *et al*. 2006). There is convergence or agreement on the importance of public investment for both economic growth and welfare improvements.

Conversely, assessments on community based wildlife resources management done to date yield a mixture of results relating to programme welfare impacts. The results pose the danger of portraying the programmes as being little worth the effort, yet the evaluations centre on aggregate welfare without taking into account that communities invest a larger proportion of the income in public infrastructure. What is common is that all assessments acknowledge that wildlife programmes have made investments in public infrastructure such as bridges, roads, schools and health facilities among others (Tchakatumba et al. 2019, Jones 2004), but not much has been done on the relative impact of the investments on relevant dimensions. It is therefore worthwhile assessing the impact of the programmes' public investment on specific or relevant welfare dimensions such as education and transformative adaptive capacity dimension that with direct link to public investment.

In the same line of thinking some results from the mainstream development sector show that the contribution of public investment to growth and poverty reduction has not always been as positive or as significant as expected. Despite the development of increasingly sophisticated methods for assessing the desirability of public expenditure during the 1960s and 1970s, large increases in public investment in many developing countries between 1974 and 1982 often yielded few returns. Reasons for this are however varied, including some unconnected with public investments such as decline in the terms of trade especially for developing country exports. Nevertheless, there is a possibility that at least one of the reasons was that the methods available to assess the desirability of public investment alternatives were flawed, badly implemented, or ignored (Sustainable Development Goals 2019, Anderson *et al*. 2006).

Nonetheless, public investment has once again become important because of the slow rates of progress that was experienced toward the targets contained in the then Millennium Development Goals, particularly in sub-Saharan African countries (Anderson 2006). There has been renewed attention in promoting public investment since 2005, which has also been taken up by the current Sustainable Development Goals (SDGs). The UN Millennium Project reports

(Millennium Development Goals Report 2015, Anderson 2006) has re-emphasised the need for a 'big push' strategy in public investment to help poor countries break out of their poverty trap. The report further argues that, to enable all countries to achieve the then MDGs, there should be identification of priority public investments to empower poor people, and these should be built into the then MDG-based strategies that anchor the scaling-up of public investments, capacity-building, resource mobilisation, among others (Millennium Development Goals Report 2015, Anderson *et al.* 2006). Hence there is value in public investment, improving some welfare dimensions and building local capacities to deal with environmental, political and economic shocks and stresses; and likely to be true for community based wildlife management programmes.

The last issue under investigation is how to explain people's behaviour and stated preferences with regards community based wildlife programmes. The premise is that if communal people have accepted the programme and are benefiting from it, then they would tolerate wildlife behaviour such as livestock predation, crop raids and wild animals attacking people. Furthermore, the decentralisation policy confers wildlife resources to the user community. This would mean that they would not engage in behaviours that are contrary to conservation principles such as poaching and revenge killing as the wild animals would be their valued asset. However, this seems not to be the case in community based wildlife programmes and apparently, more complex than the linear relationship utility theory assumes. I therefore borrow the heuristic explanatory tools from psychology to understand this complexity. Heuristic are feelings generated as a result of encounters, and remains lingering and readily available in people's mind and has the ability to trigger consistent behaviour traits (Pachur *et al*. 2012).

Heuristics are painful or pleasurable memories generated by experiences or events (Pachur *et al*. 2012). When such memories are triggered reaction or decisions are quickly made based on experience. If painful, the decision would be risk averse. Thus in such cases, decisions made are inconsistent with expected utility or more specifically preference theory, and is even deeper than the mere lack on transitivity (Pachur *et al*. 2012). Preference theory argues that if indeed preferences exist and if the principle of optimization is applicable, then an individual should place a higher reservation price on the object he prefers (Fischbacher and Gatcher 2010). The behaviour as observed in a number of cases and experiments; however appear to be inconsistent with this preference theoretical proposition. The results suggest that no optimisation principles of any sort lie behind even the simplest of human choices (Pachur *et al*. 2012). The question is

whether this is the case with members in communities implementing communal wildlife programmes; that their individual experiences with some basic dimensions of the programme determine their preferences and probably their behaviour such as poaching and revenge killing. People are thus likely to evaluate the programme based on a few basic features of the programmes that are easily recalled, rather than the metric calculations of costs and benefits. Negative encounters and associated feelings or heuristic are therefore likely to influence the resultant resource degrading behaviours such as poaching and revenge killing.

1.2 Research gaps

From a welfare perspective, the benefits of infrastructure accrue through higher incomes, infrastructure utilisation and greater opportunities, but there is uncertainty over the localized effects of specific types of infrastructure on the several aspects of social components. Better estimates are also needed of the impacts on specific welfare dimensions such as education and health, at a fine level of disaggregation such as household and individual level. Multiple indicators of social development should be employed to broaden the applicability of results.

Several methodological issues also need to be looked at closely, because what really matters for development are infrastructure services, rather than infrastructure stocks. Measuring infrastructure services, however, is difficult in the absence of information from market behavior, and few authors have attempted to measure the aggregate value of such services. Because public expenditures do not necessarily raise the capital stock but may improve its quality, aggregate studies that rely on gross measures of the capital stock may have underestimated some positive effects such improvements have on social components.

In the context of local provisioning of public infrastructure within community based wildlife management areas there is oversight of the contribution of infrastructure to welfare as the expectations have been too high. Methodological issues emerge once again where such benefits are not assessed relative to similar areas and similar localized units such as households to measure the differential effect relative to if the programme was not in place. A treatment effect approach would likely yield value in understanding the critical role that public investments have made to date.

From a sectoral perspective, the benefits of providing infrastructure stem from its role as a productive input, but there is still uncertainty over the precise magnitude of impacts that local

public investments bring at the local level. Given the range in the literature, better estimates are needed of both productivity and complementarity at a fine level of disaggregation. In the majority of empirical studies to date, impacts have been at the national level, smaller at the regional level, and lowest at the local level. This suggests that externalities generated by the size and complexity of networks are important determinants of positive impacts.

Furthermore, human behaviour is an important feature in sustainable natural resources management. An understanding of what motivates the ultimate behaviours that are seemingly contrary to conservation is key in coming up with practical solutions to reduce human induced natural resource degradation.

1.3 Objectives of the study

The general objective is to show the impact of public investments funded by community based wildlife management enterprises.

The specific objectives are to:

i. Investigate the impact of public investments by Community Based Wildlife Management programmes on household welfare; with particular reference to education production
ii. Examine the impact of public investments by Community Based Wildlife Management programmes on household adaptive capacity to environmental risks.
iii. Explore and examine the divergence in behaviour and stated preferences for the Communal Areas Management Programmes for Indigenous Resources (CAMPFIRE) by beneficiary community members.

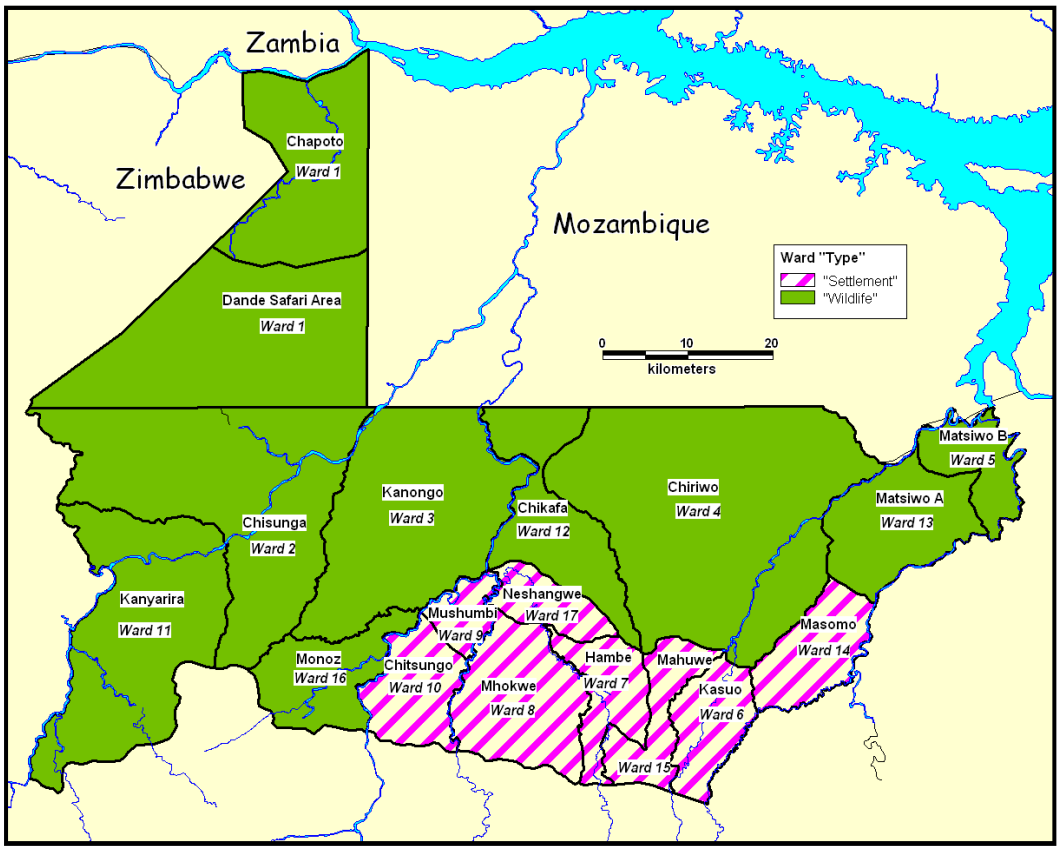
1.4 Research Questions

i. What is the impact of Community Based Wildlife Management public investments on education production?
ii. What is the impact of Community Based Wildlife Management public investments on household adaptive capacity components?
iii. What are the determinants of beneficiary communities' behaviour, perceptions of and stated preference for the Communal Areas Management Programmes for Indigenous Resources (CAMPFIRE)?

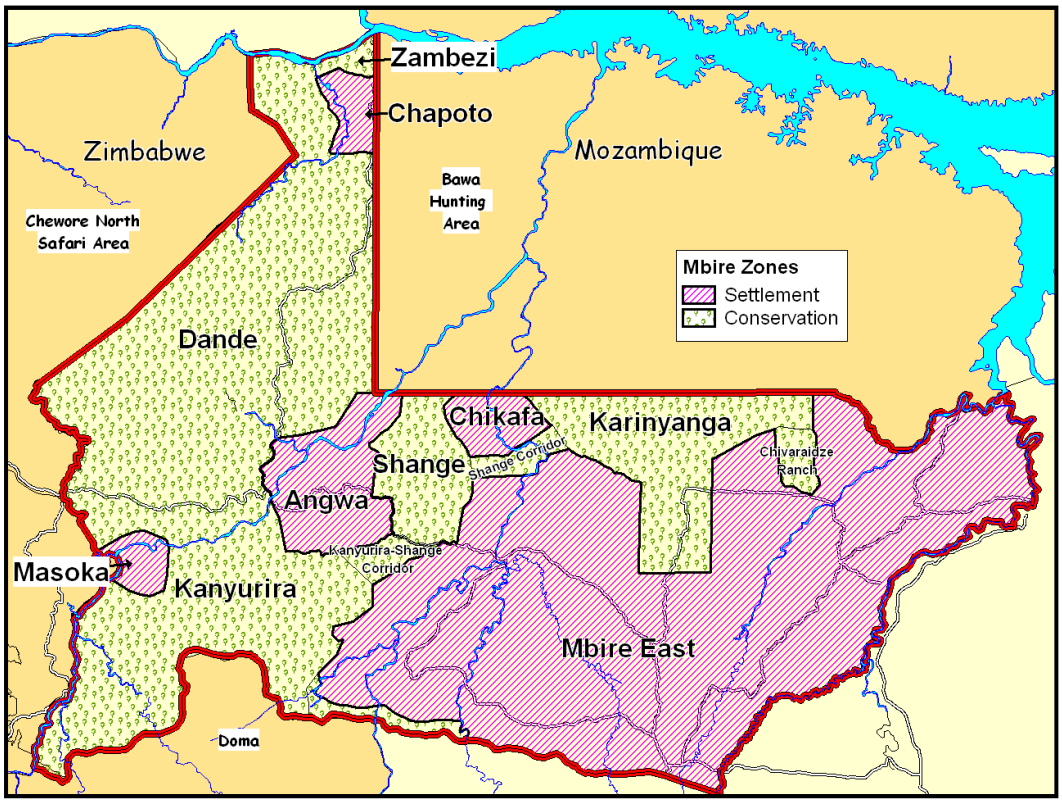
1.5 Description of the study area and sampling

The study was conducted in Mbire district, northern Zimbabwe. The district occupies the eastern part of the Mid-Zambezi valley between longitudes 30º and 31º east, and latitude 15º and 16º south. The district is to the east of Mana Pools-Chewore-Sapi wildlife management area adjacent the Zambezi River. Mana Pools-Chewore-Sapi wildlife area has been declared a world heritage site due to its rich biodiversity (Smith 2014). Mbire district also share its northern borders with Zambia and Mozambique, which are important sources of roaming large herbivore. Mbire district forms an important wildlife corridor between Manapools-Chewore-Sapi National Parks estate and Zambia's Conservation Lower Zambezi National Park and Mozambique's Tchuma Tchetu wildlife area (Map 1 and 2) (Smith 2014).

Mbire rural district is in Mashonaland Central province. The district was formerly part of Guruve district, then known as Lower Guruve, Dande communal area or Mbire. Mbire was commissioned as an independent district in 2006 with its district offices located at Mushumbi Pools. It has 17 administrative wards (Map 1).



Map 1: Mbire Rural District Council wildlife areas (Source: Mbire Rural District Council, 2011)



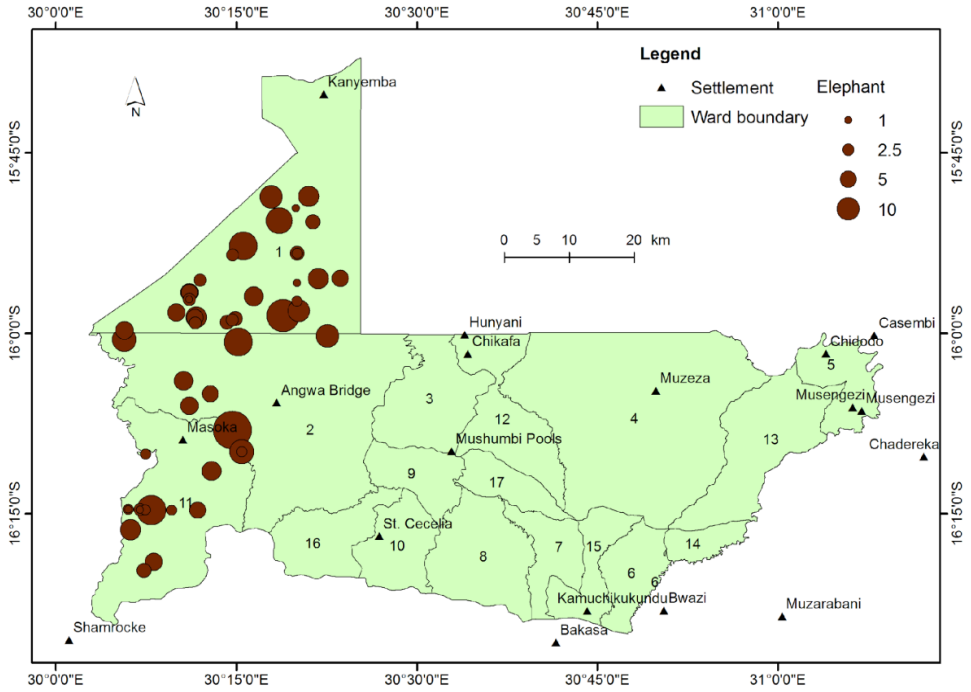
Map 2: Mbire Rural District Council wildlife areas (source: Mbire Rural District Council Natural Resources Management Plan, 2011)

I selected the district for this study because of its long history in implementing CAMPFIRE programme, a Community Based Natural Resources Management, (CBNRM) programme, since 1989. In addition, it has also been a world-renowned case study for community based natural resources management (Murphree 2009). A few of the implementing wards in the district, wards 1, 2 and 11, respectively Kanyemba, Angwa and Masoka, are responsible for the successful CBNRM image that the district enjoys, with Masoka originally outperforming the other two. Recently income data from wards shows that Ward 2 generating the most from trophy hunting. Programme performance and evaluations are usually reported for these wards independent of all others.

The district consists of several ethnic groups: Doma, Korekore, Chikunda, Zezuru and Karanga among others. Karanga and Zezuru ethnicities were originally from the Highveld of Zimbabwe, first forcibly moved during the colonial period (Dzingirai *et al.* 2015). After independence in 1980, there were programmes to eradicate tsetse flies in the Zambezi valley (Dzingirai *et al.* 2015). This attracted more people leading to another wave of migration into Mbire district as there were increased prospects of cotton cultivation and cattle rearing (Matema 2015, Nyamwanza 2013. The prospects of farming might be responsible for the selection of

settlements away from areas with dense wildlife by the migrants. The Doma and the Korekore moved further into wildlife areas as more and more migrants moved in. The last wave of migration was triggered by the 2000 land redistribution. This saw the in-migration mainly of the Doma and Korekore people who had settled in commercial farms in Mhangura area as farm labourers (Matema 2015, Nyamwanza 2013).

Four wards out of the seventeen wards: 11, 2, 7 and 17, were purposively selected for the study. Ward 11, Masoka and ward 2, Angwa are known for having higher wildlife populations, elephants and buffalos (Taylor 2009 and Murphey 2009). Map 3 shows the distribution of elephant population in 2014. As such there are more hunting activities accounting for higher wildlife returns compared to other wards in the district, and were therefore selected as the treatment group, $\mathrm{EP_{ij}(1)}$. On the other hand, wards 7 and 17 are not implementing the programme, and thus selected as the comparison or counterfactual group,$EP_{ij}(0)$.

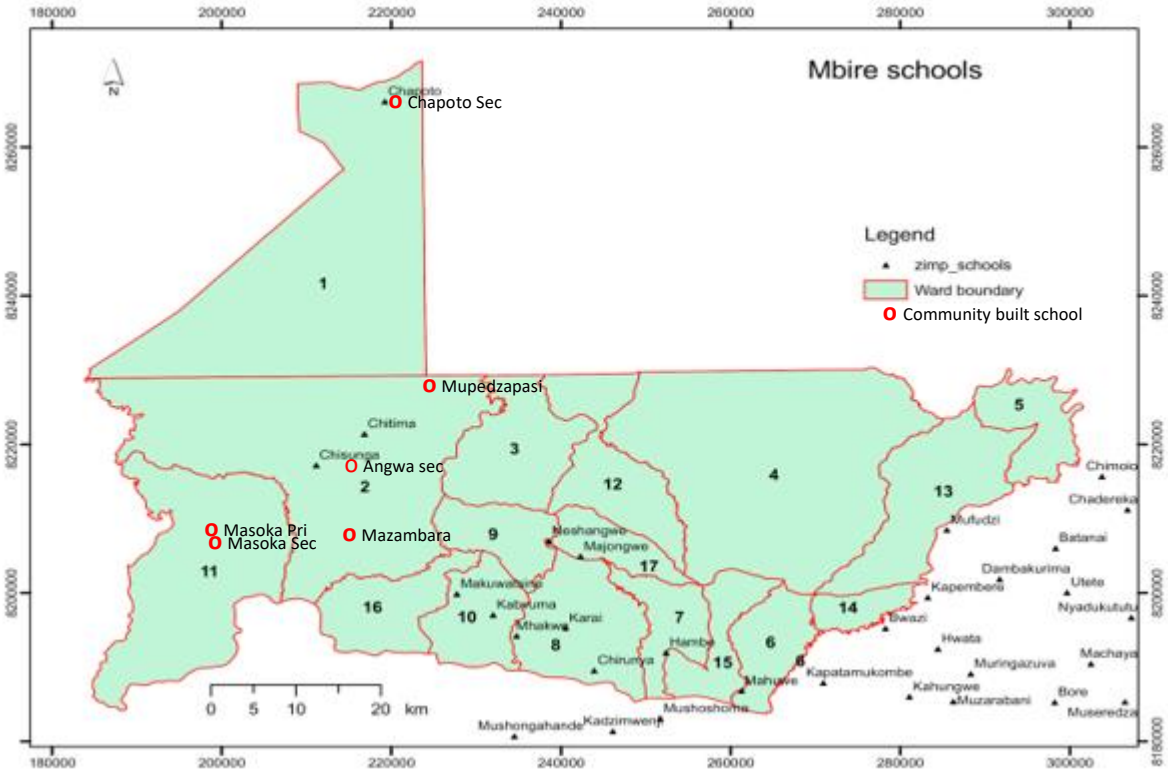


Map 3: Elephant distribution in Mbire district (Source: Mbire Rural District Council, 2011)

Wards 11 and 2 are both approximately 50km away from the administrative centre, Mushumbi Pools. Ward 11, Masoka is less accessible compared to Ward 2, Angwa because of the many streams between it and the district administrative centre. In the rainy season, flooding rivers destroy bridges making transport communication difficult. Wards 7 and 17 are located relatively close to the district centre. Ward 7 is equally difficult to access because of the bad road network. The two wards do not have high value wildlife that spends time in the wards to

guarantee any hunting attempts. Council data shows that ward 7 and 17 experience occasional one day invasions by elephants on their way to or from Mozambique or to or from Mana Pools National Park. Wild cats mainly lions also occasionally attack livestock in all the four selected wards. Across all the wards hyenas and baboons are permanent problem animals.

When Masoka community was founded in the late 1960s, there were no roads, no education and health facilities. By 1988 when the CAMPFIRE programme started Masoka still had no education or health facility and had about 45 households (Pers. Comm, Headman Kanyurira, 2016). The nearest school and clinic was Chisunga Primary School in Ward 2, approximately 40km away and schoolchildren had to be weekly boarders if they were to enrol into the school system. A few children attended school because most parents could not afford school fees and related costs. By 1980, Angwa ward had two schools, namely Chisunga and Chitima primary schools constructed by the government, and no secondary school (Map 4). Angwa ward covers a large area, making the two schools too far for the majority of its constituency.



Map 4: Distribution of education facilities in Mbire (Source: Mbire Rural District Council, 2011))

CAMPFIRE programme was first implemented in Mbire district (Taylor 2009, Murombedzi, 1997, Cutshall 1989). Masoka and Angwa were among the first beneficiaries, and each of the wards drew up landuse plans and put aside land for wildlife habitat where no settlements or

any other land uses were allowed. The land is leased originally on a five-year term, and now on a ten-year term through the Rural District Council to private safari operators (Muyengwa 2017, Taylor & Murphree 2007, Child 1996). The operators remit on average 50 per cent of the value of trophies hunted, previously to the Rural District Council and now directly to the respective beneficiary or producer communities. The district Natural Resource Officer reported that currently the communities also get a proportion of the daily rates charged to hunting clients.

An elected ward CAMPFIRE/wildlife committee, now Environmental Sub-Committee, with a two-year term manages the income realised on behalf of the community. Financial records and Key Informant interviews with committee members show that in the first decade, Masoka was realising in excess of USD100, 000 per hunting season and Angwa was getting slightly less than USD100, 000. The incomes declined to between USD70, 000 - 80, 000 for Masoka and USD40, 000 – 50, 000 for Angwa by 2015 due to a plethora of reasons ranging from reported decrease in trophy size, to international ban on elephant hunts. More recently, the income for Masoka has gone down to record low of USD40, 000 per hunting season with Angwa now getting slightly higher income.

Ward 7 (Hambe) and Ward 17 (Majongwe) are small with two schools between them, reported by the respective school heads to have been built by the government. The schools are also sparse and children had to walk long distances to school. Wards 7 and 17 had never been part of CAMPFIRE implementing wards. In terms of infrastructure Masoka was worse off followed by Angwa; a scenario reported by the interviewees to have changed with the implementation of the CAMPFIRE programme.

To understand the current scenario in relation to access to education, adaptive capacity and opinions about wildlife a sample of households was drawn. The minimum sample size for the survey was calculated based on the population size of the four wards using the normal approximation to the hypergeometric distribution, and for each sample ward using probability proportional to size:

$$n = \frac{N_{Z^2pq}}{E^2(N-1) + Z^2pq} \qquad (1.1)$$

$$n_{1,\dots k} = \left(\frac{N_{Z^2pq}}{E^2(N-1) + Z^2pq}\right) \frac{N_{1,\dots k}}{N} \qquad (1.2)$$

Where

n is the required sample size

$n_{1...4}$ are the required sub-sample sizes

N is the population size =2, 928 households

$N_{1...4}$ is the population size for each respective sample ward or administrative unit

p and q are the population proportions. (0.5 if not known).

z is the value that specifies the level of confidence you want in your confidence interval when you analyse your data. Typical levels of confidence for surveys are 95per cent, in which case z is set to 1.96 and used for this survey.

E sets the accuracy of sample proportions (0.05 to allow an error margin of 5per cent).

The calculated minimum sample size is 340 households, distributed as in Table 1-1. The last column shows the number of children aged 5 to 16 years in the sample households, which are the units of analysis for the first paper.

Table 1-1: Sample distribution

Ward		Total households	Calculated minimum sample size	Adjusted sample size	Number of children 5 – 16 years
All		2, 928	340	401	613
Treatment	Masoka	333	37	72	117
	Angwa	1, 197	139	122	201
Control	Majongwe	829	97	109	151
	Hambe	569	67	98	144

Source: *Survey data December 2015*

1.6 Organisation of the thesis

The first chapter gives an overview of the broader objectives of the thesis and the broader context around the objective functions. Chapter 2 presents the first paper, followed by the second paper in chapter 3, the third paper in chapter 4 and chapter 5 presents the conclusion and recommendations of the thesis. Chapter 2 and 3 presents results estimating the impact of CAMPFIRE programme on education production and household adaptive capacity using the Cobb-Douglass or education production function, average treatment effect on the treated (ATET), potential outcome means (POMs), regression adjustment and regression discontinuity. Chapter 4 attempts to explain the relationship between human wildlife conflict encounters and programme preference. I develop a model to explore the relationship focusing on past human wildlife conflicts as explanatory variables for people's behaviours and preferences. The model borrows the theory of heuristic from psychology, which argues that bad encounters shape people's reactions in relation to images representing or evoking the past bad encounters (Schulan 2019). The final chapter presents the conclusion, and associated policy implications of the study.

2 Chapter 2: The Impact of Communal Area Management Programme for Indigenous Resources on education production in Mbire, Zimbabwe

By

Collen Matema[1], Edwin Muchapondwa[2], Jeanette Manjengwa[3]

2.1 Abstract

The paper investigates the effects of the public investment by Communal Area Management Programme for Indigenous Resources (CAMPFIRE)'s on education production. The objectives are to estimate the average treatment effect of the CAMPFIRE programme on children's participation in formal education and identify the socioeconomic inputs that influence education production system. The study uses the post-test only control group design and Average Treatment Effect on the Treated (ATET) in estimating the impact of CAMPFIRE programme induced changes on participation in formal education of school going-age children. I used propensity score estimation to correct for confounding factors, and allow comparison of units with similar background characteristics. Results show that education production improves by 12 per cent when children are under the CAMPFIRE programme than when they are not. However, results from education production function show that socio-economic inputs or characteristics are significant factors in explaining variation in education production in CAMPFIRE programme implementing areas than in non-programme implementing areas. This indicates that the programme design not remove the influence of household characteristics in education. Differential access to education is still evident. Therefore, while public investments by the programme improves education production, it needs to be re-configured to address skewedness between the less and better resourced households.

Key words: ***Education production, Communal wildlife management, Average Treatment Effect on the Treated, public investment***

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2.2 Introduction

This paper investigates the effects of Communal Area Management Programme for Indigenous Resources (CAMPFIRE) on education production in Mbire district, Zimbabwe. CAMPFIRE is a Community Based Wildlife Management programme initiated to spearhead rural development including education production. I estimate education production using children's education participation rate. The objectives of the paper are to (1) estimate the average treatment effect on the treated (ATET) of CAMPFIRE programme on children's participation in formal education, (2) identify socioeconomic inputs that influence education production and (3) estimate effects of socioeconomic inputs on education production in CAMPFIRE programme areas. Public Investment Theory guides the study, which argues that public investment influences both public and private production (Rajaram *et al*. 2014). I use post-test only group design and propensity model procedure to estimate average treatment effect on the treated, ATET; and education production function to identify key socioeconomic inputs and estimate their interaction with CAMPFIRE programme in the production of education output (Lechner 2015, Nabil *et al.* 2011, Heckman and Vytlacil 2001). The hypothesis is that CAMPFIRE programme improves education production reducing the influence of socioeconomic inputs.

One of CAMPFIRE programme's socioeconomic objectives is to alleviate poverty through non-consumptive natural resource use for communities living adjacent wildlife areas (Tchakatumba et al. 2019, Chigonda 2018, Taylor 2009, Murphree 2009). The beneficiary communities realise income from 'leasing' out land to private safari-hunting operators (Taylor 2009; Hutton, *et al*. 2005). Rural District Councils hold land in trust of communities and have the Appropriate Authority Status to make contractual arrangements with the Safari operators and leasing the land on behalf of the communities, with representation from local level councilors. The communities use the realised income benefits to address poverty issues they encounter. Poverty issues include food, education, health and communication among others (Villar 2017, Goerlich 2014, Weber 2011, Gordon 2006). Across most of Southern Africa Community Based Wildlife Management communities invest a larger proportion of the income in public infrastructure such as schools, clinics, roads and bridges; and offer social services through subsidies, for example in education and health (Tchakatumba *et al*. 2019, de Vette *et al*. 2012). However, there is dearth of evidence and interest on the effects of such programmes

on education production. Education is an important dimension for poverty alleviation, with long term potential of moving people out of poverty, for example through improved potential for higher incomes (Potancokova and Goujon 2014, Gordon 2006, Taubman and Wales 1975). In Zimbabwe, reports show food insecurity and low school attendance rates in economically marginal districts (Jones L. *et al.* 2010a), yet most CAMPFIRE programmes are implemented in such areas. This has raised questions among beneficiary communities, academia and public media on relevance of CAMPFIRE programme to households' welfare such as education production and food security, among others (Dzingirai et al. 2015, Dzingirai 1996). The paper thus presents evidence for policy decision on relevance of the programme for participating households concerning access to education for children, using the case of four sub-district administrative units in Mbire district of Zimbabwe.

The key questions being addressed in this paper are; (1) Do public investments made by CAMPFIRE programmes have effects on education production outputs? (2) Which socioeconomic inputs influence education production in CAMPFIRE programme areas? And (3) To what extent do socioeconomic characteristics affect education production in CAMPFIRE programme implementing areas?

The paper is organised as follows:

The following section discusses the theory of public investment followed by a discussion on the nexus between community based natural resources management principles and the welfare of communal households. The following section specifies the model outlining key variables used in the analysis and discusses the hypotheses to be tested. Next section outlines descriptive statistics before detailed discussion of the results of the impact of CAMPFIRE on education production. The last section discusses results and policy implications thereof.

2.3 Public investment theory

Public investment is financing or capitalisation in goods and services that are publicly consumed, characterised by difficulty in exclusion. It can also be viewed as public expenditure that adds to the public physical capital stock or capital expenditure in national accounts data (Oukhallou 2016, Abdul *et al*., 2015, Bivens 2012, Anderson *et al*., 2006). Much public investment takes the form of infrastructural outlays: roads, schools, health facilities, equipment etc. However, some of the outlays are of a more current form, but contributing to capital formation. For example, government spending on technology, education and health contributes

not only to an individual's human capital but also to that of society, with benefits that can extend for a lifetime (Garcia-Milà & McGuire 2018, Psacharopoulos 2006, Boissiere 2004, McAuley 2001, Taubman and Wales 1975). Under such cases, the capital good is less tangible.

Public investment theory started centuries ago. For example, Adam Smith outlined the essence of public goods theory more than two centuries ago. Paul Samuleson, developed Smith's work in more mathematical rigor, and put forward his theory of public expenditure about a century ago (Baram 2019). Anderson *et al*., (2006) notes that early planners who recognized the potential for promoting development through public investment include Myrdahl (1957) and Hirschman (1958). Anderson *et a*l., (2006) further notes that there was a revival of interest in growth theory, beginning late 1980s with the works of Guild (2000), Arthur (1994), Krugman (1991), Lucas (1988), Romer (1986), and more recently advocates of the Millenium and Sustainable Development Goals (SDG) (Sustainable Development Goals 2020, Abdul *et al*. 2015).

Public investment theory argues that markets have their limits in the provision of public goods and services (Oukhallou 2016). The private sector will typically not supply public goods and services, as they cannot charge a price for their use because of the non-excludability nature of public goods and services. Government, or responsible authorities at local level, through their ability to raise revenues from domestic taxation or foreign aid, must therefore provide public goods and services (Sustainable Development Goals 2020, Anderson 2006).

Non-excludability concept states that the main function of prices in markets is to ration supply of scarce goods to those who can offer scarce resources in exchange. Excluded would be those who cannot pay, or who do not wish to pay. Thus, additional investment can increase quantity and/or quality of this rationed amount, benefiting households and firms in the process (Oukhallou 2016, Abdul *et al*., 2015). In view of a firm, its share of profits increases as public investment increases, taking the form:

$$\pi_i = f(p_i, \bar{G}_k, x_j) \qquad (2.1)$$

where π_i is the profit of firm *i*, p_i are the prices of the various goods and services produced or used as inputs by firm *i*, $\bar{G}_k$ is the fixed amount of various types of public capital to which a

firm has access, and x_j is a set of other characteristics which affect a firm's profits (Anderson *et al*., 2006).

However, some goods and services are difficulty to exclude others. Economists refer to national defense as a classic case in non-excludability because it would be impossible to provide national defense to some people and communities and not to others, based on individual payments (Abdul *et al*., 2015, Guild 2000). When non-payers cannot be excluded, private markets generally fail to provide goods or services; and the task rests on the government or local authority with jurisdiction over the area. Non-excludability makes market development difficult in-spite of the fact that provision of such goods and services would benefit both consumers and producers.

On the other hand, non-rivalry is when there is no shortage of the good concerned. In other words, there is no marginal cost of allowing additional users. The profit of non-rivalry investment accrues to the community in terms of non-market benefits, for example water and air quality. It is difficult to give value to such benefits but it is a conventional aspect of cost-benefit analysis. In this respect, projects are economically viable as long as they return positive net present values to the community at appropriate discount rates even though this might not be financially viable (Anderson *et al*., 2006).

In addition, most infrastructure investments involve a long lead-time between outlays and yields. Even if the problems of non-excludability and non-rivalry is overcome, private markets will not necessarily provide the optimum level because private investors seek a high return in the short term. Firms tend to seek investments with short payback periods, short termism. Infrastructure projects, because of their capital intensity, are typically slow to yield a return (Garcia-Milà & McGuire 2018, McAuley 2001). Therefore, national and local Governments make long-term investments than private sector as they do not run the risk and usually raise the capital outlay through taxes or public programmes such as community-based programmes.

Neo-classical investment theory states that the firms focus on maximising profits. Maximising profits in each period will yield an optimal capital stock. Infrastructure or public investment serves as a direct input into production processes; the production function takes the form of the conventional Cobb-Douglas function:

$$Y(t) = f(K(t), L(t) = AK^{\alpha}L^{1-\alpha} \qquad (2.2)$$

Where $Y(t)$ is the firm's output, K is the capital and L is labour all in period t
An increase in government public investment increases the firm's output.

Thus, the introduction of public capital or core infrastructure in the production function is based on the view that the flow of services that it produces raises the productivity of private inputs, firms or households (Anderson *et al.* 2006).

At times private sector invests in public infrastructure through government collaboration, for example, by forming Public-Private Partnerships (PPP). The purpose of such collaborations would be to provide public goods and services. The role of government when private sector provides public investments is to guarantee returns to the private sector as the ultimate purchaser of the asset (Anderson *et al.* 2006). Under community based programmes and considering non-excludability and non-rivalry conditions of public goods, public investment is a favorite approach to redistribute publicly generated income.

Impact of infrastructure

The impact of public infrastructure on development can be viewed from two angles (Table 2.1):
(a) Impact on sectoral development and
(b) Impact on social development.

Impact on sectoral development

Public infrastructure contributes to growth by lowering production costs for private firms so increases productivity and profits leading to more investment by the private sector, and attracting new firms and households (labour) into the area; the *crowding-in effect* (Table 2-1) (Garcia-Milà & McGuire 2018, Guild 2000).

Table 2-1: Impact of infrastructure investment on development

Impacts on Sectoral Development	***Impacts on Social Development***
Productivity:	**Income:**

Increased output as a result of direct input and higher productivity	Higher wages through improved productivity
Structural and comparative cost changes through improved technology	Direct and multiplier effects of infrastructure construction wages
Complements/substitutes:	**Access:**
Reduced costs of production and transactions through complementarity	Access to markets: cheaper inputs, higher output prices, and alternative employment
Increased productivity of other factors through complementarity	improved health, education, and social services due to better mobility and access
Location:	**Consumption:**
Productive amenities attract firms, consumption amenities attract labor	Consumption value of infrastructure services
Induced private investment through lower costs and higher returns	Environmental improvement

Source: Guild (2000)

If infrastructure serves as a complement to other inputs, private capital is attracted with an increasing public investment. If infrastructure is a substitute for privately provided factors, higher public investment should lead to lower costs for labour or capital or both. Facilities such as roads, which have few close private substitutes, should always be complementary to private capital, whereas power and water supplies, which have readily available private substitutes, may go either way (Guild 2000).

Impact on social development

From a social development perspective public investment theory predicts positive impacts on growth through improvements in human capital, education and health caused by better amenities that infrastructure represents. The benefits accrue through social agglomeration economies and higher productivity, which should raise wages. Within the social development category, there are also three types of impacts: income effects, access effects, and consumption effects. If better infrastructure does improve worker productivity, it is expected that wages will increase and attract workers. Higher levels of infrastructure investments may thus be able to boost growth rate of labour force and raise regional income, which should translate into higher per capita or per household income (Oukhallou 2016, McAuley 2001).

Infrastructure construction is also raise incomes through a temporary multiplier effect on wages and materials, and through a permanent expansion of employment opportunities through greater accessibility. Better transportation and communications also mean improved access to health care, education, and markets for produce and consumer goods especially in rural or less developed areas. Thus, areas with better networks of both kinds are more likely to have

improved access to educational and more diverse employment and household asset accumulation (Oukhallou 2016, McAuley 2001).

Infrastructure should also advance social development to the extent that it provides services that people value. Amenity values of better facilities and access to services attract households. Infrastructure services are important consumption items in themselves. For example, better roads not only improve access to markets, they also save people time and provide opportunities for social interaction across a wider area (Anderson *et al.* 2006, Guild 2000).

To analyse these effects, one can assume a household utility function of the form:

$$V_h = f(m_h, p_j, z_k) \qquad (2.3)$$

Where V_h is the utility of household h, m_h is the disposable income of household h, p_j are the prices of the various market goods and services consumed by the household, and z_k are the fixed quantities of various goods and services consumed by the household that are publicly provided. The direct impact of public investment on household welfare is given by:

$$dV_h / d\, z_k \qquad (2.4)$$

However, this tend to be smaller, the higher the initial amount of the public good and service being provided – diminishing marginal utility. It will also vary according to household preferences; some households prefer or value particular goods and services (Guild 2000).

Public investments change the price of various market goods and services used and/or produced by firms, and consumed by households; depending on whether it is a substitute or complement to other goods and services consumed by households or used by firms (Bivens 2012). The impact of a change in the price of a market good or service on household utility is given by:

$$dV_h / dp_i. \qquad (2.5)$$

Some public investments also impose implicit non-income taxes on households; for example, resettlements impose substantial non-income costs (psychological) on households that have to

move and affects poor resourced households more than better-resourced households (Guild 2000).

The impacts discussed herewith are consistent with the view of development as improved capabilities advanced by Sen (1981).

The discussion in this section shows that impacts of public investment can be analysed at a highly disaggregated level. Such an approach allows for differential impact of public investment across firms and households, and the 'indirect' effects of public investment, which arise through changes in the relative price of goods and services. These effects are likely to be more significant in practice.

Empirical Studies of Infrastructure and Development

The empirical studies on these relationships can be viewed from two perspectives. First are studies that address sectoral development in terms of productivity of infrastructure, its complementarity with private capital, and its effect on firm location. Second are studies that address social development in terms of income, access to services, and consumption of services.

i. Sectoral development

The evidence is clear that public capital boosts sectoral development through national and regional growth of output, employment, and total factor productivity. Aschauer (1989) first showed a very high impact of core infrastructure (roads, power, water, and sanitation). Munnell (1990) then showed that the impact of public capital was roughly equal to that of private capital. These results show that investment in public capital has a very high payoff with an output elasticity of 0.33. An output elasticity of 0.33 implies an annual return of 33 cents' worth of economic activity for every dollar invested.

In the manufacturing sector, Lee and Anas (1992) and Suarez-Villa and Hasnath (1993) find that aggregate infrastructure increase firm output and productivity by lowering costs, increasing the productivity of other factors of production, and increasing the rate of technological innovation. In the agricultural sector studies by Binswanger *et al.* (1993), Ahmed and Hossain (1990), Pradhan, *et al.* (1990) and Antle (1983, 1984), produced much similar results.

In the second major subset of sectoral impacts, infrastructure interacts with private capital in two ways. Scholars argue that if the availability of infrastructure increases the productivity of private factors, then it is a complement and should lead to greater private investments. However, if infrastructure substitutes for private capital, then investments in infrastructure will result in lower private investments. Guild (2000) reports that studies by Aschauer (1989), Binswanger *et al.* (1993), Eberts (1991), Eberts and Fogarty (1987), Looney and Winterford (1993), and Pradhan *et al.* (1990), find that infrastructure provision results in higher levels of private investment.

ii. Social development

The role of infrastructure in sectoral development suggests that its availability may be as important to individuals as it is to firms. The impacts of infrastructure on household welfare take several forms: income, access to services, and the consumption value of infrastructure.

Households may realize higher incomes through productivity and increased opportunities for employment of their labour through better communications and transport. Duffy-Deno and Eberts (1989), who find that a dollar's worth of infrastructure raises incomes about 10 cents. Ahmed and Hossain (1990) find higher incomes in developing country regions with better access to infrastructure. They demonstrated that the effect is due to increased opportunities for non-farm employment, higher wage employment in agriculture, and typically longer duration of employment.

Investment in infrastructure projects also raises incomes through direct employment creation in construction and operations. Although not strictly long-term development, public works programs have often been used as countercyclical tools to counteract recession or accelerate growth. In confirmation, Duffy-Deno and Eberts (1989) find significant employment and multiplier effects though of limited duration. Rural households benefit through better terms of trade for their output and better access to public services. Ahmed and Hossain (1990) and Antle (1983, 1984) show positive effects on incomes due to higher farm gate prices for produce and attributed this to better transportation, communications, irrigation, and electricity in rural areas. They also find significant positive effects on education and health.

The most direct impact on social welfare is through actual use of infrastructure services, as they are an important component of household consumption (Bahl and Linn 1992). Better infrastructure affects the mobility of individuals and thus their access to education, health care, and other social services (Oukhallou 2016, McAuley 2001, Van deWalle 1998). Transportation infrastructure in particular has a pervasive effect on access to employment and education and thus on alternative income opportunities.

Lagging regions would most likely benefit from investments in social services such as health care and education in preparation for eventual expansion of productive capacity. Hansen (1965a, 1965b) confirm his thesis in two early studies in Europe. Later studies in the United States and Europe by Costa *et al*. (1987), Cutanda, and Paricio (1994) added further positive evidence. These findings have also been confirmed for developing countries by Looney and Frederiksen (1981), Ahmed and Hossain (1990), and Looney and Winterford (1993). The consensus is that existing disparities in regional development are related to differences in public capital. Taken together, these studies imply that infrastructure investments need to be targeted to levels of development as well as specific project objectives. They argue that infrastructure surpluses will do no good in lagging areas that are unlikely to develop anytime soon. Other studies also suggest that infrastructure investment has its largest impact when combined with other forms of productive public expenditure, such as effective education and health spending (Guild 2000).

2.4 Community Based Natural Resources Management and welfare

Community Based Natural Resources Management (CBNRM) programmes are incentive based natural resources management systems. The view that if communities are made to economically benefit from conserving natural resources they are more efficient than conservation without utilisation or national parks protectionist approach (Bessette 2020, Tchakatumba et al. 2019, de Vette 2012, Hutton, *et al.* 2005).

In southern Africa, Governments implemented community based natural resources management programmes in response to perceived unsustainable resources utilisation (Tchakatumba et al. 2019, Gandiwa 2013a). Earlier scholarship had suggested conservation through protecting natural resources from use by people (Hardin 1969). Hardin argues that communal natural resources in fragile environments are likely to be degraded as users compete to harvest resources without conserving, as there will be no private incentives for conservation,

a scenario he referred to as 'the tragedy of the commons'. Hardin therefore suggests that governments should put in place strict measures to protect biodiversity. The influence of the 'tragedy of the commons' thinking led to the creation of protected areas, largely national parks. Later studies however showed that governments do not have the capacity to monitor all protected areas and therefore had failed to harness people's 'resource degrading behaviour' such as over harvesting, revenge killing and poaching (Chigonda 208, Murphree 2009). The later thinking, common property theory, which encompasses decentralisation, argues that people can sustainably conserve common resources when they own, manage, use and significantly benefit from the specified resources (Shereni 2020, Mudzengi 2020, Ostrom *et al.* 2007, Ostrom 2007, 1992, 1990; Ostrom & Ostrom 1986; Murphree 2009, 2000, 1994, 1990; Olsson *et al.* 2004 and Chitsike 2000).

In Zimbabwe, community-based wildlife management idea started in response to wildlife decline experienced in the 1960s due to increased poaching activities. Commercial farmers were shooting on sight and communal farmers using snares to protect their crops and livestock from wild animals (Macheka *et al*. 2020, Child 1996). In addition, the 1972 Stockholm Conference on biodiversity conservation encouraged natural resource management systems that benefit producer communities, especially those found around protected wildlife areas (Caldwell 1996). This led to a shift in wildlife policy in Zimbabwe, starting with the 1975 Parks and Wildlife Act (Taylor 2009, Lindsey *et al*. 2011). The Act allowed private commercial farm owners to utilise wildlife on their properties commercially. This culminated into the establishment of private wildlife conservancies (Mudzengi 2020, Lubilo 2018, Cumming 1990). The approach saw an increase in the number of wildlife, and the concept was adapted for communal areas hence referred to as 'Communal' Areas Management Programme for Indigenous Resources (CAMPFIRE) (Biggs 2019, Taylor 2009). The programme started in areas with high-value wildlife, targeting communities through their responsible Rural District Councils. To have rural communities engage in wildlife business, interested Rural District Councils apply for Appropriate Authority status from the Zimbabwe Parks and Wildlife Management Authority, now Parks and Wildlife Authority (Mudzendi 2020). As a pre-requisite, the Rural District Councils are to commit to transfer the wildlife management and benefits to sub-district administrative units such as wards or villages, referred popularly as producer communities as they live with and promote production of wildlife. By 2009, 57 of the 63 rural district councils were implementing the programme at different intensities and for different resources other than the high-value wildlife (Taylor 2009).

In Mbire district, former Lower Guruve CAMPFIRE programme started to be implement in 1988 (Taylor 2009, Muchapondwa 2003). Ideally, under CAMPFIRE arrangement, elected committees manage realised income. Households in participating communities benefit either directly or indirectly. Direct benefits take the form of cash dividends and food, such as meat from trophy hunting, problem animals or meat quota. Indirectly households and individuals benefit by access to education and health services. Cash dividends were popular at the beginning of the CAMPFIRE programme (Tchakatumba et al. 2019, Taylor 2009, Hutton *et al*. 2005). However, communities increasingly invested larger proportions of wildlife income in public infrastructure because of increasing population sizes in beneficiary communities. Household cash dividends became insignificant (Hutton *et al*. 2005). More so, as public funds distribution of benefits is more prudent by investing in public goods and services (Jones 2007, 2004 & Jones B. 2006).

Empirical studies in Southern Africa demonstrate the varied impact of the community based natural resources management programmes. In Zambia for example, Bandyopadhyay and Tembo (2010) determine the impact of community based wildlife management and participation in community institutions on food consumption expenditure. Results show that gains for living in Game Management Areas were large but unevenly distributed and that the gains accrue mainly to the relatively well-resourced households. They also show that infrastructure does not necessarily translate into short-term household level gains. In Namibia Riehl *et al*. (2015) and de Vette (2012) find mixed effects of CBNRM programmes at the household level. They find that CBRNM programmes have positive effects on malaria prevention, negative effects on *school attendance* and household wealth, and no effect on diarrhoea prevalence. In Zimbabwe, a number of socio-economic evaluations such as Harrison *et al.* (2014) and Muchapondwa (2003) find little evidence of community based natural resources management impact on poverty reduction.

Public investment theory purports that investing in public goods has a positive impact on the welfare of individuals, increasing access for less resourced people (Wilhelm and Fiestas 2005), and therefore addresses the equity challenges. From the Theory of Change perspective and supply-demand theory (Baram 2019, Rockett *et al*. 2008) I envision that: 'if a community participates in community based wildlife management and invests in public infrastructure such as schools and related social support and related expenditure, individual costs are lowered and demand for education services increase: leading to increased access and utilisation of public service by beneficiary communities.'

There has also been pressure to increase public investment in developing countries to improve less resourced people's welfare (Rajaram *et al.* 2014, Anderson *et al*. 2006). Anderson *et al*. (2006) explore the possible micro-economic effects of public investment, on household income, poverty and income distribution. Their findings show that public investments have positive impact on household welfare, though there is no clear agreement on the extent or scope (Garcia-Milà & McGuire 2018).

2.5 CAMPFIRE Treatment Effect on education

Treatment effect literature evaluates policy or programme impact or effect on population of interest. It investigates average impact of policies or programmes that have partial participation at some point (Heckman and Vytlacil 2001). This creates a natural experimental design where one part is affected and the other is not. This can therefore be manipulated to assess the impact of an intervention or programme. In this case there would be a *treatment group* that is affected or participating in the programme and a *comparison group* or *counter-factual* that is not participating, which can be used as a control group (Heckman and Vytlacil 2001; Lechner 2015). One can therefore answer how policy or programme induced changes affect specific aspects of the population of interest. Thus, we can use the estimated response to the variation in observed policy changes to produce internally valid estimators.

Assume:

EP_i^1 is an education outcome (education participation) that an individual experience when s/he participates in a programme such as CAMPFIRE.

EP_i^0 is the education outcome (education participation) experienced when an individual does not participate in the programme.

The programme impact would therefore be the difference in outcomes of variable X when participating and not participating. The estimator:

$$\alpha = E(EP_i^1 - EP_i^0) \qquad (2.6)$$

Where the $E(\cdot)$ is taken across the population of interest.

However, because one cannot observe the same individual at the same time participating and not participating. The optimal would be to compare average treatment effect of the treated

sample to the average of non-participating/comparison/counter-factual or control group that is not in the programme, as specified below.

Thus, one can consider average treatment effect on the treated, ATET:

$$E(EP_i^1 - EP_i^0 | T_i = 1) \qquad (2.7)$$

Where T_i is a binary indicator of programme impact that equals 1 if an individual participates and 0 otherwise. ATET captures the effect of the programme on those who actually participated. If it were possible to observe outcomes for a representative sample of members of N individuals randomly selected from the population of interest, the average treatment effect would be:

$$\frac{1}{N}\sum_{i=1}^{N}(EP_i^1 - EP_i^0) \qquad (2.8)$$

Post-test only control group design for community based natural resources management

Post-test control group design is used were impact of a treatment is observed after some time. I use the post-test only control group design for this paper, to consider the impact of the CAMPFIRE programme induced changes on school-going-age children's participation in formal education. Outcomes are observed after more than two and a half decades of the programme implementation. The population is sorted into treatment and comparison groups were the treated are the sub-district units (wards), that are implementing the programme, and the comparison group are the wards that did not implement the programme. The design suits well into experimental design as the individuals or households in the two groups differ only in terms of programme implementation that targeted sub-district administrative units with high value wildlife. The characteristics of households in implementing and non-implementing wards are largely the same. For example, environmental conditions, ethnicity, etc are more or less the same, from which similar households can be discerned. Furthermore, treatment and control groups are mutually exclusive and exhaustive. That is no household belongs to both subgroups and every household belong either to one or to the other group.

We thus define our outcome variable as follows:

$$EP_i = \{1, if\ school\ going\ age\ child\ belongs\ to\ an\ implementing\ ward,\ and\ 0, if\ not\}$$

Where *EP* indicates the level of participation of the child in formal education; *i*, is the school going age child from the treatment or comparison population (CAMPFIRE or non-CAMPFIRE wards respectively).

We evaluate whether public investments by the communal areas management programme for indigenous resources (CAMPFIRE) programme have had an impact on children's school participation rate. Anecdotal evidence from education reports generally show that participation and enrolment rates are lower in marginal, 'CAMPFIRE' wards compared to non-CAMPFIRE wards in Mbire district (UNICEF 2015). Traditionally there has been less infrastructural investment by pre and post-independence governments in most marginal areas. However, when the CAMPFIRE programme started there have been huge public investments by the programme in education, health and road infrastructure over and above government support. (Jones 2004). Post-independence government supported the initiative but in a similar manner across the country. The expectation is that with the implementation of the programme the enrolment rate and therefore participation in education for children of school going age has over the years either matched or exceeded non-CAMPFIRE wards in the district.

We therefore observe EP_i for random samples of size N_1 from CAMPFIRE implementing wards and N_0 from non-CAMPFIRE wards. The estimator is:

$$\hat{\alpha} = \frac{1}{N_1}\sum_{i=1}^{N_1} EP_i - \frac{1}{N_0}\sum_{j=1}^{N_0} EP_j \qquad (2.9)$$

Thus, the programme impact is estimated by the difference in mean outcomes between the treatment and comparison groups after application. The post-test only control group design can yield an unbiased estimate of treatment impact (Heckman and Vytlacil 2001, Lechner 2015).

However, there are always within and between group heterogeneity or selection bias making simple comparison of means less robust. To correct for confounding factors I use propensity score estimation to allow comparison of units with similar background characteristics, X_i (Austin 2011).

$$\Delta\mu = ATET + SB \qquad (2.10)$$

Where:

$\Delta\mu$ is the propensity score estimate

$ATET$ is the average treatment effect on the treated

SB is the selection bias

The propensity score theorem states that the outcome is independent of treatment given background characteristics:

$$Y_{1i}, Y_{0i} \perp D_i | P(X_i) \qquad (2.11)$$

or

$$EP_{1i}, EP_{0i} \perp\!\!\!\perp D_i \,|\, P(X_i) \qquad (2.12)$$

Where: Y_{1i} is outcome when treated, EP_{1i} is education production when in a CAMPFIRE area

Y_{0i} is outcome if not treated, EP_{0i} is education production if not in a CAMPFIRE area.

D_i Selecting into treatment

Expected causal effect on the treated would therefore be:

$$E[Y_{1i} - Y_{0i} | D_i = 1] \qquad (2.13)$$

or using the law of iterated expectation:

$$E[E[Y_{1i} | D_i = 1, P(x_i) - E[Y_{0i} | D_i = 1, P(x_i)] | D_i = 1 \qquad (2.14)$$

Treated and untreated units are matched using background characteristics, $P(x_i)$ – propensity score. Propensity score model allows regrouping observations into strata of similar background characteristics or propensity scores, and means for each stratum is calculated. I use nearest neighbour matching to group/stratify the sub-samples around generated propensity scores (Austin 2011). To estimate the average treatment effect across the entire sample I weigh the average for each stratum:

$$ATE \approx \sum_s \mu Y_{1s} - \mu Y_{0s} \qquad (2.15)$$

μY_{1S} Average for treated sample,

μY_{0S} Average for the untreated sample

We match the treated group, children living in CAMPFIRE programme areas with a non-treated group, children in non-CAMPFIRE programme areas.

2.6 Education production function and CAMPFIRE

Education production function is an application of the economic concept of the cobb-douglas production to the field of education (Coates 2003, Hanushek 1995, Gyimah-Brempong and Gyapong 1991, Bowles 1970). It relates inputs affecting education production or output. I adapt the same approach and include community based natural resources management as a fixed input in the production function to see whether it influences children's participation in formal education. In addition, I argue that the programme has an effect of making socio-economic characteristics of children less important in the production of education, as the programme takes over the role of parents through public provision of education. I presume therefore, that socio-economic characteristics of parents, level of education or wealth, for example (Gyimah-Brempong and Gyapong 1991) are premised to be important variables for non-participating communities compared to communities participating in community based wildlife management programme. Thus, I apply the model to treatment and comparison groups to see if changes caused by the programme affect the role of parent characteristics on education production. I consider education as a production process in which inputs such as community resources for example fees, infrastructure (X), and household socioeconomic characteristics (Z) factors to produce education outputs, participation *EP*.

The education production function thus takes the form of:

$$EP = EP(X, Z, \varepsilon) \qquad (2.16)$$

Or in stochastic terms:

$$EP = \alpha + \beta x + \beta z + \varepsilon \qquad (2.17)$$

Where education participation is a function of observed (covariates) and unobserved (random disturbance) factors.

I assume that each observed value of EP_i is the sum of observed variables, and unobserved captured by the random term, ε. The equation attempts to estimate unknown parameters, α and β. Running the model for the treatment and comparison group or controlling for treatment/comparison gives the contribution of each covariate to changes in education production output, EP_i conditional to programme inclusion or exclusion.

Using Shapiro-wilk and Shapiro-Francia test for normality, education production variable was not normally distributed. The data was normalised by squaring the education production (Table 2-2).

Table 2-2: Shapiro-wilk and Shapiro-Francia tests for normal data

Variable: squared education production	Observations	W/W'	V/V'	z	Prob>z
Shapiro-wilk test	613	0.9959	1.659	1.228	0.10971
Shapiro-Francia test	613	0.99605	1.706	1.202	0.11462

Sources: Survey data December 2015

The model then takes the form:

$$EP_i^2 = \alpha + \beta x + \beta z + \varepsilon \qquad (2.18)$$

2.7 Hypotheses

Wards with high value wildlife are coming from a relatively worse-off position, but after almost three decades of benefiting from the programme the hypothesis is that they have reached or surpassed education production level that would obtain if they were not subjected to the CAMPFIRE programme treatment. Thus, (1) school-going age children participation in education is higher when treated to CAMPFIRE programme than when not treated, or at the least equal to when not treated:

$$\frac{1}{N_1}\sum_{i=1}^{N_1} EP^1 \geq \frac{1}{N_0}\sum_{i=1}^{N_0} EP^0 \,|D = 1 \qquad (2.19)$$

Where EP^1 is education production output for children when they are subjected to CAMPFIRE programme and EP^0 is education production output for children if they are not treated to the CAMPFIRE programme. Alternatively:

The null hypothesis is that CAMPFIRE has an effect on children's school participation and expressed as:

$$H_O: \frac{1}{N_1}\sum_{i=1}^{N_1} EP_i^1 - \frac{1}{N_0}\sum_{j=1}^{N_0} EP_i^0 \geq 0 \qquad (2.20)$$

The alternative hypothesis is:

$$H_A: \frac{1}{N_1}\sum_{i=1}^{N_1} EP_i^1 - \frac{1}{N_0}\sum_{j=1}^{N_0} EP_i^0 < 0 \qquad (2.21)$$

I further hypothesized that (2) socio-economic characteristics are less important in influencing children's participation in education in treated group than in the non-treated group due to

education subsidies associated with the treated group. Thus, we expect the co-efficiencies of the socioeconomic characteristics to be zero.

$$\beta_1 = 0|X_1 \qquad (2.22)$$

Where $\mathbf{X_1}$are socioeconomic characteristics such as parent education, household income, household size, gender of household head, and child sex, and $\boldsymbol{\beta_1}$ is the contribution of socioeconomic characteristics to child participation in formal education for the treatment or counterfactual group.

2.8 Research methods

The ***dependent variable*** is the measure of school participation by children aged 5 to 16 years. There is no specific continuous variable measuring the level of participation in formal education for individual children of school-going age. I developed a tentative measure extending the years in school concept from the UNESCO Institute of Statistics (Potancokova and Goujon 2014;Stukel and Feroz-Zada 2010; Perelman and Santin 2011; Rothstein 2008;). Years of schooling are used for population of age 25 and above to calculate the average years of schooling for a given population. I extended the concept to children of school-going age for basic education in the country, 5-16 years in Zimbabwe. Basic education in Zimbabwe is covered in 12 years; 1 year for grade 0, 7 years to complete primary education and 4 years to complete lower secondary education. I conceptualise full participation in education as enrolling into education at the right age and proceeding in the right grade-for-age throughout the schooling period (Potancokova and Goujon 2014). Non-participation entails being of school going age but never attended/enrolled into formal school.

Variation in participation would come through dropping out and repeating, and is catered for as years in school are calculated by the number of years expected to complete each grade rather than the actual years spent in school. A child for example who is 10 years old is expected to have spent 6 years in school and should be in grade 5; 1 year in grade 0 at age 5, and 5 years transiting from grade 1 through to 5. However, if he/she is in grade 4 after repeating, the child is considered to have spent five years in school, instead of six. In terms of participation the child would be at 5/6 or 0.83 point out of the possible 1 as he has spent 5 years in school instead of the 6 years expected at his or her age. From this conceptualisation, one can calculate the relative participation in education for an individual school-going age child using the child's age (for expected years in school), current grade or grade child dropped out of school system (to get years spent in school). Years in school are expressed as a proportion of the number of

years that the school-going age child is expected to have been in school at his or her current age.

The ***expected*** years in school, for the current grade is the number of years the child is expected to have completed each grade. Table 2-3 shows the number of years expected to complete each grade/form, and the official age for each grade/form in Zimbabwe.

Table 2-3: School level by years to complete and official age

School level	Grade/form	Years to complete level	Official age for grade/form
Pre-primary (Grade)	0	1	5
Primary (Grade)	1	2	6
	2	3	7
	3	4	8
	4	5	9
	5	6	10
	6	7	11
	7	8	12
Lower secondary (Form)	1	9	13
	2	10	14
	3	11	15
	4	12	16

(Sources: Adapted from Zimbabwe Ministry of Primary and Secondary Education 2013)

Thus the individual child's participation in education would be the official years to reach current grade (O_{cg}) expressed as a proportion of expected years in school for the child's age (X_{age}) conditional to being of age 5 to 16.

$$EP_i = \frac{O_{cg}}{X_{age}} | 5 \leq a_i \leq 16 \qquad (2.23)$$

Where a_i is the age of an individual child

The education participation scale varies between 0 and 1, with 0 representing a child who is of school-going age but has never enrolled into school system, and 1 a school-going age child in the correct grade for her/his age. In exceptional cases a score above 1 shows a child of school going age who is a year or more above his/ her grade for her age; younger than the official age for the grade in which s/he is in.th conceptualisation allows comparison of children of different ages.

Data for the paper was collected using the survey method. Appendix D and E show the individual question items that were administered . Table 2-4 shows education inputs, household social, economic and community inputs/characteristics that were collected.

Table 2-4: Education production inputs

Household social characteristics	Household economic characteristics	Community economics
Child sex (0=female, 1=male)	Salaried agric industry (0=No 1=Yes)	Primary school fees (USD)
Child age	Salaried non-agric industry (0=No 1=Yes)	Secondary school fees (USD)
Orphan	Salaried wildlife industry (0=No 0=Yes)	Cross a river to school (0=No 1=Yes)
Double orphan	Number of cattle	Distance to school (m)
Household resident period (years)	Number of donkeys	Cross wildlife area to school (0=No 1=Yes)
Household size	Number of goats	
Household head sex (0=female, 1=male)	Number of poultry	
Household head years in school		
Ethnicity		
Religion		
Marital status of household head		

Sources: Survey data December 2015

Social characteristics consisted of household demographics such as sex and marital status of household head as well as household size. It also includes child related characteristics as possible determinants of participation in formal education. Economic characteristics centred mainly on asset accumulation such as livestock units owned.

Ethnicity has affects demand for education. The assumption is that different ethnic groups have different encounters with education systems and therefore collected ethnic affiliations of children's household. Religion was premised to have an influence in a number of household decisions including children's participation in education. The hypothesis is that religion influences parents' decisions on whether to send and support children's education.

At community level, determinant factors collected were mainly user fees, distance to school and presence of other physical barriers such as rivers and wildlife. Key informant interviews were also conducted with school authorities. Data on historical income for CAMPFIRE implementing sample wards since Zimbabwe adopted multi-currency system in 2009 was collected.

2.9 RESULTS

2.9.1 Income and infrastructure development

Table 2-5 shows income that the two sample wards generated between 2009 and 2015. It was reported that at least 60 per cent of the income in wards 2 and 11 was invested in public infrastructure. The council reported that it was in a bid to push to 75 per cent the proportion that has to go to public investment.

Table 2-5: CAMPFIRE income by ward (USD)

Year	Ward 2 (US$)	Ward 11 (US$)
2009	*	*
2010	*	84, 361.00
2011	45, 000.00	92, 360.00
2012	40, 000.00	84, 326.00
2013	47, 000.00	73, 000.00
2014	50, 000.00	72, 000.00
2015	40, 000.00	53, 000.00

**figures were not available*

Source: Survey data December 2015: Ward CAMPFIRE committee financial record books – Treasurers

In CAMPFIRE communities, school structures are easily constructed and maintained with no direct cost on parents. Meanwhile non-CAMPFIRE communities were struggling to invest in infrastructure. School heads interviewed reported that schools in both CAMPFIRE and Non-CAMPFIRE areas get the same support from the government, for example through the School Improvement Grant (SIG) that is funded by UNICEF or from other interested organisations such as Campaign for Female Education (CAMFED) programme targeted at assisting disadvantaged girls. The government, depending on school enrolment, for example, directly employs all teachers. School development committees are responsible for any extra staff.

Key informants at schools in CAMPFIRE wards reported that they get financial support from CAMPFIRE programme to run day-to-day school activities. Of particular note is support towards sporting activities. Schools in CAMPFIRE areas, wards 2 and 11, reported that they submit their budgets to their respective CAMPFIRE committees and would usually get the financial support they need. In addition, all schools in CAMPFIRE wards get funding from CAMPFIRE for extra labour costs. CAMPFIRE income, for example, pays for the general staff such as guards. The community also use CAMPFIRE income to subsidise education. In Masoka for example education costs are fully funded and children do not pay school fees. In Angwa, Ward 2 school fees are lower than in the control wards. CAMPFIRE income also supports children who excel at O level, who wish to proceed to 'A' level, and further to University. On the contrary, Non-CAMPFIRE wards 7 and 17 do not have such community

level income sources to support infrastructural development and welfare of school children. Parents have to contribute towards any school related infrastructural projects. The government through the Public Works Department mainly sponsored most infrastructures in Non-CAMPFIRE wards. Informant interviewees reported that parents directly fund any other local level contribution.

2.9.2 Descriptive statistics

Masoka and Angwa sub-district units, from which the treatment sample was drawn, started implementing CAMPFIRE programme in the late 1980s. Table 2-6 presents the descriptive statistics for the variables used in the education production model and variation between treatment and comparison groups. The level of significance is based on an unequal variance t-test between means.

Table 2-6: Children's social characteristics

Variable	Full sample	Non-campfire	Campfire	Sig.
Social characteristics				
Child sex (0=female, 1=male)	0.47	0.44	0.50	.047
Child age	10.41	10.51	10.31	.753
Orphan	0.05	0.07	0.04	.000
Double orphan	0.04	0.06	0.03	.000
Household resident period (years)	25.45	18.18	32.73	.046
Household size	5.73	5.67	5.78	.664
Household head sex (0=female, 1=male)	0.82	0.81	0.84	.019
Household head years in school	6.33	7.23	5.43	.307

Sources: Survey data December 2015

The sample has significantly more girls than boys. Non-CAMPFIRE areas have significantly higher proportion of girls than boys compared to CAMPFIRE areas. There is also a significantly higher proportion of orphans and double orphans in Non-CAMPFIRE areas than CAMPFIRE areas. All the other social characteristics are similar between comparison and treatment samples.

Table 2-7 shows sample children's ethnicities. Proportions of different ethnic groups are significantly different between Non-CAMPFIRE and CAMPFIRE areas. CAMPFIRE areas have significantly higher proportion of Doma and Korekore ethnicities, meanwhile Karanga and Zezuru ethnicities are significantly higher in Non-CAMPFIRE areas.

Table 2-7: Ethnicity of sample children

Variable	Full sample	Non-campfire	Campfire	Sig.
Ethnicity				
Doma	0.09	0.05	0.13	**.000**
Karanga	0.07	0.13	0.02	**.000**
Korekore	0.56	0.47	0.65	**.000**
Zezuru	0.12	0.20	0.04	**.000**

Sources: Survey data December 2015

Table 2-8 shows the religious affiliation of sample children's households.

Table 2-8: Religious affiliation of children's households

Variable	Full sample	Non-campfire	Campfire	Sig.
Religion				
Apostolic	0.30	0.44	0.16	**0.000**
Christian gatherings	0.04	0.00	0.07	**0.000**
Muslim	0.03	0.06	0.00	**0.000**
No religion	0.08	0.11	0.06	**0.000**
Pentecostal	0.14	0.17	0.11	**0.000**
Protestant	0.12	0.12	0.12	0.745
Roman catholic	0.02	0.02	0.02	0.721
Traditional	0.28	0.10	0.46	**0.000**

The religious affiliations significantly differ between CAMPFIRE and Non-CAMPFIRE areas. Non-CAMPFIRE areas have significantly higher proportions of Apostolic, Muslim, Pentecostal and households that claimed to have no religious affiliation. CAMPFIRE areas have significantly more traditional religion than Non-CAMPFIRE areas.

Table 2-9 shows descriptive statistics of economic inputs included in the education production function.

Table 2-9: Household and community economic characteristics

Variable	Full sample	Non-campfire	Campfire	Sig.
Household economic characteristics				
Salaried agric industry *(0=No 1=Yes)*	0.02	0.00	0.03	**0.000**
Salaried non-agric industry *(0=No 1=Yes)*	0.07	0.10	0.04	**0.000**
Salaried wildlife industry *(0=No 0=Yes)*	0.05	0.01	0.09	**0.000**
Number of cattle	2.69	4.92	0.45	**0.000**
Number of donkeys	0.14	0.11	0.17	**0.014**
Number of goats	4.73	6.07	3.39	**0.000**
Number of poultry	5.24	5.19	5.29	0.713
Community economics				
Primary school fees *(USD)*	10.28	12.28	8.27	**0.000**
Secondary school fees *(USD)*	31.61	45.82	17.41	**0.000**
Cross a river to school *(0=No 1=Yes)*	0.56	0.36	0.75	**0.000**
Distance to school *(m)*	3379.61	3487.14	3272.08	0.170
Cross wildlife area to school *(0=No 1=Yes)*	0.56	0.37	0.75	**0.000**

Sources: Survey data December 2015

Availability and direct cost of education significantly differ between CAMPFIRE and non-CAMPFIRE areas for both primary and secondary education. In CAMPFIRE areas, a significantly larger proportion of children cross wildlife area or a river to get to school. However, the distance to school is similar in CAMPFIRE and non-CAMPFIRE areas, with an average of approximately 3 km.

2.9.3 Impact of living in CAMPFIRE area on education production

On average education, output for sample children is 63 per cent of full production. Thus, children in the sample are not participating fully in education (Table 2-10). The non-treated sub-samples have the highest and lowest education output; Hambe ward has the highest and Majongwe ward has the least.

Table 2-10: Children's participation level in education by ward

Group	Ward	Mean participation	Observations	Standard deviation	Variance
Treatment	Masoka	0.63	117	0.321	0.103
	Angwa	0.62	201	0.343	0.117
Comparison	Hambe	0.67	144	0.340	0.116
	Majongwe	0.60	151	0.305	0.093
Total		0.63	613	0.329	0.108

Sources: Survey data December 2015

On average, the treatment group has slightly less education production compared to the counterfactual group. It appears that children living in Non-CAMPFIRE areas are participating

more in education compared to children living in CAMPFIRE programme implementing wards.

I tested the variance in education participation for the sample children using the T-test procedure and a test value of 1 representing the expected attendance rate for each child. Results show that attendance is 0.628, which is significantly lower than 1 with a standard deviation of 0.329 and a standard error of 0.013.

To test whether there are differences in children's participation in education between children living in CAMPFIRE areas and those in Non-CAMPFIRE areas, the Leven's Test for equality of variance (Table 2-11) and regression discontinuity (Table 2-12) were used. Results show that there are no significant differences in education participation between treatment and comparison group. The null hypothesis is therefore plausible; that education participation rate of children living in CAMPFIRE programme implementing areas is equal to or greater than that for children living in non-CAMPFIRE programme areas.

Table 2-11: Test for equality of education participation means between children living in CAMPFIRE areas and Non-CAMPFIRE areas

	Levene's Test for Equality of Variances		**t-test for Equality of Means**						
								95% Confidence Interval of the Difference	
Participation rate in education	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	2.095	0.148	0.356	611	0.722	0.010	0.027	-0.043	0.062
Equal variances not assumed			0.357	610	0.722	0.010	0.027	-0.043	0.062

Sources: Survey data December 2015

Table 2-12: Participation rate in education, regression discontinuity

Participation rate in education	**Coefficient**	**Standard error**	**t**	**P>t**	**[95% Conf. Interval]**	
CAMPFIRE	-0.010	0.027	-0.36	0.722	-0.062	0.043
Constant	0.633	0.019	33	0	0.595	0.671

Sources: Survey data December 2015

However, the above conclusion assumes that treatment and control groups are homogenous. Treatment and control populations are in fact heterogeneous. Groups with different characteristics would respond differently to the same treatment. Using regression adjustment, other confounding factors were controlled. These include children's age, sex, parent education,

ethnicity and household asset ownership that seem to be different between the treatment and control groups. The sign for campfire becomes positive, indicating that there are other confounding factors affecting children's participation in education.

In order to correct for this heterogeneity, the treatment and control sub-samples were matched using propensity score matching procedure. The propensity score model was first estimated using the treatment dummy variable campfire, where $T_i = 1$ if treated and $T_i = 0$ otherwise. To match the following variables were used: sex of child, whether they cross wildlife area or river going to school, household ownership of goats and poultry and distance to school. The model is robust at 95% confidence level and the balancing property of the propensity score is satisfied and five groups are generated (Table 2-13).

Table 2-13: Internally homogenous groups

	Matched groups					
Household characteristics	1	2	3	4	5	Matched sample average
	Mean					

Participation rate in education	**0.74**	**0.77**	**0.80**	**0.69**	**0.74**	**0.75**
Number of cattle	3.85	3.23	2.95	1.08	0.97	2.29
Number of donkeys	0.40	0.03	0.30	0.18	0.16	0.16
Number of goats/sheep	8.00	4.12	4.57	2.12	4.17	4.12
Number of poultry	7.98	4.94	5.79	3.71	6.69	5.46
Child age (years)	11.55	11.29	11.84	9.96	10.27	10.88
Distance to school (km)	5,088	2,639	4,526	3,684	2,506	3,335
Education expenditure (USD)	46.13	30.41	40.38	14.72	18.29	27.24
Residence period (years)	19.70	22.61	23.74	45.10	22.99	27.36
Household size	5.83	5.43	5.87	6.27	5.49	5.72
Head Years In School	5.54	6.73	6.18	5.91	6.60	6.33
	Proportion					
Girls	62.50	53.19	62.30	53.76	38.71	52.34
Orphan	5.00	6.30	6.60	3.20	2.15	4.67
Education assistance	14.29	6.79	6.67	12.22	19.78	11.46
Diaspora	0.00	0.71	0.00	0.00	0.00	0.23
Urban	17.50	21.28	16.39	12.90	30.11	20.33
Head sex: female	35.00	24.11	13.11	9.68	13.98	18.22
Doma	0.00	3.55	3.28	17.20	12.90	8.18
Karanga	5.00	12.77	9.84	2.15	4.30	7.48
Korekore	70.00	47.52	60.66	50.54	64.52	55.84
Zezuru	15.00	15.60	16.39	8.60	1.08	10.98
Apostolic	62.50	33.33	24.59	22.58	23.66	30.37
Christian gatherings	0.00	1.42	0.00	7.53	13.98	5.14
No religion	2.50	13.48	9.84	5.38	3.23	7.94
Pentecostal	12.50	9.22	21.31	9.68	15.05	12.62
Roman Catholic	0.00	0.71	1.64	3.23	2.15	1.64
Traditional religion	7.50	19.15	31.15	36.56	27.96	25.47
Wildlife wage labour	7.50	6.38	3.28	10.75	20.43	10.05
Non-Agricultural wage labour	40.00	25.71	42.62	32.97	44.09	35.06
Cross river	10.00	10.64	78.69	97.85	86.02	55.61
Cross wildlife area	7.50	17.73	32.79	54.84	80.65	40.65

Sources: Survey data December 2015

The five internally homogenous groups have the following characteristics (Table 2-13). The sub-groups 1 to 5 have propensity scores of 0.08, 0.2, 0.4, 0.6 and 0.8 respectively. Group 1 has more livestock units and on average has longer distance, 5km to cover to get to school compared to all other groups. The group also has the highest per capita expenditure on education, USD46.13 per year and has the least residence period, approximately 20 years. The group also has the highest proportion of female-headed households. However, approximately 10 per cent of the children in group 1 cross a river or wildlife areas to get to school.

On the other end, groups 4 and 5 have the least livestock ownership, though group 5 is second highest in poultry ownership. The two groups have the least per capita expenditure on

education. Group 4 has the longest resident period, 45 years. Groups 4 and 5 have the highest proportion of children who cross-rivers or wildlife area to get to school.

In comparing group means across strata between treatment and control groups, more treated groups have higher mean participation rate (Table 2-14). In three out of the five groups, children living in CAMPFIRE areas participate more in education than similar children living in Non-CAMPFIRE areas.

Table 2-14: Mean education participation rate of the matching treatment and control groups

Block/group	CAMPFIRE	Non-CAMPFIRE	Difference
	Mean participation rate	Mean participation rate	Mean difference
1	0.817	0.727	0.090
2	0.820	0.754	0.066
3	0.783	0.815	-0.032
4	0.685	0.705	-0.020
5	0.756853	0.598214	0.158638

Sources: Survey data December 2015

Running Average Treatment Effect of the Treated using nearest neighbour matching, ATETND all 318 treated observations were successfully matched with 174 observations from the control group/ Non-CAMPFIRE areas. ATET results show that there is 12.3% higher education production under treatment compared to if they are not treated or under the programme (Table 2-15).

Table 2-15: Average Treatment on the Treated using nearest neighbour matching, ATETND

Children in treatment.	Children in control matches.	ATT	Std. Err.	t
318	174	0.123	0.074	1.666

Sources: Survey data December 2015

In other words, compared to children with similar socioeconomic background characteristics living in Non-CAMPFIRE programme areas, children living in CAMPFIRE areas participate more in education. The conclusion is that if the programme were not implemented one would expect children participation in education to be significantly lower. Using this evidence CAMPFIRE programme has a positive and significant causal effect on school participation or education production. The hypothesis that the programme increases education production for treated subjects or children is therefore plausible.

However, while the matching procedure has shown that the programme might be working in improving access to education for children living in CAMPFIRE areas compared to if the programme was not implemented; it does not show the effects of other confounding inputs and interaction between covariates and treatment. Feasible Generalised Least Squares (FGLS) was run to estimate interaction of CAMPFIRE with socioeconomic and school inputs in the production of education. FGLS is a procedure to estimate unknown parameters in a linear regression model (Greene 2002). It is a more efficient method compared to Ordinary Least Squares (OLS). However, heteroscedasticity cannot be ruled out, as outliers are unavoidable. This is catered for by using FGLS, estimating hhat=exp(ghat) then running the WLS using weight 1/hhat.(Greene 2002).

First, I ran the correlation test of all inputs against education production output. The following inputs are significantly correlated with education production output (Table 2-16):

Table 2-16: Education production inputs correlation test

Education inputs	Corr. Coefficient	Sig.
Child sex	-0.103	0.011
Child age	0.322	0.000
Karanga	0.078	0.054
Pentecostal	0.072	0.075
Protestant	0.089	0.027
Traditional	-0.103	0.011
Household head schooling years	0.101	0.013
Number of cattle	0.078	0.055
Number of donkeys	0.088	0.029
Number of goats/sheep	0.133	0.001
Number of poultry	0.182	0.000
Number of hoes/axes	0.232	0.000
Number of ploughs	0.142	0.001
Livelihoods: wildlife	0.079	0.052
Livelihoods: salary	0.134	0.001
Livelihoods: sell wildlife	-0.154	0.000
Primary age	-0.196	0.000
Secondary age	0.196	0.000
Cross river to school	-0.076	0.089

Sources: Survey data December 2015

The education production was tested to find if it is normally distributed. Figure 1 shows that it is not normally distributed.

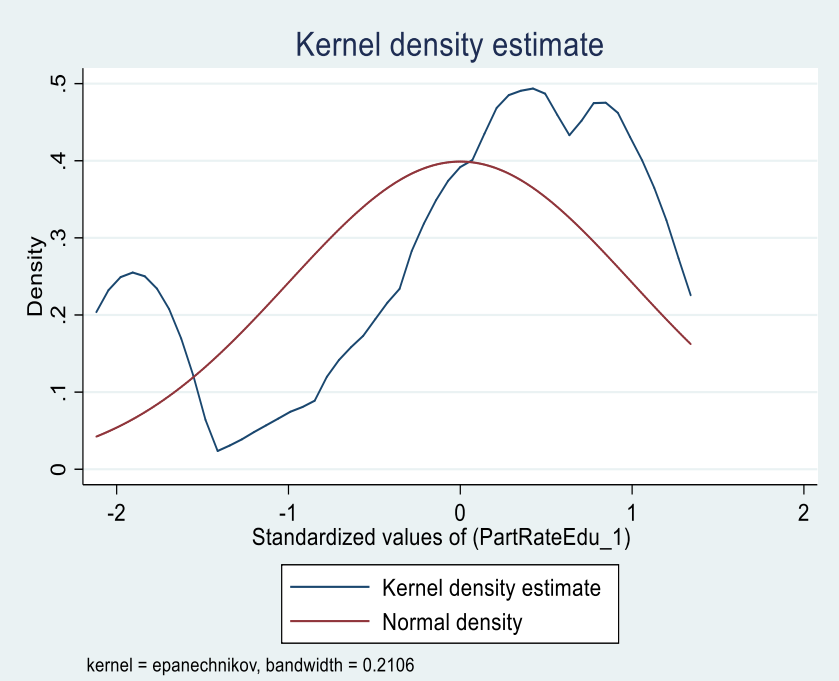

Figure 1: Kernel density estimation - education participation rate (*Sources: Survey data December 2015)*

The education variable was standardised by squaring and when tested using the Kernel density estimation the result yielded a normal distribution curve (Figure 2).

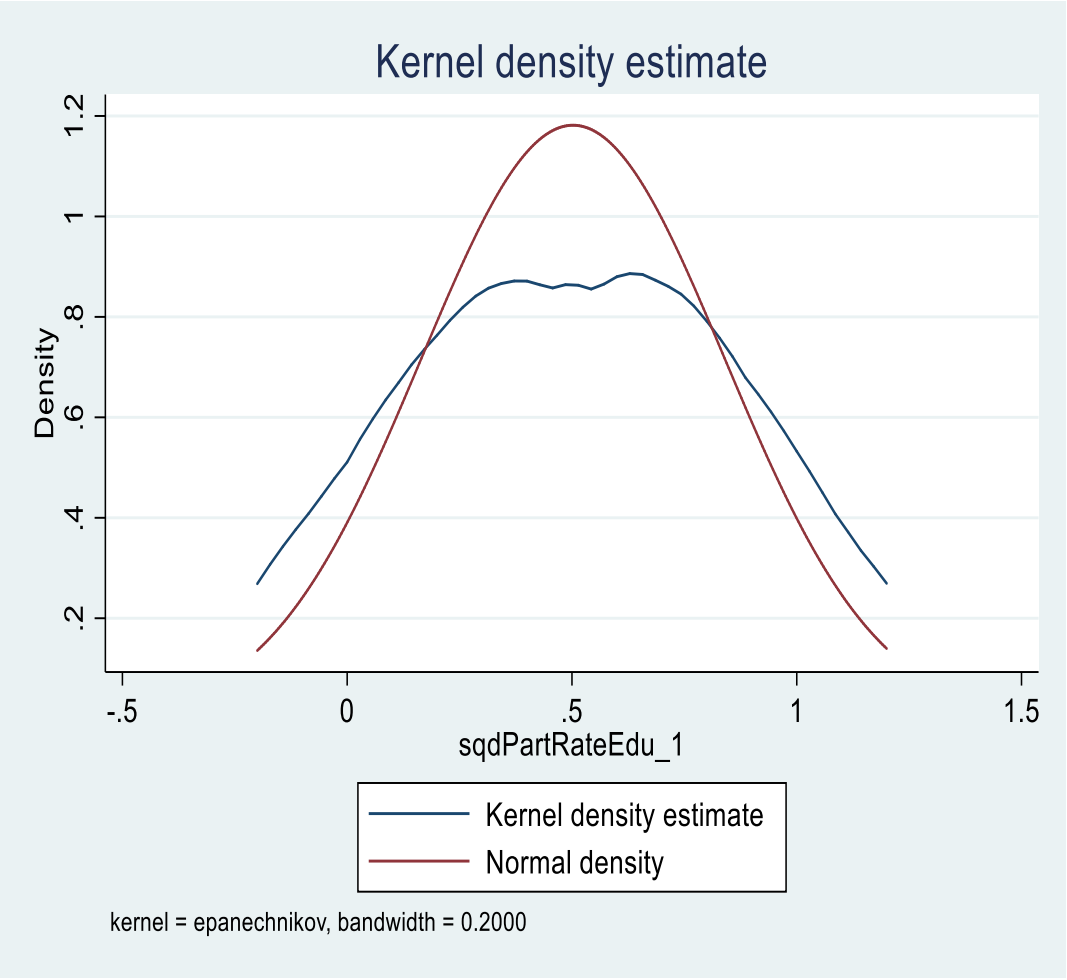

Figure 2: Kernel density estimation - squared education participation rate (*Sources: Survey data December 2015)*

The inputs are regressed and using BETA procedure to transform the coefficients into z-standard units to weigh the importance of each input in education production function. The hypothesis is that socioeconomic inputs do not affect the production of education and therefore the estimate would be 0. The full models are presented in Appendix A, Table 86, and include all the possible socioeconomic and school inputs. The results show that when all the covariates are included the model can explain 46 per cent of education production variation.

The model with all covariates shows that implementing CAMPFIRE programme increases education production by approximately 12 per cent. The importance of CAMPFIRE location is positive and significant. The second important factor is ethnicity and shows that children whose parents are of ethnicities other than Doma are more likely to participate in education. Religion has no effect on the production of education while ownership of goats and poultry contributes significantly. Of the school inputs interrogated, crossing wildlife area to get to

school reduces education production by approximately 11 per cent. If specific location effect is included, Masoka has the highest effect, increase education production by 48 per cent or 0.998 in z-score units.

However, if only variables with significant correlation to education production are included the model explains approximately 16 per cent of the education production or output (Table 2-17).

Table 2-17: Education production model of covariates that are significantly correlated to squared education production

Education Participation Rate	Coeffient	Standard error	t	P>t	Beta
Campfire	0.062	0.029	2.150	**0.032**	0.157
Distance to school	0.000	0.000	1.570	0.118	0.091
Cross river to school	-0.028	0.022	-1.310	0.191	-0.071
Primary fees	0.008	0.003	2.920	**0.004**	0.222
Secondary fees	-0.001	0.000	-2.120	**0.034**	-0.150
Child sex	-0.043	0.018	-2.390	**0.017**	-0.108
Child age	-0.012	0.003	-3.860	**0.000**	-0.189
Cross wildlife area	-0.084	0.022	-3.800	**0.000**	-0.209
Education expenditure 20015	0.001	0.000	3.430	**0.001**	0.183
Number of goats	0.001	0.001	1.740	**0.082**	0.089
Number of poultry	0.005	0.001	3.240	**0.001**	0.160
Employment	0.123	0.041	3.020	**0.003**	0.144
Constant	0.705	0.070	10.060	**0.000**	

Education output: children education participation rate
R-square=0.183, Adjusted R-squared=0.159 n=420
Sources: Survey data December 2015

Table 2-18 shows results for models with varying covariates with normalized education production (squared education production). The results show that if the model includes all variables without standardizing education production the model explains 26 percent of the variation in education output. However, when education production variable is normalised and all variables are included in the model approximately 22 percent of variation is explained. On the other hand, when programme variable (CAMPFIRE) is excluded from the model and the education production is normalized 20 percent of the variation in education output is explained.

Table 2-18: Education production model results

Model parameters	**EduPart**	**squared EduPart**	**squared eduPart**	**square EduPart**
Number of obs	425	425	425	425
F(32, 392)	5.67	6.92	6.43	12.52
Prob > F	0	0	0	0
R-squared	0.3163	0.2637	0.2467	0.183
Adj R-squared	0.2604	0.2213	0.1995	0.159
Root MSE	0.17199	0.24819	0.25071	0.255
variables	**all var.**	**all var.**	**campfire var excl**	**corr. Var**

Sources: Survey data December 2015

Table 2-19 shows the marginal effects of each of the covariates on education production if the model is run for each sub-sample. Results show that school input and socioeconomic inputs are important in the production of education for the treatment group compared to non-treated group.

Table 2-19: Socioeconomic inputs in education production by treatment and control sub-samples

Education Squared participation rate	Treatment		Control	
	Masoka	**Angwa**	**Hambe**	**Majongwe**
	Coeffient	Coeffient	Coeffient	Coeffient
School inputs				
Distance to school	0.000	9.49e-06	1.1e-04	3.68e06
	(2.230)	(5.42e-06)	(1.46e-05)	(8.84e-06)
Primary fees	-	-	-	0.014
				(0.028)
Secondary fees	-	4.9e-04	02.1e-04	4.4e-04
		(0.022)	(0.002)	(0.001)
Cross river	-0.133**	-0.051	0.063	-3.73e-04
	(0.052)	(0.042)	(0.048)	(0.038)
Cross wildlife area	-0.107*	0.004	0.022	-0.034
	(0.056)	(0.034)	(0.151)	(0.038)
Household socioeconomic inputs				
Child sex (Male =1)	-0.016	-0.032	0.003	-0.081*
	(0.042)	(0.028)	(0.032)	(0.038)
Child age	-0.023***	-0.019***	-0.009	-0.007
	(0.007)	(0.005)	(0.005)	(0.007)
Education expenditure 2015	0.003***	0.002**	0.001*	0.001
	(0.001)	(0.001)	(0.0005))	(0.000)
Number of goats	-1.2E-05	0.009**	-2.78e-05	0.001
	(0.004)	(0.003)	(0.003)	(0.001)
Number of poultry	0.005	0.003*	0.004	0.002
	(0.004)	(0.002)	(0.003)	(0.003)
Employment (wildlife)	0.182***	0.036	-	-0.024
	(0.054)	(0.064)		(0.191)
Constant	0.714***	0.910*	0.820***	0.612
	(0.127)	(0.461)	(0.097)	(0.476)
Prob>F	0.000	0.000	0.137	0.033
R-square	0.486	0.300	0.144	0.184
Adjusted R-square	0.43	0.236	0.005	0.094
Observations	93	122	94	111

****** denotes 10% significant level, ** the 5% level and *** the 1% level. Standard errors are given in parentheses.*

Sources: Survey data December 2015

The school input and socioeconomic characteristics significantly explain 43 percent of education production in Masoka and 24 per cent in Angwa. For example, in Masoka crossing a river or wildlife area to get to school reduces education production by 13 per cent and 11 per cent respectively while it has no effect in Angwa and both control groups. Children's age significantly explains variation in school participation rate in Masoka; an increase in children's age by one year reduces school attendance by 0.02. Parents' expenditure and employment increase children's school participation in Masoka. In other wards, these variables do not explain variation in children's participation in education.

2.10 Discussion and conclusion

Results show that the treatment and comparison wards differ in income disposable to communities. CAMPFIRE programme implementing wards have significantly large amounts of community income, above USD40, 000 for Masoka and above USD50, 000 for Angwa per hunting season accruing from the CAMPFIRE programme hunting activities. Non-CAMPFIRE wards have none. The ethnic composition significantly differs between the CAMPFIRE programme implementing and Non-CAMPFIRE wards. There are a significantly larger proportion of minority Doma people in the two CAMPFIRE sample wards. Religion, household and community economics also vary across the sample. With surprisingly Non-CAMPFIRE wards significantly better resourced than CAMPFIRE wards.

Within this context, results show that children participation in education is generally low across the sample for both CAMPFIRE and Non-CAMPFIRE wards. A simple comparison of children participation in education shows no significant difference and likely to send a wrong message about the impact of CAMPFIRE on education production. Sometime scholars use simple comparisons (means) and raise questions about the significance of the programme in rural development. However, using ATET impact assessment procedure shows that if children with similar demographic and socioeconomic characteristic are compared, , children in CAMPFIRE programme implementing wards have a higher participation rate in education than their counterfactual; though there is variation across the matched strata.

Further attempt was made to try to explain variation in school participation within CAMPFIRE programme implementing areas. Using Feasible Generalised Least Squares to estimate interaction of CAMPFIRE with socioeconomic and school inputs, results show that about one-half of the variation in education output or participation is explained. It shows that living in CAMPFIRE area increases education production by approximately 12 per cent compared to similar children living in areas that are not implementing the programme. CAMPFIRE programme has the highest impact in Masoka. However, there are variations within CAMPFIRE communities. , Variation in household resources or accumulated assets explain observed variation in education production.

In contrast in Namibia Riehl, *et al*. (2015) find that the rate of growth in school attendance in Conservancy areas is significantly lower compared to children living outside conservancy areas, 45 per cent less likely to increase. They further concluded that presence of conservancy is causing the lack of improvement in school attendance over time. In agreement with

(Bandyopadhyay and Tembo 2010) they conclude that indirect benefit of community based natural resources management public infrastructure investment has not yet been realised. However, the source of the data they use is not designed to take cognisance of conservancy distribution and different households are used between the two periods they analyse. Results here are slightly different possibly, as the case used for this study has had a long period implementing the programme. Mbire realises relatively higher incomes from hunting activities. It has more specific arrangements to subsidise education: making it less expensive. The other possible source of difference might be that the case studied here is of one district and better performing sub-district administrative units. Including less performing sub-district administrative units may possibly yield different results. Results for this study is similar to findings by Shereni (2020) and Tchakatumba *et al*. (2019) in Zimbabwe based on people's perceptions. People reported benefits from infrastructure investments. However, the point here is that better performing CBNRM programmes improve education output if investments are directed towards public infrastructure

Bandyopadhyay and Tembo (2010) find that living in community based natural resources management areas; Game Management Areas in Zambia has substantial welfare gains though the distribution was skewed. This study also points at the skewed distribution of community based natural resources management gains for children living in CAMPFIRE areas.

The hypothesis was that participation in education for children living in CAMPFIRE programme-implementing areas is equal to or higher than children living in comparison areas. Results show that children living in CAMPFIRE areas participate more in education compared to similar children living in Non-CAMPFIRE areas. The interpretation therefore is that the presence of CAMPFIRE programme is responsible for the increase in school participation rate of children.

In addition, socioeconomic and school inputs have significant influence in the production of education in CAMPFIRE programme implementing areas. Children's sex, age, direct cost of education and household asset ownership such as livestock, are significant inputs with positive influence in the production of education in CAMPFIRE programme implementing areas. In addition, school inputs such as user fees, rivers and wildlife prevalence have negative influence on education production.

The implications of the results are that continued support of the programme, specifically to improve its impact on the less resourced households can yield better results on education production.

3 Chapter 3: The impact of community based wildlife management on rural household adaptive capacity in Mbire district, Zimbabwe

By

Collen Matema[4], Edwin Muchapondwa[5], Jeanette Manjengwa[6]

3.1 Abstract

The paper investigates impact of a community based wildlife management programme in Zimbabwe on household adaptive capacity. Adaptive capacity denotes the ability of a system, such as a household, to adjust, modify or change its characteristics or actions to moderate potential damage, take advantage of opportunities or cope with consequences of shocks or stresses. The paper uses propensity score matching and regression adjustment to estimate programme average treatment effect on the treated/participating households. The paper further uses the linear feasible least squares regression model to decipher impact of other covariates.

Results show that the programme has a positive effect on overall adaptive capacity. However, the programme's effect is negative on social, economic and human capacities while positive on households' transformative or physical capacity. The average social capital index, for example, is 0.011 or 1.1 per cent less when households implement CAMPFIRE programme than average of 0.061 or 6.1 per cent that would obtain if these households were not. The human capital capacity index would be 0.006 less than 0.076, if the households were not implementing the programme. The economic capacity index is 0.008 less when treated than average of 0.068 that would have occurred if the programme-implementing households had not implemented the programme. However, on physical capacity potential outcome is 0.038

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higher than 0.183 if the programme-implementing households had not implemented. On the overall household adaptive capacity index, potential outcome is 0.012 higher than 0.388 that would obtain if the programme-implementing households were not implementing the programme. The results reflect investment trajectory in the area; a higher proportion of income from conservation programme has been invested in public goods provisioning, improving physical capacity of respective households. Lessons from the results are that impacts of investments are visible on components that are directly affected by the investment portfolio configuration. An aggregate figure will not tell the whole story and without reference to the investment configuration, the programme would appear to be less worth.

3.2 Introduction

The paper investigates effects of community based wildlife management programmes on household adaptive capacity using a case study from Zimbabwe. The programme in Zimbabwe, referred to as Communal Area Management Programme for Indigenous Resources (CAMPFIRE), was initiated as a rural development approach; first in marginal areas with high value wildlife and then in communities elsewhere in the country with worthwhile natural resources (Chigonda 2018, Taylor 2009, Murphree 2009). The debate for this paper is whether the programme as a policy instrument enhances different components of adaptive capacity at the household level. Adaptive capacity is the ability of systems such as households and communities, to absorb or withstand shocks, recover and select livelihoods pathways that are more productive under changing environmental, political and economic conditions (Lockwood *et al*. 2015, Jones L. *et al*. 2010a, and Jones L. *et al.* 2010b). The hypothesis is that CAMPFIRE programme creates an enabling environment to allow households and communities to improve different components of Adaptive Capacity (AC), enabling them to improve food security and well-being. In Mbire however, a larger proportion of households are categorised as poor, with between 77 to 89 per cent poverty prevalence (UNICEF 2015). Furthermore, highest poverty prevalence is reportedly in sub-district administrative units that are implementing the CAMPFIRE programme (Jones L. *et al*. 2010a). This has raised questions within academia and policy makers in the country about relevance of the programme to rural development (Mbereko *et al*. 2017). The debate has also been raised across southern Africa and other parts of the world where similar initiatives have been implemented (Hutton *et al.* 2005).

Apart from political and economic marginalization, communities living adjacent to wildlife areas in Southern Africa are more at risk to climate related shocks and stresses. This is largely because the areas experience precarious climate conditions while they are politically and economically weak making them less able to positively respond to negative impact of environmental change (Makina 2010). In addition,

the areas are regarded as fragile environments as the soils are mainly sodic and easily degradable (Jones L. et al 2019, Cummings 1990). The areas were therefore 'delineated' for wildlife production under protected areas management approach (Murphree 2009, Taylor 2009, Hutton *et al*. 2005, Cumming 1990). Literally, the areas received little government development support due to their marginality and perceived low economic potential (Jones 2004). Nonetheless, the areas have been and are home to millions of people, previously with no legal access to wildlife resources. These people experience crop raids by wildlife, livestock predation and attacks as additional shocks to recurrent adverse climate conditions (Macheka *et al.* 2020). In Zimbabwe poor economic performance since the late 1990s, adds to increased vulnerability of these marginal communities (Dekker 2009). The option to implement the communal areas wildlife management programme in Zimbabwe allows such communities to utilise wildlife legally and economically. The aim of this paper aim is to investigate whether the programme increased capacity of the respective communities to deal with climate and economic shocks and stresses. This allows policy makers to understand adaptive capacity components that the programme need to focus on to improve capacities of these at-risk-communities.

CAMPFIRE is not explicitly designed with a focus on adaptation, but like any other development programme, it is likely to influence households' and communities' capacities to adapt to changing shocks and trends (Jones L. *et al*. 2010a, 2010b). Adaptation is increasingly becoming an economic necessity as it allows systems to become sustainable under uncertain environmental (Lockwood *et al.* 2015) and economic conditions (Makina 2010, Dekker 2009, and Clemens 2005). However, there is limited understanding of the impact that community based wildlife resource management systems, such as CAMPFIRE in Zimbabwe, have on household adaptive capacity, or how the programme can be directed to support adaptation among communal people. Governments, non-governmental organisations and other development practitioners should address how they can enhance the capacity of systems/people (Brooks and Adger 2007), and therefore the need to know what matters to people to adapt before they can build people's capacities.

The specific objectives of the paper are to:

(1) Determine the adaptive capacity levels of sample households.
(2) Identify the socio-economic inputs or factors that influence adaptive capacity.
(3) Estimate the CAMPFIRE programme average treatment effect (ATET) on household adaptive capacity, and different components of household adaptive capacity.

The Cobb-Douglas production function is used to estimate production of adaptive capacity of sample households to deal with recurrent shocks and stresses. Treatment effect theory is further used here to understand effect of the CAMPFIRE programme on adaptive capacity. Post-test only group design,

regression adjustment and the Potential Outcome Means model procedures have been used to estimate CAMPFIRE programme treatment effect on participating households.

The paper addresses the following key questions around household adaptive capacity:

(1) What is the adaptive capacity of households in non-CAMPFIRE and CAMPFIRE programme implementing areas?
(2) What are the socio-economic inputs or factors influencing household adaptive capacity?
(3) Does the CAMPFIRE programme influence household adaptive capacity and different adaptive capacity components?

As a latent construct, adaptive capacity cannot be measured directly, and is context specific (Lockwood *et al*. 2015). Some studies identify indicators of adaptive capacity, and generate indicators from the vulnerability and resilience literatures. Indicators are aggregated to produce indices (UN 2018, Aziz 2015, Sietchiping 2008).

This study is guided by public investment theory, which purports that public investment influences production; including private 'household' production (Rajaram *et al.* 2014). The hypothesis is that there is higher household adaptive capacity if households are treated to the CAMPFIRE programme than if they were not. The Theory of Change is that the CAMPFIRE programme allows households and communities to build assets that improve respective households' capacities to positively respond to shocks and stresses they encounter.

The following section discusses literature around shocks and stresses and the economics of adaptation to situate the broader discussion.

3.2.1 Shocks and stresses in Zimbabwe

Shocks and stresses are environmental, political, economic or social conditions that negatively affect systems productivity such as households, communities and countries. Shocks and stresses are external to the production system (Thathsarani & Gunaratne 2017). Zimbabwe experiences a multitude of shocks and stresses such as economic downturn, climate change, droughts and a plethora of human and livestock diseases (Chanza 2018, Clemens & Moss 2005)

Since the early 1990s, Zimbabwe has been grappling with political and economic challenges manifesting in the form of unprecedented hyperinflation, which successively impacted households and individuals negatively (Makina 2010, Clemens & Moss 2005). Makina (2010) refers to the period after 1997 as an economic crisis period. Government decision to redistribute commercial farms was met with global condemnation and trade embargoes. This has seen negative terms of trade forcing major

companies to close increasing the rate of unemployment in the country to record highs. Availability of goods and services in the country plummeted to crisis levels affecting even agricultural production, as inputs were not accessible (Dekker 2015). The negative impact did not spare wildlife producing areas. Previous gains in investments met with supply challenges. However, reports on hunting industry show that business remained high but inflation was the more damaging as wildlife producer communities were getting their share of proceeds from hunting in local currency, affecting investments negatively.

Over and above the political and economic shocks and stresses, Zimbabwe, like most countries in southern Africa and the world also faced climate related shocks and stress in the form of droughts, floods and climate change (Chanza 2018, Unganai 1996). Technically climate change is a statistically significant variation either in the mean state of the climate or in its variability, persisting for an extended period of approximately 35years (Fussel and Klein 2006, Unganai & Kogan 1998, Unganai 1996). Different perceptions over climate change have led to the emergence of several schools of thought. One view is that increase in greenhouse gas emissions by human activities is causing global warming. The warming trend is viewed as reversible if correct measures are taken. Climate change will not manifest itself merely as a gradual change in average conditions, but will be characterised by an increase in the frequency and intensity of extreme events such as droughts and floods (Parry *et al*. 2007). This view has been the most influential; arguing that disaster is eminent if no action is taken.

The other school of thought or view is that the warming trend is a normal phenomenon in the long term, which would happen with or without anthropogenic influence (Intergovernmental Panel on Climate Change - IPCC 2007a&b). A third view is that the atmosphere is too complex to be studied to produce precise information on future climate trends. However, advocates of this view believe in taking action as a precautionary measure (Intergovernmental Panel on Climate Change 2007a&b).

Inspite of the different views there is strong evidence in support of a changing climate. Zimbabwe's mean temperature, for example, has been increasing by 0.8°C since 1933. This translates to a 0.1°C rise in temperature per decade. On the other hand, precipitation has been declining as evidenced by observed national average precipitation from 1900/01 to 1993/94 seasons (Manatsa *et al.* 2010). Driest seasons were experienced in the late 1920s to 1949, late 1950s to 1972 and from 1980 to present (Chanza 2018, Hulme *et al.* 2001, Hulme & Sheard 1999, Unganai 1996, Hulme 1992). On average precipitation has declined 10% over 93 years translating to approximately 1% decline per decade. The trend is expected to continue. With the predicted global climate change having been blamed on human greenhouse gas emissions,

future scenarios for Zimbabwe and southern Africa were developed using General Circulation Models (GCM). Indications are that with the doubling of carbon dioxide gas, which is a major component of greenhouse gas emissions, mean air temperature will increase by 2 to 4°C (Chanza 2018, Unganai 1996, Hulme and Sheard 1999). This raises concern for developing countries such as Zimbabwe which are having problems within the current climate regime and whose economy is agro-based and therefore more vulnerable to any negative trends in climate (Manatsa et *al*. 2010).

Climate change impacts on agriculture have largely been modeled using satellite data and countries located within the tropics, including Zimbabwe, are predicted to be hardest hit (FAO 2019, Tschakert 2007 and Dietz S. *et al*. 2007). ICRISAT, an international research organisation on tropical agriculture, for example, has pegged climate change to cause a decline of between 8-30 per cent in grain productivity. This presents a major blow to the then Millennium Development Goal 1, and current Sustainable Development Goal 1, on reducing extreme poverty. According to Parry *et al*. (2007), climate change is already happening and will continue to happen. This calls for the development of systems that can adapt to the changes to lessen the negative impacts thereof. There is general agreement that improving adaptive capacity require serious investment especially in public infrastructure. This has seen a shift to supporting infrastructure development promulgated by the Sustainable Development Goals (SDGs) development strategy (UN. 2018).

3.2.2 Current perspectives on the adaptation concept

In most marginal areas, access to food is a critical and primary issue. Households struggle to create livelihoods strategies sustainable within their environment that ensures continued access to adequate food (Sullivan 2005). Success in coping and adaptation attempts is varied within and between communities owing to differences in their capacities to deal with stresses and shocks (Cinner *et al.* 2018). Adaptive capacity is the system's coping capacity (Cinner *et al.* 2018, Fazey *et al*. 2007, Turner *et al.* 2003 and Adger 2008) or capacity of response (Gallopin 2006). Turner *et al*. (2003) distinguish capacity to cope or respond from adaptive capacity. They consider both as components of the resilience of a system. As noted by Smit and Wandel (2006), some authors apply ''coping ability'' to shorter-term capacity or the ability to just survive, and use ''adaptive capacity'' for longer-term or more sustainable adjustments. This implies that the adaptive capacity is dynamic. Human systems' components are constantly re-organized in line with changing internal and external conditions (Carpenter *et al.* 2005).

Adaptive capacity therefore is an evolutionary concept that recognizes that fixed stability is unlikely (Cinner *et al.* 2018).

Adaptive and coping capacity (both as capacity of response) are therefore the system's ability to adjust to a disturbance, moderate potential damage, take advantage of opportunities, and cope with the consequences of a transformation that occurs. Recent scholarship prefer to call the whole package resilience (Lockwood et al. 2015). Capacity of response is an attribute of the system that exists prior to political, economic, social or environmental shock or stress. Adaptiveness has been used to mean the status of being adapted. In this view an adaptive trait or an ''adaptation'' becomes a feature of structure, function, or behavior of the system or household and its members that is instrumental or key in securing the adaptiveness (Lockwood *et al.* 2015, Cassidy and Barnes 2012).

At global scale, and in response to climate change, two fundamental strategies, mitigation and adaptation have been proposed (Alberini *et al.* 2006, Fussel and Klein 2006). Mitigation is the process of limiting global climate change through reducing the emission of greenhouse gases and enhancing carbon sinks through maintaining forest areas (Fussel and Klein 2006). On the other hand, adaptation aims at moderating negative effects of climate change through a wide range of system specific actions (Fussel and Klein 2006). Mitigation has received more attention than adaptation from both scientific and policy level as reflected by the work of United Nations Framework Convention on Climate Change (UNFCCC), Kyoto protocol and Intergovernmental Panel on Climate Change (IPCC). The United Nations Framework Convention on Climate Change (UNFCCC)'s ultimate objective, as stated in Article 2, is the stabilization of greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (Parry *et al*. 1997). Facilitating adaptation to climate change is mentioned at a lesser prominent position, although one could argue that the level at which humans' interference become dangerous is in part determined by adaptation activities (Parry *et al.* 1997). The Kyoto Protocol's efforts to limit the quantitative level of greenhouse gas emissions is complemented by less specific provisions to evaluate and facilitate adaptation measures (Parry *et al*. 1997). In addition, the Intergovernmental Panel on Climate Change established by World Meteorological Organization and United Nations Environment Programme (UNEP) has the same predicament. Intergovernmental Panel on Climate Change is mandated to assess peer reviewed literature on climate change and present it in a form that policy makers understand. Intergovernmental Panel on Climate Change is organized into three working groups that focus on different climate change related issues.

Working group1 focuses on the scientific aspects of climate change, Working group 2 assesses the impact of climate change and options for adaptation, while Working group 3 looks at how to limit greenhouse gas concentrations. However, working group3 has been focusing more on climate change impact at the expense of adaptation (Kates & Wilbankd 2003, Kates 1997).

Practitioners and scholars argue that adaptation is more relevant than mitigation at local level, especially in developing countries, and addresses not only climate but also any shocks and stress such as political, economic and social shocks and stresses. Instead of dealing with climate change per se, it is argued that it is worth helping vulnerable communities adapt to current climate variability and future change (Cassidy and Barnes 2012, Huq and Reid 2007). In response to perceived impacts of climate change, there has recently been a shift towards community-based adaptation.

Community-based adaptation is a development concept that recognizes the importance of a bottom-up approach in solving challenges faced by vulnerable communities. Community based adaptations are based on tapping local knowledge to build effective ways of dealing with adverse conditions including climate change.

Adaptation has now emerged as an urgent policy priority, prompting action both within and outside the climate change negotiations (Parry *et al*. 2007). Conventional approaches to understanding climate change were limited to identifying and quantifying the potential long-term climate impacts on different ecosystems and economic sectors. While useful in depicting general trends and dynamic interactions between the atmosphere, biosphere, land, oceans and ice, this top–down, science driven approach failed to address regional and local impacts of climate change, and the local abilities to adapt to climate-induced and other changes. There is value to study the convergence between community-based adaptation and community-based conservation programmes to understand possibilities of improving community preparedness to political, economic, social and environmental shocks and stresses.

The concept of adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to shocks and stresses (Cinner *et al.* 2018, Smit & Wandel 2006). Adaptation needs vary across geographical scales (local, national, regional, global) and temporal scales (coping with current impacts versus preparing for long-term change). Reactive adaptation takes place after the initial impacts of climate change have

occurred. Anticipatory adaptation takes place before impacts become apparent (Cinner *et al.* 2018).

In practical terms, adaptation in motivated by private (individual households and companies) or public interest (government; local or central). Planned adaptation is consequence of deliberate policy decision, based on the awareness that conditions have changed or are expected to change, and that some form of action is required to maintain a desired state. Autonomous adaptation involves changes that systems will undergo in response to changing conditions, such as climate, irrespective of any policy, plan or decision (Cinner *et al.* 2018).

3.3 The economics of adaptation

The concept of adaptation has found its way into almost every sector. It has become a requirement for effective economic development at all developmental scales (Thathsarani and Gunaratne 2017). Adaptation is also recognized as an integral part of most policies in the advent of climate and other changes. Adaptation economists note that assessing adaptation varies from normal economic appraisal as it focuses on risks and uncertainties (Troltzsch *et al.* 2017)

In economic sense, adaptations are behavioural changes and capital investments that are triggered by environmental changes such as political, economic, social and climate change (Mendelsohn 2012, Mendelsohn *et al.* 1996 & 1994). According to economic theory, adaptations are efficient if costs are lower than benefits. At the individual, household, or firm level, adaptations are efficient because the benefits and costs are borne by the decision maker. The change in behaviour or capital commitment to reduce the anticipated harm is part of adaptation. Thus, a set of adaptations that maximize net benefits are referred to as efficient adaptations, where benefits are greater than costs. When the results of an adaptation decision affect only the decision maker such as the household or firm, the actions are referred to as private adaptation. The decisions affect their own welfare. In this case, the decision makers aim to maximize their own welfare and therefore chooses actions or adaptations that make them better (Mendelsohn 2012). The following example from Mendelsohn (2012) demonstrates how affected households and firms make decisions when faced with a shock or stress.

Imagine a utility function (U) that involves goods (X) but also contains climate (C) or any other shock or stress. The individual maximizes utility, subject to a budget constraint determined by some income (Y):

$$\text{Max } U(X, C) \text{ s:t: } Y = PX, \qquad (3.1)$$

where P is a vector of prices. Using Roy's Identity, we can identify a set of demand functions for this individual:

$$X_1 = D_1(P, Y, C), \qquad (3.2)$$

$$X_2 = D_2(P, Y). \qquad (3.3)$$

The change in behavior because of the change, for example climate (C) is the adaptation. When the change makes the household well off, then it is an efficient adaptation. The factors that make the subject able to choose adaptation are the indicators of adaptive capacity (Mendelsohn 2012). However, if the subject does not know that a new set of behaviour, given available resources will make it better off, they may not engage in adaptation. In addition, if the subject does not have the necessary resources to undertake or invest in adaptation, then they may not undertake adaptation. There is therefore the need to invest in specific or relevant assets or resources that have the potential to make households better able to efficiently adapt when necessary (Watkiss 2015). Because the future state of climate is unknown, people will be reluctant to make as much adaptations as they would under perfect information (Mendelsohn 2012). The following section discusses the concept of adaptive capacity.

3.4 Adaptive Capacity Framework

There are different approaches to understand adaptive capacity, the more common one being an asset based approach. An asset based approach views adaptive capacity as a function of ownership of, or access to assets that enhance economic activities in the face of shocks and stresses (Jones L. et *al.* 2010a). Assets allow subjects to invest in adaptation activities. Adaptive capacity therefore represents subjects' potential to adapt, rather than their actual actions of adaptation (Engle 2011). However, Brooks and Adger (2007) extend adaptive capacity to include actions that lead to adaptation and the ability of systems to use resources or assets effectively in pursuit of adaptation. Recent approaches to adaptive capacity have added social capital, innovation, subjects' willingness to adapt and governance issues as additional adaptive capacity components (Jones L. et *al*. 2010, IPCC 2007, Adger 2008). This study assesses adaptive capacity as measured from the asset-based approach with an addition of the social capital component. The study further argue that public investment by CAMPFIRE programme had positive influence on welfare components improving the capacity of the system to adapt to shocks and stresses. While other approaches to adaptive capacity are equally important, they are beyond scope of this study. Adaptive capacity development refers to the process of enhancing adaptive capacity, and is regarded as a key component of adaptation (Avila-Foucat *et al*. 2010, Brooks and Adger 2007).

The asset-based approach view adaptive capacity as comprising of the following components or assets: physical resources, human resources, financial, information and livelihood diversity (Lockwood et *al.* 2015). The approach uses the sustainable livelihoods' five capitals framework; arguing that the more

assets a household or community has, the more capacity they have to withstand, recover from and adapt to changing environmental conditions. However, issues around metric measurement of adaptive capacity are still unresolved, owing to context specificity of the concept (Moreira *et al*. 2019, Warrick *et al*. 2017, Brooks and Adger 2007).

Physical resources or capacities broadly include natural assets such as land and infrastructure. Infrastructure takes the form of built public environment or structures such as roads, health and education facilities (Garcia-Milà & McGuire 2018, IPCC 2007). Access to physical resources indicates the potential that households have in dealing with shocks and stresses. Human resources or capacities are the productive qualities of household members. These include skills that household members have, and the number of physically able household members in the productive age range (Ellis 2000). In addition, (*farming*) experience, education level, literacy, proportion of adults and better health means more skills available to adapt to shocks and stresses that households may encounter. These components are regarded as indicators of adaptive capacity (Lockwood et *al.* 2015).

Individuals or households with higher education levels are regarded as being better able to make informed decisions in adapting to shocks and stresses. Farmers that are more educated have had better access to information and technologies, and are better able to exploit these resources in adapting to shocks and stresses (Lockwood et *al.* 2015). In addition, households that are more literate have better quality labour, with better opportunities to attract higher incomes which can be used to finance adaptation efforts. Hence, such households are regarded as having higher capacity compared to households with fewer literate members (Lockwood et *al.* 2015). Households with more farming experience are also expected to adapt better to climate related shocks as they can draw lessons from the past.

Financial resources are also an indicator of adaptive capacity and represent households' ownership of and access to financial wealth. The assumption is that access to finance makes households better able to finance adaptation and recovery mechanisms to climate and other shocks and stresses (Ellis 2000). Financial resources include the amount of remittances from family members living outside of the community, financial savings (including livestock units in farming communities), and access to credit facilities. In farming communities, livestock are a form of savings as they can easily be liquidated to finance a wide range of activities or to smooth consumption when production is depressed. Henceforth, livestock units are indicative of the amount of financial resources available to farming households to finance adaptation processes (Brooks and Adger 2007).

In addition, having access to information improves decision-making process in the face of shocks and stresses. Information is disseminated through trainings, government extension services and having access to (climate) information in the recent period to enable timeous decision-making and response. Access to information is also represented by having, for example, a functional communication gadget,

broadcast or electronic device, which can be used as a media through which information can be transmitted (Brooks and Adger 2007). At community level, this takes the form of having communication infrastructure that allows individual households' connectivity.

Livelihoods diversity is another key component in adaptive capacity assessment. In farming communities, it takes the form of the number of sources of food or income over the recent period; representing crop, livestock and income diversity. Diversity has an effect of spreading the risk as different diversity components have different sensitivities to different shocks and stresses, and therefore strengthens recovery process and options to adapting to changing conditions (Reardon *et al*. 1988). Faced with shocks or stresses households can therefore select from the wide range of diversity components by picking on less sensitive and more productive livelihood options.

The social capital component describes relations of trust, reciprocity and exchange, evolution of common rules and role of social networks (Jones L. *et al.* 2019, Adger 2006, 2000). In the context of adaptive capacity, social capital is the ability of a society to act collectively when faced with shocks and stresses (Adger *et al*. 2005, 2001). Ability to act collectively is demonstrated by membership in social groups, participation in collective action and reciprocity inside and outside respective communities (IPCC 2007).

In the event of shocks, adaptive capacity components (*assets or resources*) enable households to reduce the magnitude of negative impacts thereof, and allow households to invest in sustainable livelihoods that are responsive to changing environment conditions (Ellis 2000). Better-resourced households are therefore better able to reduce or mitigate negative impacts of shocks and stresses. Because of its community-based approach to development, the CAMPFIRE programme by default is therefore expected to have invested in these critical areas improving the different adaptive capacity components, which make households and communities better able to deal with shocks and stresses. Brooks and Adger (2007) note that adaptation strategies will not be successful unless there is a willingness to adapt among those affected. This means that systems or households may have the capacity or resources necessary for adaptation, but if the capacity is not translated into action or adaptation, the system will not successfully adapt.

3.5 Methodology and research methods

There is not yet universally agreed standard components and measures of adaptive capacity. Adaptive capacity covers a multitude of factors (Selm *et al.* 2018, Asumanu 2017, Vincent 2007). For the purpose of this paper, adaptive capacity shall include selected components shown in Table 3-1 derived from reviewed literature on adaptive capacity, and relevance to the study site, identified during the scoping study period. The components are social capital, livelihoods diversity, human resources (knowledge and skills), and access to infrastructure/physical capital. The selected components are not exhaustive

but form the basis of further studies on adaptive capacity in community based natural resources management areas. Table 3-1 also shows how the household adaptive capacity components are measured for this study, designed in a way that allows comparison among the sample units or households. The approach uses each variable's maximum value in the sample as a highest possible, and compares all other respective units to that value to show the relative capacity. I used equal weighting for each major adaptive capacity component.

Table 3-1: Adaptive capacity components and the respective sub-components

1. **Social capital** (0.25)	2. **Household economic characteristics/ diversity** (0.25)	3. **Human capital /Knowledge and skills** (0.25)	4. **Access to physical capital/ infrastructure** (0.25)
Social capital: **Household share of social capital** $(\boldsymbol{x} = \frac{\boldsymbol{observed\ value\ for\ household\ x}}{\boldsymbol{variable\ maximum\ value}})$ i) Household participation in community organizations ii) Collective action iii) Social support (within) iv) Social support (outside) (0=No 1=Yes)	**Economic activities (0.125)** Household share of economic activities $\boldsymbol{x} = \frac{\boldsymbol{observed\ value\ for\ household\ x}}{\boldsymbol{variable\ maximum\ value}})$ i) Participation in agricultural value chains-crops (0=No 1=Yes) ii) Participation in agricultural value chains-livestock (0=No 1=Yes) iii) Participation in non-agricultural value chain (0=No 1=Yes iv) Salaried agricultural industry (0=No 1=Yes) v) Salaried non- agricultural industry (0=No 1=Yes) vi) Participation in trade (Own formal business) vii) Receive remittances (0=No 1=Yes) viii) Access to credit facilities (0=No 1=Yes) **Household's share of livestock assets (0.125)** $(\boldsymbol{x} = \frac{\boldsymbol{observed\ value\ for\ household\ x}}{\boldsymbol{variable\ maximum\ value}})$ i) Share of cattle ii) Share of donkeys iii) Share of goats iv) Share of poultry	Household share of human capital $\boldsymbol{x} = \frac{\boldsymbol{observed\ value\ for\ household\ x}}{\boldsymbol{variable\ maximum\ value}})$ i) Years of education of household head ii) Highest years of education in household iii) Proportion of adults with primary education (literacy) iv) vocational/skills trainings, number of respective trainings completed by any household member/s	i) Household distance to nearest primary school (0 if +5km, 1 if less than 5km) ii) Household's distance to nearest health facility (0 if +10km, 1 if less than 10km)

Sources: Survey data December 2015

The study uses household survey method to extract data useful for the measurement of adaptive capacity shown in Table 3-1. For this study, I first identified the dimensions of adaptive capacity as suggested in literature that might be of significance to rural communities in the study site, and verified them through group discussions in the study site. I then developed question items and indices constructs that allow empirical measurements of adaptive capacity dimensions at the household level.

Households were randomly selected from the four purposively selected sub-district units, wards. The four wards are in the same district, Mbire and experience roughly the same climate conditions. Two of the wards, Angwa and Masoka have been implementing the CAMPFIRE programme for the past three decades while the other two, Hambe and Majongwe have never implemented the programme. Four hundred and one (401) household heads or their spouses were interviewed and the responses are used to construct the relative adaptive capacity of each sample household.

3.6 Adaptive capacity index construction

Adaptive capacity (AC) varies between 0 and 1 $(0 \leq AC \geq 1)$ Where 0 shows that the household has no capacity to deal with shocks or stresses that it may encounter; while 1 shows that the household has access to resources to deal with challenges that it may encounter. The index for adaptive capacity is calculated using equal weighting approach where each component contributes equally to the final adaptive capacity index (Thathsarani & Gunaratne 2017, Cassidy & Barnes 2012). Of the four broad components shown in Table 3-1, each contributes equally, 0.25 points to the overall adaptive capacity index 1:

$$AC_i = s_i + d_i + h_i + p_i + e_i \qquad (3.4)$$

Where AC_i is the household adaptive capacity,

s = the social capital

d = household diversity representing the different economic activities that the household engages in

h = human capital

p = physical capital or infrastructure and

e = the error term or margin of error

For each sub-component, the index is obtained by calculating the household share of the variable as represented by the variable maximum value within the sample. The assumption is that the highest value for each adaptive capacity indicator within the sample represents the maximum possible, and is used to compare each household adaptive capacity status. The following section shows the respective sub-components of each major adaptive capacity components, and how the value is calculate:

3.6.1 Social capital:

$$s = f(s_1, s_2, s_3, s_4, \ldots) \qquad (3.5)$$

Or in stochastic terms

$$s = s_1 + s_2 + s_3 + s_4 \qquad (3.6)$$

$$s = \sum_{i=1}^{n}\left(\frac{Grp_i}{Var.Max.Value} \times 0.0625\right) + \sum_{i=1}^{n}\left(\frac{CA_i}{Var.Max.Value} \times 0.0625\right) + \sum_{i=1}^{n}\left(\frac{CommSup_i}{Var.Max.Value} \times 0.0625\right) + \sum_{i=1}^{n}\left(\frac{OCommSup_i}{Var.Max.Value} \times 0.0625\right) \qquad (3.7)$$

Where:

s_1 is the household share of group membership (Grp_i)

s_2 is the household share in participation in collective action (CA_i)

s_3 is the household share of community support ($CommSup_i$)

s_4 is the household share of support from outside the community ($OCommSup_i$)

3.6.2 Household diversity index

Household diversity index (d) is calculated from two main components, share of economic activities (EA) and share of livestock assets (LA). Household diversity has a maximum contribution of 0.25 or 25 percentage points to the overall adaptive capacity:

$$d = f(d_1, d_2) \qquad (3.8)$$

Or in stochastic terms

$$d = d_1 + d_2 \qquad (3.9)$$

$$d = \sum_{i=1}^{n}\left(\frac{EA_i}{Var.Max.Value} \times 0.125\right) + \sum_{i=1}^{n}\left(\frac{LA_i}{Var.Max.Value} \times 0.125\right) \qquad (3.10)$$

Where:

d_1 is the household share of economic activities shown in Table 21 (EA_i)

d_2 is the household share of livestock assets such as cattle, goats, poultry and donkeys (LA_i)

3.6.3 Human capital

Human capital for the study is represented by household head's share of education (*Ed*) and household's share of skills (*Sk*).

$$h = f(h_1, h_2) \qquad (3.11)$$

or in stochastic terms

$$h = h_1 +, h_2, \qquad (3.12)$$

$$h = \sum_{i=1}^{n} \left(\frac{Ed_i}{Var.Max.Value} \times 0.125\right) + \sum_{i=1}^{n} \left(\frac{Sk_i}{Var.Max.Value} \times 0.125\right) \qquad (3.13)$$

Where:

h_1 is the household head's share of years of education, which is calculated by expressing the number of completed years of education of head of household as a proportion of the variable maximum value within the sample (Ed_i).

h_2 is the household's share of skills (Sk_i)

3.6.4 Physical capital

Share of physical capital is the proportionate access to public infrastructure, measured by whether the household is within acceptable distance from the public infrastructure. In this study access to education ($EdInfr_i$) and health ($HeInfr_i$) were reported to be important and therefore used to measure the capacity thereof, as follows:

$$p = f(p_1, p_2) \qquad (3.14)$$

Or in stochastic terms

$$p = p_1 + p_2 \qquad (3.15)$$

$$p = \sum_{i=1}^{n} \left(\frac{EdInfr_i}{Var.Max.Value} \times 0.125\right) + \sum_{i=1}^{n} \left(\frac{HeInfr_i}{Var.Max.Value} \times 0.125\right) \qquad (3.16)$$

Where:

p_1 is whether the household is within acceptable distance to the nearest primary school ($EdInfr_i$); within 5km radius.

p_2 is whether the household is within acceptable distance to the nearest health facility ($HeInfr_i$); within 10km radius (PICES 2014).

The variables are dummy variables, taking the value of 1 if within acceptable distance and 0 otherwise.

3.7 CAMPFIRE Treatment Effect on household adaptive capacity

Treatment effect literature attempts to evaluate policy or programme impact or effect on the population of interest. It investigates the average impact of policies or programmes that have partial participation at some point in time were participation is only for a sub-population group (Heckman and Vytlacil 2001). Because of partial treatment, it creates a natural experimental design. Not everyone would be affected by the policy or participating in the programme. This can be manipulated to assess the impact of an intervention or programme on a number of economic parametres. The design has a 'treatment group' that is affected or participating in the programme, and a *comparison* group or *counter-factual* that is not participating. Non-participants act as a control group to see variable level if units/households are not under treatment (Lechner 2015, Heckman and Vytlacil 2001). It can therefore be used to answer how policy or programme induced changes affect specific aspects of adaptive capacity. The estimated response to the variation in observed policy changes can be used to produce internally valid estimators of the impact (Lechner 2015).

Assume:

AC_i^1 is the adaptive capacity outcome that an individual household experiences when it participates in a programme such as CAMPFIRE.

AC_i^0 is the adaptive capacity outcome experienced when an individual household does not participate in the programme

The programme impact would be the difference in outcomes of the adaptive capacity when participating and not participating in the programme. The estimator would be:

$$\alpha = E(AC_i^1 - AC_i^0) \tag{3.17}$$

Where the $E(\cdot)$ is taken across the population of interest.

However, we cannot observe the same household when it does and does not participate. The optimal would be to compare average treatment effect on the treated sample to the non-participating/comparison/counter-factual or control group that is not in the programme as specified below.

Thus one can consider average treatment effect on the treated households, ATET:

$$E(AC_i^1 - AC_i^0 | T_i = 1) \qquad (3.18)$$

Where T_i is a binary indicator of programme impact that equals 1 if a household participates and 0 otherwise. ATET captures the effect of the programme on those who actually participated. If it were possible to observe outcomes for a representative sample of members of N individuals randomly selected from the population of interest, the average treatment effect would be:

$$\frac{1}{N}\sum_{i=1}^{N}(AC_i^1 - AC_i^0) \qquad (3.19)$$

3.8 Household adaptive capacity Post-test only control group design

The paper uses post-test only control group design and consider the impact of the CAMPFIRE programme induced changes on household adaptive capacity. Outcomes are observed after almost three decades of the programme implementation. The population is sorted into treatment and comparison group were the treated are the sub-district administrative units, wards that are implementing the programme, and the comparison group are the wards that are not implementing the programme. The design suits well into experimental design as the households in the two groups largely differ only in terms of programme implementation as the programme targeted wards with high value resident wildlife. The characteristics of the households in implementing and non-implementing wards are assumed the same, for example environmental conditions, ethnicity and economic activities. The treatment and control groups are mutually exclusive and exhaustive. That is, no household belongs to both subgroups and every household belongs either to one or to the other group.

We define our selection variable as follows:

$$T_i = \{1, if\ \ household\ belongs\ to\ an\ implementing\ ward,\ \ and\ 0,\ \ otherwise\} \qquad (3.20)$$

Where *T* indicates the treatment; *i,* is the household from the treatment or comparison population, CAMPFIRE or non-CAMPFIRE wards respectively.

We evaluate whether public investments by the CAMPFIRE programme has an impact on household adaptive capacity.

We therefore observe AC_i and the different components for random samples of size N_1 from CAMPFIRE implementing wards and N_0 from non-CAMPFIRE wards. The estimator is:

$$\hat{\alpha} = \frac{1}{N_1}\sum_{i=1}^{N_1} AC_i - \frac{1}{N_0}\sum_{j=1}^{N_0} AC_j \qquad (3.21)$$

Thus, the programme impact is estimated by the difference of mean outcomes between the treatment and comparison groups after application. The post-test only control group design yield an unbiased estimate of treatment impact (Heckman and Vytlacil 2001; Lechner 2015). The following section discusses the regression adjustment and potential outcome means, treatment effect analysis procedure used to estimate the programme impact on household adaptive capacity.

3.9 Treatment effect analysis framework

Treatment effects are estimated using various procedures such as social experiments, instrumental variables, regression models, matching estimators and stratification. Normal regression compares outcomes between units while treatment inferences compare different treatments if applied to the same units or in other words, what would happen if the units or individuals were under different exposure regimes. Thus, treatment effect estimates the potential outcome, as we cannot observe the same subject under treatment and under control at the same time. Therefore, its predictive inference in the potential outcome framework. Thus estimating treatment effect requires 1. Getting close substitutes to represent the potential outcome, 2. Randomization/experimentation or 3. Some statistical adjustments. Getting close substitutes for example allows inference of potential outcome for subjects under treatment and controls and therefore estimate the treatment effect (Ghosh & Coffman 2015). Randomisation and experimentation allows observed outcomes from a sample to infer about the entire population were close matches are chosen prior to the treatment. The approach is based on the idea that it is difficult to observe the same unit under different treatments so samples of similar units are compared drawn from different treatments. Furthermore, statistical adjustment, such as regression adjustment is useful were similarity between groups is difficulty to get, and were randomisation is not ethical or practical. The following section discusses the propensity score matching and regression adjustment analysis procedures, which are used to test the CAMPFIRE, programme treatment effect on adaptive capacity.

3.9.1 Propensity score matching

Matching is similar to regression; the difference is that instead of fitting missing data for comparison, it matches individuals or units with same covariates. Propensity score matching is a method to reduce bias in estimating treatment effect with observational data. Thus propensity score matching is used to correct for confounding factors. Propensity scores are generated using background characteristics, X_i to get close matches (Austin 2011).

$$\Delta\mu = ATET + SB \qquad (3.22)$$

Where:

$\Delta\mu$ is the propensity score estimate

$ATET$ is the average treatment effect on the treated

SB is the selection bias

Propensity score theory states that the outcome is independent of the treatment given background characteristics:

$$Y_{1i}, Y_{0i} \perp D_i | P(X_i) \qquad (3.23)$$

or

$$AC_{1i}, AC_{0i} \perp\!\!\!\perp D_i \,|\, P(X_i) \qquad (3.24)$$

Where: Y_{1i} outcome when treated, AC_{1i} adaptive capacity if under CAMPFIRE programme

Y_{0i} Outcome if not treated, AC_{0i} adaptive capacity if not under the programme.

D_i Selecting into treatment

Expected causal effect on the treated would therefore take the form:

$$E[Y_{1i} - Y_{0i} | D_i = 1] \qquad (3.25)$$

or using the law of iterated expectation it can be expressed as follows:

$$E[E[Y_{1i} | D_i = 1, P(x_i) - E[Y_{0i} | D_i = 1, P(x_i)]] | D_i = 1 \qquad (3.26)$$

A set of variables were selected using the logistic model to generate propensity scores. The logistic model identifies the variables that are associated with the treatment. These are used to generate propensity scores for each unit or individual household. After the propensity scores are generated they are used to match units across the treatment groups and average outcome of interest can be generated for comparison.

$$ATE \approx \sum_s \mu Y_{1s} - \mu Y_{0s} \qquad (3.27)$$

μY_{1S} Average for treated sample,

μY_{0S} Average for the untreated sample

The treated group, households living in CAMPFIRE area is matched with a non-treated group, households in non-CAMPFIRE area. This yields the outcome if the treated were not treated and conversely outcome if the untreated were treated, while in this case we are interested in the outcome of the treated if they were not treated. The outcome gives us the treatment effect on the treated.

3.9.2 Regression Adjustment and Potential Outcome Means

Regression adjustment represents one of the approaches to estimate treatment effect as pointed out earlier (Ghosh & Coffman 2015). However, the procedure uses linear model to fit missing data for comparison purposes, or estimating the outcome of treated units if they were not treated. By fitting a regression model an estimation of what would have happened to the treated individuals had they not been treated could be achieved. In cases where matching on propensity is difficult or less desirable, regression adjustment procedure is a more reliable option (Myers & Lous 2013). Regression adjustment is the more favoured and efficient option, however if model assumptions are violated it can give biased results (Myers & Lous 2013). In this paper, I chose to use regression adjustment to compare the results with the propensity score matching methods. The central question when using the regression adjustment is to compare the *expected* values of potential outcomes of the individual units given treatments. The causal effect of exposure is thus defined by differences of potential outcomes corresponding to different exposures regimes (Ghosh & Coffman 2015).

The key identifying assumption that facilitates causal inference under this scenario is:

$$E[Y_{0i}|X_i, D_i] = X_i'\beta \qquad (3.28)$$

β is the vector of regression coefficients. From the equation it can be shown that:

$$E\{Y_i(D_i - E[D_i|X_i])\}/E\{D_i(D_i - E[D_i|X_i])\} = \alpha \qquad (3.29)$$

Thus we have the coefficient of D_i derived from the population regression Y_i on D_i and X_i

We therefore adopt the following notation:

i index subjects included in the study; Y_i would therefore denotes the response or outcome for subject i ; Z_i is the exposure or treatment for the subject i; X_i denotes the value of other covariates or conditionals. The hypothetical outcome quantities that represent the possible outcomes under different exposure alternatives or regimes can therefore be denoted by:

$$Y_i(z) \qquad (3.30)$$

This is the hypothetical outcome for the subject i if exposure or treatment is set to z. $Y_i(z)$ is termed counterfactual or the potential outcome (Stephens 2016).

If the exposure is binary, then the potential outcomes

$$\{Y_i\,(1), Y_i\,(0)\} \qquad (3.32)$$

denotes the response or outcome which results for individual subject i if exposed or otherwise respectively. The observed outcome Y_i can be expressed as potential outcomes and observed exposure, Z_i as follows:

$$Y_i = (1 - Z_i)Y_i(0) + Z_i Y_i(1) \qquad (3.33)$$

In cases where exposure has multiple values then the potential outcomes will be denoted by:

$$\{Y_i(z_1), Y_i(z_2) \ldots, Y_i(z_d)\} \qquad (3.34)$$

These are the outcomes if the subject is exposed to different treatment levels or options $z_1, z_2 \ldots z_d$ respectively. The outcome or response Y_i can thus be expressed in terms of potential outcomes (PO) and observed exposure options, Z_i as follows:

$$Y_i = \sum_{j=1}^{d} 1_{zj}\,(Z_i)Y_i(z_j) \qquad (3.35)$$

Where $1_A(Z)$ represents random variable for set A, with $1_A(Z)$ =1 if $Z \epsilon$A, and 0 otherwise.

However, if the exposure is on a continuous scale then the potential outcome takes the following form representing outcomes for individual *i* if the subject is exposed to level z which varies in the set $\mathbb{Z}$:

$$\{Y_i\,(z), z\ \epsilon\ \mathbb{Z}\} \qquad (3.36)$$

Stephens (2016).

But it is not possible to observe more than one potential outcomes for the same subject *i*; this is a big challenge for the treatment effect inference. In a case with binary treatment for example,

$$Y_i(0) \text{ and } Y_i(1) \qquad (3.37)$$

we cannot observe the same subject under different treatments. Hence, regression adjustment inference centres on comparing expected values of different potential outcomes (Stephens 2016, Freeman 2008). Treatment effects are therefore the differences in potential outcomes relative to varying exposure levels. In a binary exposure case, treatment effect would be the difference between potential outcome of the units if treated and potential outcome if the unit were under control group:

$$Y_i(1) \text{ and } Y_i(0) \qquad (3.38)$$

Regression adjustment estimators run separate regressions for the treated and non-treated samples; means of predicted outcomes. Regression adjustment is applicable for randomized controlled experiments. The estimates are calibrated using non-parametric models. Each subject has potential responses to a number of treatments (Freedman 2008). In this case, only one response is observable conditional to the assignment of the subject, as we cannot observe the same subject for the different treatments. Other potential responses or treatment outcomes of the same subject remain unobservable and therefore will be fitted or predicted using the linear regression model.

Covariates are then used to compensate for minor imbalances in the assignment groups (Freeman 2008).

The potential response Y_τ where $T\epsilon\{0, 1, \ldots\ldots, K\}$

The potential responses for binary treatment are denoted by Y_{0i} and Y_{ki} where:

Y_{0i} is the response for subject *i* if the subject did not receive treatment and *i=1 …n*

Y_{ki} is the response of subject *i* if the subject receive treatment, where k=1 …K.

The most common thinking are the scenarios where there are only two levels or binary treatment. There are also cases where there are different levels of treatments or doses of treatments. In this study, I consider a binary treatment level, which suits well under partial policy application, where one group receives treatment, CAMPFIRE programme and the other not.

We consider:

The potential outcome means denoted by:

$$POM = E(Y_T) \qquad (3.39)$$

Average treatment effect denoted by:

$$ATE = E(Y_{1i} - Y_{0i}) \qquad (3.40)$$

Average treatment effect on the treated denoted by:

$$ATET = E(Y_{1i} - Y_{0i}|\mathrm{T} = 1) \qquad (3.41)$$

The response or outcome model would be:

$$y_0 = x\beta_0 + \varepsilon_0 \qquad (3.42)$$

$$y_1 = x\beta_1 + \varepsilon_1 \qquad (3.43)$$

$$y = \tau y_1 + (1 - \tau)y_0 \qquad (3.44)$$

The treatment model takes the form:

$$\tau = \begin{cases} 1 \\ 0 \end{cases} 1\ if\ treated\ and\ 0\ otherwise \qquad (3.45)$$

y_0 and y_1 are not observable; y, x, τ are observed

Random disturbances are independent

The estimators are a combination of outcome model and the treatment model. The complete data consist of outcome, which would obtain if treated and outcome if not treated. If this were the case, simple calculation would yield ATET. However, the observed data has missing data in comparison to the ideal complete data and is nonignorable

In summary the Regression Adjustment (RA) first model the potential response independent of treatment, then a conditional expectation is estimated for the treatment and the counterfactual samples and lastly the produced estimators are used to calculate the Potential Outcome Means (POM) and then the ATE and ATET.

3.9.3 Regression discontinuity

Regression discontinuity dates back to the 1960s as another way of estimating treatment effect (Lee and Lemiaux 2010). The procedure is used here to complement the results from propensity score matching and regression adjustments procedures or models. Regression discontinuity has been used owing to its 'mild assumptions' in comparison to other approaches yet it also produces more credible results (Lee and Lemiaux 2010). The idea behind regression adjustment is that where an intervention selects participants based on some cut off points that would have an effect on the outcome of interest for which the incentive is being offered. The cut-off point creates a dummy that selects the units into to two treatments, those below or outside of the target forming the control and those above or within the target forming the treatment group. The regression adjustment can easily be estimated using regression. In this case if you want to estimate the relationship between X and Y variable assuming they have a linear relationship you run a pure linear regression model. To take account of the discontinuity a dummy variable representing the two sides of the variable is added to the linear model.

$$y = B_0 + B_1 x + B_2 I(x > x_0) + e \qquad (3.46)$$

In the model B_2 is the coefficient of the dummy variable and is therefore taken to be the programme or treatment effect.

3.10 Hypotheses

We hypothesise that the CAMPFIRE programme increases household adaptive capacity significantly higher than *if* the households were not under the programme:

$$\frac{1}{N_1}\sum_{i=1}^{N_1} AC^1 > \frac{1}{N_0}\sum_{i=1}^{N_0} AC^0 | T = 1 \quad (3.47)$$

Where AC^1 is adaptive capacity of households living in CAMPFIRE implementing areas and AC^0 for counterfactual households, living in Non-CAMPFIRE areas. Alternatively

The null hypothesis that CAMPFIRE has an effect on household adaptive capacity can be expressed as:

$$H_0 : \frac{1}{N_1}\sum_{i=1}^{N_1} AC_i^1 | T = 1 - \frac{1}{N_0}\sum_{j=1}^{N_0} AC_i^0 | T = 1 > 0 \quad (3.48)$$

The alternative hypothesis is:

$$H_A : \frac{1}{N_1}\sum_{i=1}^{N_1} AC_i^1 | T = 1 - \frac{1}{N_0}\sum_{j=1}^{N_0} AC_i^0 | T = 1 < 0 \quad (3.49)$$

3.11 Results

This section gives the descriptive statistics of the sample variables used in the analysis. The first part highlights the reported or stated shocks experienced in the area, which subjects struggle to adapt to. The second section reports the status for the different components of, as well as the overall adaptive capacity. The last section discusses the results of the analyses showing the treatment effect of the CAMPFIRE programme on household adaptive capacity.

3.11.1 Descriptive statistics

3.11.1.1 Experiences of shocks and stresses

Results show that Mbire district experiences a number of shocks as shown in Figure 3. The most frequently reported shocks are crop raids by wild animals, dry spells, unemployment and floods respectively. The pattern is the same across the treatment, CAMPFIRE and counterfactual, Non-CAMPFIRE implementing areas. However, CAMPFIRE implementing areas experience more crop raids than non-CAMPFIRE implementing areas. In non-CAMPFIRE areas, dry spells are the most frequently reported shock. There are no significant differences in each shock experience across the treatment and the counter-factual group.

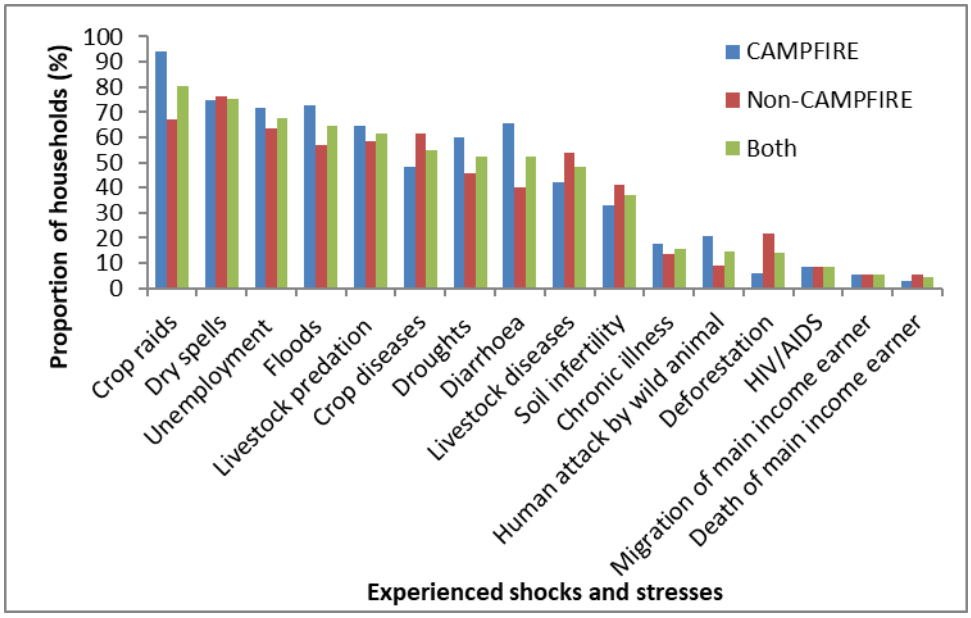

Figure 3: Experienced shocks and stresses (*Sources: Survey data December 2015)*

The shocks were analysed using the relative proportion of shocks that each unit or household reportedly experience. The number of shocks and stresses that households reported is expressed as a proportion of the number of shocks reported by the sample. This gives an indication of the relative vulnerability of the subjects to shocks and stresses:

$$x_i = \left(\frac{Number\ of\ shocks\ experienced\ by\ \ household\ x}{Total\ number\ of\ shocks\ \ reported\ in\ the\ community}\right) X100 \qquad (3.50)$$

Where x_i is the household's relative vulnerability expressed as a proportion of shocks/stresses reported in the sample.

Table 3-2 shows that the treatment group experience a higher share of shocks and/or stresses in the district.

Table 3-2: Mean share of shock experience

CAMPFIRE	mean	min	max	sd
Non-CAMPFIRE	0.37	0.00	0.71	0.16
CAMPFIRE	0.41	0.00	0.71	0.14

Sources: Survey data December 2015

T-test results show that the share of shocks is significantly higher in CAMPFIRE areas than in non-CAMPFIRE areas ($p=0.010$). Thus, households in the programme implementing areas are relatively more vulnerable to shocks and stresses compared to households in non-implementing areas.

The following section discusses the economic capacity of sample households.

3.11.1.2 Economic adaptive capacity

i. Livestock ownership

The sample households have varied levels of livestock ownership. Households owning poultry have on average 5.3 units, followed by goats and sheep (3.9) and cattle at 2.2 units (Table 3-3). Households in CAMPFIRE implementing areas have a more poultry units compared to households in non-CAMPFIRE areas. However, households in CAMPFIRE areas own less livestock units for shoats, cattle and donkeys.

Table 3-3: Livestock ownership by treatment and ward

Ward	*Cattle*	*Donkeys*	*Goats and sheep*	*Poultry*
CAMPFIRE				
Mean	0.43	0.13	3.57	5.42
Min	0	0	0	0
Max	10	6	27	64
Ward 2				
Mean	0.61	0.12	3.07	4.74
Min	0	0	0	0
Max	10	6	20	64
Ward 11				
Mean	0.13	0.14	4.43	6.61
Min	0	0	0	0
Max	2	3	27	32
Non-CAMPFIRE				
Mean	3.97	0.17	4.2	5.19
Min	0	0	0	0
Max	42	5	112	36
Ward 7				
Mean	3.56	0.04	3.24	5.33
Min	0	0	0	0
Max	25	2	25	34
Ward 17				
Mean	4.34	0.28	5.07	5.06
Min	0	0	0	0
Max	42	5	112	36
Full sample				
Mean	2.26	0.15	3.9	5.3
Min	0	0	0	0
Max	42	6	112	64

Sources: Survey data December 2015

An independent t-test was run to determine if there are differences in livestock ownership between CAMPFIRE and Non-CAMPFIRE areas. Cattle ownership was found to be significantly higher in Non-CAMPFIRE areas; 3.97±0.43 compared to CAMPFIRE areas, 0.43±0.11; *p=0.000*. While there are no significant differences in poultry, donkeys and goats and sheep ownership between the two groups.

ii. Share of livestock

Compared to the maximum per capita cattle owned in the selected wards, Non-CAMPFIRE wards have a significantly higher share (Table 3-4), 0.09±0.01) compared to CAMPFIRE implementing households, 0.01±0.002, *p=.000*.

Table 3-4: Share of cattle by ward

Ward	Mean share of cattle	Min	Max
CAMPFIRE	0.007	0	0.24
2	0.010	0	0.24
11	0.003	0	0.05
Non-CAMPFIRE	0.094	0	1.00
7	0.090	0	0.60
17	0.103	0	1.00
Total	0.054	0	1.00

Sources: Survey data December 2015

On the other hand, there are no statistically significant differences in the share of donkeys, shoats and poultry ownership across the wards and between CAMPFIRE and Non-CAMPFIRE wards

In our adaptive capacity model, livestock contributes a maximum of 0.125 points. Table 3-5 shows the mean state of the livestock contribution to adaptive capacity across the treatment and comparison groups. On average, the sample has a capacity below 10 per cent, with Non-CAMPFIRE implementing areas having statistically higher capacity compared to CAMPFIRE areas. However, CAMPFIRE implementing areas have households with the highest livestock adaptive capacity with approximately 59 per cent (0.073) contribution to the livestock component of the adaptive capacity sub-index.

Table 3-5: Mean share of livestock contribution to adaptive capacity by treatment

CAMPFIRE	Mean share of total share of livestock	Standard deviation	Min	Max (0.125)
CAMPFIRE	0.005	0.007	0	0.073
Non-CAMPFIRE	0.008	0.011	0	0.070
Both	0.006	0.009	0	0.073

Sources: Survey data December 2015

Support for the accumulation of livestock assets in the CAMPFIRE programme would potentially boost household adaptive capacity.

3.11.1.3 Livelihoods diversity

Seventeen (17) individual livelihoods activities that are utilised by the sample households. Each of the more diversified households use eleven (11) of the reported livelihoods activities. The value 11 is the maximum possible livelihoods in assessing the share of livelihoods adaptive capacity sub-index. Table 3-6 shows that on average sample households utilise approximately one-half, ~55 per cent of the maximum possible livelihoods activities that a household can potentially utilise.

Table 3-6: Share of livelihoods diversity

Ward	Mean livelihoods diversity	Min	Max	sd
CAMPFIRE	0.540	0.364	1.000	0.116
2	0.538	0.364	1.000	0.119
11	0.543	0.364	0.909	0.111
Non-CAMFIRE	0.551	0.364	0.909	0.123
7	0.554	0.364	0.909	0.123
17	0.549	0.364	0.909	0.124
Total	**0.546**	**0.364**	**1.000**	**0.120**

Sources: Survey data December 2015

Results show that there are no statistically significant differences in livelihoods diversity across the wards, and between treated and non-treated sample households.

For the study, the maximum possible contribution of livelihoods diversity to the livelihoods component of the adaptive capacity is 0.125 or 12.5 per cent. Table 3-7 shows livelihoods diversity contribution to the adaptive capacity index. On average, livelihoods diversity capacity is approximately 55 per cent, i.e. 0.068 of 0.125 maximum contribution possible. There are no statistically significant differences in livelihoods diversity adaptive capacity between the treatment and the counterfactual sub-samples.

Table 3-7: Livelihoods diversity contribution to adaptive capacity index

Ward	Mean contribution	Min	Max (0.125)	SD
CAMPFIRE	0.067	0.045	0.125	0.015
2	0.067	0.045	0.125	0.015
11	0.068	0.045	0.114	0.014
Non-CAMPFIRE	0.069	0.045	0.114	0.015
7	0.069	0.045	0.114	0.015
17	0.069	0.045	0.114	0.015
Total	**0.068**	**0.045**	**0.125**	**0.015**

Sources: Survey data December 2015

The total economic adaptive capacity comprises of livestock and livelihoods diversity components, which together contributes a maximum of 0.25 or one quarter to the overall adaptive capacity index; Table 3-8 shows the sample's economic activity contribution to the overall adaptive capacity by treatment and ward.

Table 3-8: Mean share of total economic activity to adaptive capacity index

Ward	Mean share of total economic activity (0.25)	Min	Max (0.25)	sd
CAMPFIRE	0.072	0.045	0.141	0.017
2	0.071	0.045	0.141	0.018
11	0.073	0.045	0.114	0.015
Non-CAMPFIRE	0.077	0.045	0.170	0.021
7	0.076	0.045	0.131	0.017
17	0.077	0.045	0.170	0.025
Total	**0.074**	**0.045**	**0.170**	**0.020**

Source: Survey data December 2015

Non-CAMPFIRE implementing areas have statistically significant higher economic adaptive capacity, 0.077 ±0.002 (30.60 per cent of 0.25) compared to CAMPFIRE implementing areas, 0.072±0.001 (28.75 per cent of 0.25), *p=0.019*. Figure 4 shows that there are deep deficits in economic adaptive capacity in both treatment and counterfactual group.

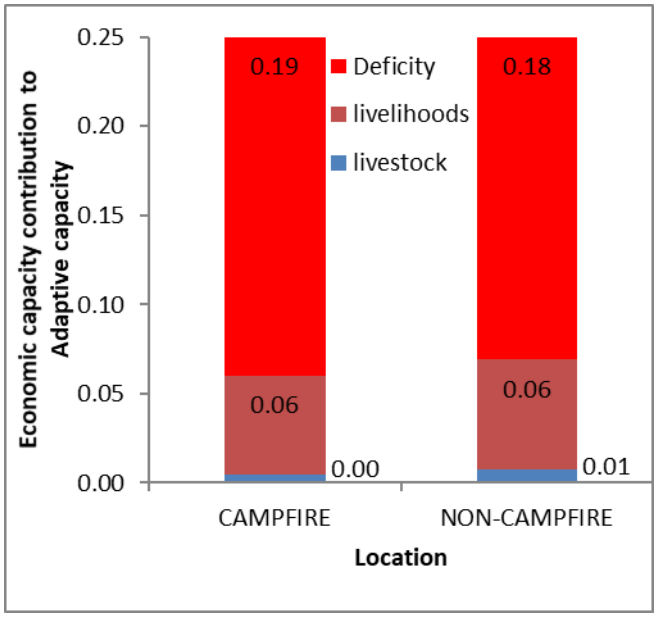

Figure 4: Economic capacity and deficit by treatment (*Sources: Survey data December 2015)*

3.11.1.4 Social capital

Social capital consists of households' participation in social groups, participation in collective action, support from within and outside the community. These components have the potential to improve the ability of households and communities to mobilise resources, and positively respond to shocks and stresses that the households may encounter.

i. Participation in groups

Share of household participation in groups is calculated by comparing the highest number of groups that any household in the sample affiliate to; which in this case is 8. Eight (8) becomes the maximum possible number of social groups a household can participate in. The more the number of groups a household's members are a part, the higher is its relative capacity to deal with shocks and stresses as it can get material, technical or moral support from the group members in case they encounter shocks/stresses.

Table 3-9 shows the mean share of households' participation in social groups across the target wards, and by treatment. The results show that households' participation in groups is low; 8.9 per cent. Ward 17 has the highest share of households' participation in groups while ward 2 has the least.

Table 3-9: Mean share of participation in groups

Ward	Mean share of household participation in social groups	Min	Max	sd
CAMPFIRE	0.051	0	0.625	0.100
2	0.027	0	0.375	0.061
11	0.092	0	0.625	0.134
Non-CAMPFIRE	0.124	0	1.000	0.161
7	0.088	0	0.500	0.122
17	0.156	0	1.000	0.184
Total	**0.089**	**0**	**1.000**	**0.140**

Sources: Survey data December 2015

When analysed across treatment and non-treatment households, non-CAMPFIRE implementing households participate more in social groups. However, there is less variation in the number of groups households participate in within CAMPFIRE implementing wards. Ward 2 has the lowest participation rate. Non-CAMPFIRE sample has significantly higher share of social group participation, 12 (1) per cent compared to CAMPFIRE sample, 5 (0.7) percent, p=.000.

The total maximum contribution of group participation to household adaptive capacity index is 0.0625. Table 3-10 shows that the sample has an average capacity of 0.006 (9 per cent of 0.0625). It shows that there is low adaptive capacity with relation to households' participation in groups.

Table 3-10: Mean group participation contribution to adaptive capacity

Ward	Mean group participation contribution	Min	Max (0.065)	sd
CAMPFIRE	0.003	0	0.039	0.006
2	0.002	0	0.023	0.004
11	0.006	0	0.039	0.008
Non-CAMPFIRE	0.008	0	0.063	0.010
7	0.006	0	0.031	0.008
17	0.010	0	0.063	0.012
Total	**0.006**	**0**	**0.063**	**0.009**

Sources: Survey data December 2015

The Non-CAMPFIRE sample has a significantly higher group participation rate or adaptive capacity sub-index 0.008 (12 per cent of 0.0625) compared to the CAMPFIRE sample, at 0.003 (5 per cent of 0.0625). Indication from the results show that there is possibly a lack of support of social clubs by the programme. Reports show that there had been many activities in the initial stages of the CAMPFIRE programme implementation, probably because there was significant financial support from donors towards social group formation. However, over the years the financial support has reportedly dwindled leading to a steep decline in the number of functional social clubs supported by the programme, and consequently a decline in household participation in social groups.

ii. Collective action

Collective action entails participation of households in community level activities for the benefit of the whole community, such as in maintaining public infrastructure as roads and bridges. In the sample, collective action was centred on schools, clinics, roads and bridge construction and maintenances. Participation in any one of these indicates collectivism. Table 3-11 shows the share of collectivism by ward and treatment.

Table 3-11: Mean share of collective action by ward and treatment

Ward	Mean share of collective action	Min	Max
CAMPFIRE	0.577 (0.495)	0	1
2	0.648 (0.480)	0	1
11	0.458 (0.502)	0	1
Non-CAMPFIRE	0.609 (0.489)	0	1
7	0.500 (0.503)	0	1
17	0.706 (0.458)	0	1
Total	**0.594 (0.492)**	**0**	**1**

Sources: Survey data December 2015

There is no significant difference in the mean share of collective action between households in CAMPFIRE and Non-CAMPFIRE implementing communities, *p=0.257*. Total maximum contribution of collective action to adaptive capacity index is 0.0625. Table 3-12 shows the mean collective action contribution to adaptive capacity by ward and treatment. Collective action contribution to the overall adaptive capacity is relatively higher for non-CAMPFIRE communities. Ward 11 has the least collective action contribution, indicating relatively weak bonding among the respective community members.

Table 3-12: Collective action contribution

Ward	Mean collective action contribution to adaptive capacity index	Min	Max (0.0625)	sd
CAMPFIRE	*0.036*	*0*	*0.0625*	*0.031*
2	0.040	0	0.0625	0.030
11	0.029	0	0.0625	0.031
Non-CAMPFIRE	*0.038*	*0*	*0.0625*	*0.031*
7	0.031	0	0.0625	0.031
17	0.044	0	0.0625	0.029
Full sample	**0.037**	**0**	**0.0625**	**0.031**

Sources: Survey data December 2015

However, there is no significant difference between the treatment and comparison samples in their collective action component contribution to adaptive capacity.

iii. Social support

Social support consists of household support from family or non-family members from both within (community social support) and outside the communities (outside social support). Social support enables community households to respond effectively to shocks and stresses that they may encounter through resource transfer from other households or communities. Social support is some kind of cohesion created within and with outside communities, that allows resource mobilisation in dealing with recurrent challenges.

Four types of social support include family, extended family, non-relative same ethnic group and non-relative different ethnic group. Households that reported the most support got it from three (3) out of the four (4) community social support components. Compared to this maximum possible social support is very low across the sample, with CAMPFIRE areas experiencing the least share of community support 9 (1.00) percent, significantly lower than Non-CAMPFIRE areas, 14 (2.00) percent, *p=.0024*.

Contribution of the community social support to adaptive capacity is pegged at a maximum of 0.0625 and Table 3-13 shows that the contribution is very low across the sample.

Table 3-13: Community social support contribution to adaptive capacity

Ward	Community social support contribution to adaptive capacity	Min	Max (0.0625)	sd
CAMPFIRE	*0.006*	*0*	*0.032*	*0.009*
2	0.004	0	0.021	0.008
11	0.007	0	0.042	0.010
Non-CAMPFIRE	*0.009*	*0*	*0.053*	*0.014*
7	0.008	0	0.042	0.011
17	0.009	0	0.063	0.017
Total	0.007	0	0.063	0.012

Source: Survey data December 2015

There is a significant difference between treatment and counterfactual samples; Non-CAMPFIRE have significantly higher community social support contribution to the adaptive capacity; *p=.001*.

Share of outside social support is significantly different across treatments. CAMPFIRE wards' share of social support from outside of their communities is lower; approximately 9 (1.00) percent compared to Non-CAMPFIRE areas, 13 (2.00) percent.

The contribution of outside social support to the adaptive capacity index is also low. Results show that to the allocated 0.0625 points, it contributes only 0.007 points. None treated sample has higher (0.008) social support compared to 0.005 for treated sample.

Social capital contribution to adaptive capacity index is pegged at 0.25 or 25 percentage points of the overall adaptive capacity index. The social capital component contribution to adaptive capacity for the full sample is 0.06 (or 24 per cent of 0.25 maximum possible). Table 3-14 shows the different social capital components contribution to adaptive capacity by treatment.

Table 3-14: Social capital components contribution to adaptive capacity by treatment

Social capital component	*CAMPFIRE*		*Non-CAMPFIRE*	
	Index (Max. for each component =0.0625)	Proportion (%) of maximum contribution	Index (Max. for each component =0.0625)	Proportion (%) of maximum contribution
Participation in groups	0.003	4.8	0.008	12.8
Collective action	0.036	57.6	0.038	60.8
Within Community support	0.006	9.6	0.009	14.4
Outside social support	0.005	8	0.008	12.8
	Max=0.25		***Max=0.25***	
All	***0.05***	***20***	***0.063***	***25.2***

Sources: Survey data December 2015

CAMPFIRE areas have statistically lower social capital, 0.049±0.002 (20 per cent) compared to Non-CAMPFIRE areas, 0.0627±0.003 (25.2 per cent), *p*=.002. Figure 5 shows that there is a large social capital deficit across the sample; CAMPFIRE communities have a deeper social capital deficit compared to non-CAMPFIRE areas.

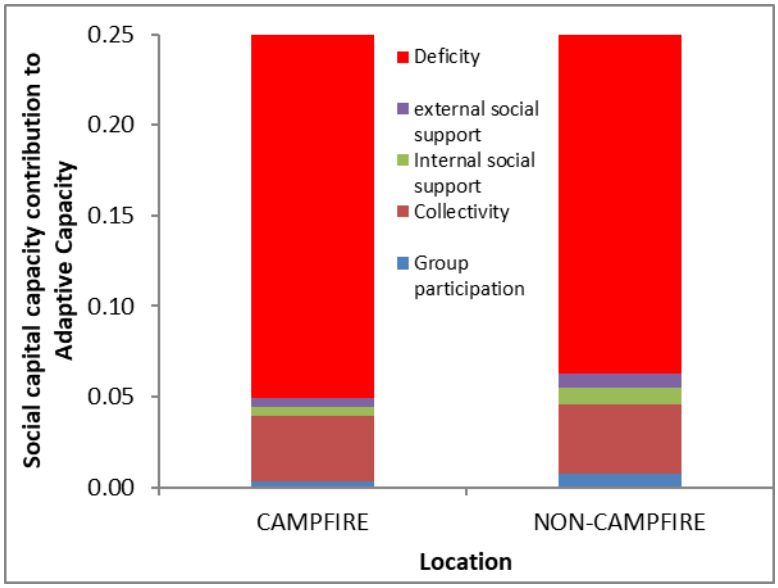

Figure 5: Social capital contribution to adaptive capacity by treatment (*Sources: Survey data December 2015)*

This result is supported by the fact that funding of social clubs stopped in the early 2000s when donor funding stopped (Tchakatumba 2019). Social clubs used to have direct budget support during the early years of the programme and as the economic situation in the country became more and more bleak; the programme budget was not adequate to support anything outside of infrastructure development (Muyengwa 2017). Muyengwa (2017) further reports that elite capture led to a fall in active participation in the programme and any related activities.

3.11.1.5 Human capital

The human capital component contributes up to a maximum of 0.25 to the total adaptive capacity index. Human capital is composed of household head share of education and household members share of skills. Education component contribute 0.125 to the human capital component. Compared to 11 years of education regarded as basic in the country, the CAMPFIRE sample has smaller share of household head years of education, 0.51 compared to Non-CAMPFIRE sample with 0.62, *p=.002*

The most diversified household in the sample was found to have members trained in a maximum of three skills categories, and this is used as the maximum possible. Skills training is generally low across the sample. Less than one-quarter have vocational training and about one-fifth have natural resources management training.

There are no significant differences between the treatment and the counterfactual samples relative to share of skills (Table 3-15).

Table 3-15: Mean share of skills by treatment

Treatment	Mean share of skills	Proportion (%) of maximum contribution/ capacity	Min	Max	sd
CAMPFIRE	0.020	16.32	0	0.125	0.030
Non-CAMFIRE	0.019	15.52	0	0.125	0.031
Total	0.020	15.91	0	0.125	0.031

Sources: Survey data December 2015

Table 3-16 shows the human capital component, combining share of household head education level and trainings received by household members. Non-CAMPFIRE areas have significantly higher share of human capital compared, 0.096 to CAMPFIRE areas, and 0.084. Probably members in non-treated areas self-support in acquiring skills, as they have to meet all their household needs as opposed to treated sample that rely heavily on public income and support from the programme. Human capital component contributes one third in CAMPFIRE areas while it contributes about two fifths in Non-CAMPFIRE areas, out of the maximum 0.25 points it can contribute; *p=0.0232*.

Table 3-16: Mean share of human capital

Treatment	Mean share of human capital	Proportion (%) of maximum contribution/ capacity	Min	Max	sd
CAMPFIRE	0.084	33.6	0	0.25	0.057
Non-CAMFIRE	0.096	38.4	0	0.25	0.061
Total	0.090	36.0	0	0.25	0.059

Sources: Survey data December 2015

Figure 6 shows that CAMPFIRE communities have a larger deficit in human capital capacity.

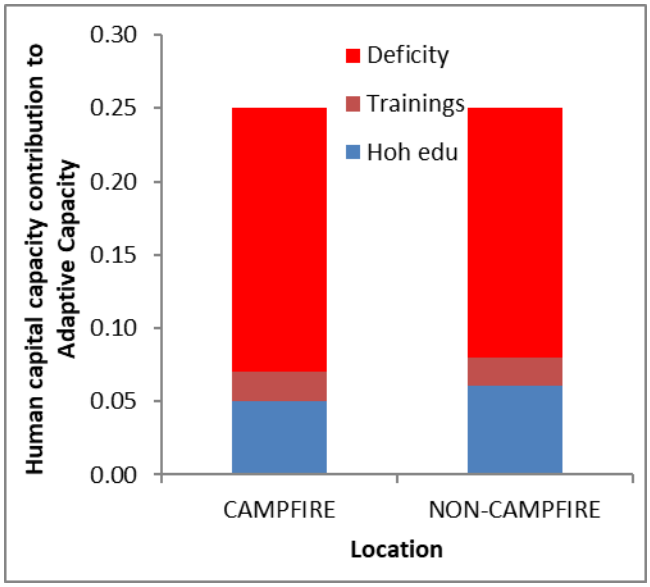

Figure 6: Human Capital index by treatment (*Sources: Survey data December 2015)*

3.11.1.6 Access to public service

Results show that access to education facilities is high across the two sub-samples; about 87 per cent of surveyed households live within the prescribed or standard radius of 5 km to the nearest primary school. On the other hand, CAMPFIRE communities have higher access to health facilities; 99 per cent live within the 10 km prescribed radius compared to 81 per cent for non-CAMPFIRE communities in the sample.

Table 3-17 shows access to education and health combined. The index range from 0-1 with 1 representing a household that has 100 per cent access (capacity) to both or in other words living within 5 km radius from the nearest primary school and within 10 km radius from the nearest health facility.

Table 3-17: Mean share of public service

Ward	Mean share of public service	Min.	Max.	sd
CAMPFIRE	0.928	0	1	0.190
2	0.889	0	1	0.227
11	0.993	0.5	1	0.059
Non-CAMPFIRE	0.845	0	1	0.296
7	0.944	0.5	1	0.159
17	0.757	0	1	0.358
Total	0.885	0	1	0.254

Sources: Survey data December 2015

Access to public service contributes 0.25 points (25 per cent) to the adaptive capacity index, with the sub-components access to education and health contributing 0.125 each. Table 3-18 shows that CAMPFIRE communities on average have a higher capacity or access to public service compared to non-CAMPFIRE communities. CAMPFIRE communities have approximately 93 per cent access level or capacity. The difference is statistically significant, *p=.0005*.

Table 3-18: Public infrastructure service contribution to adaptive capacity

WARD	Mean contribution of share of public service to overall adaptive capacity	Proportion(%) contribution/capacity level (*0.25=100%*)	Min.	Max.	sd
CAMPFIRE	0.232	92.78	0	0.25	0.048
2	0.222	88.93	0	0.25	0.057
11	0.248	99.31	0.125	0.25	0.015
Non-CAMPFIRE	0.211	84.54	0	0.25	0.074
7	0.236	94.39	0.125	0.25	0.040
17	0.189	75.69	0	0.25	0.089
Total	0.221	88.53	0	0.25	0.063

Source: Survey data December 2015

Figure 7 shows that access to public service is high across the sample. CAMPFIRE communities have higher capacity compared to non-CAMPFIRE communities and the deficit is shallow.

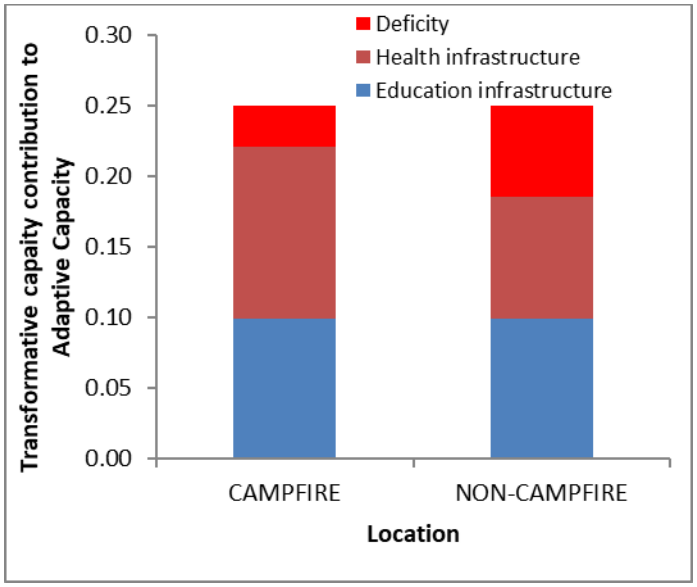

Figure 7: Public service contribution to adaptive capacity (*Sources: Survey data December 2015)*

The different components of adaptive capacity were tested using student's ttest procedure to see if they are significantly different between campfire and non-campfire areas. Only physical capital adaptive capacity component is significantly higher in campfire areas than in non-campfire areas. The rest are significantly lower in campfire areas compared to non-campfire areas (Table 3-19).

Table 3-19: Adaptive capacity components

ttest by campfire	Coef.	Std. Err
Economic capital	-0.010***	0.002
Social capital	-0.013***	0.004
human capital	-0.010*	0.005
Physical capital	0.036***	0.007

Sources: Survey data December 2015

The following section discusses the adaptive capacity of the sample households.

3.11.1.7 Adaptive Capacity Index (ACI)

This section summarises the adaptive capacity of the sample households. The adaptive capacity index is a measure of the level of potential that a household has, shown by a set of selected components, access to public service, human capital, social capital and economic capital. Table 3-20 shows the adaptive capacity index (ACI) of the treatment and control sub-samples.

Table 3-20: Adaptive capacity index by treatment

Ward	Adaptive Capacity Index	Min.	Max.	sd
CAMPFIRE	0.438	0.106	0.727	0.099
2	0.421	0.106	0.637	0.100
11	0.468	0.299	0.727	0.088
Non-CAMPFIRE	0.450	0.137	0.757	0.118
7	0.445	0.183	0.633	0.102
17	0.455	0.137	0.757	0.131
Total	0.444	0.106	0.757	0.109

Sources: Survey data December 2015

The results show that on average the non-CAMPFIRE communities have a higher adaptive capacity than CAMPFIRE communities do. However, there is within group heterogeneity. Within the CAMPFIRE communities, Ward 11 has the highest adaptive capacity compared to all sub-groups while ward 2, which falls within the CAMPFIRE sub-group, has the lowest capacity across all the sub-groups. There are no statistically significant differences in adaptive capacity between CAMPFIRE and Non-CAMPFIRE communities, $p=.427$.

Figure 8 shows the distribution or contribution of each sub-component of the adaptive capacity and the associated deficits to reach the desired or optimum level. For both, the deficit level is above one-half. The largest contribution to adaptive capacity comes from access to public infrastructure or transformative capacity which has an average contribution level of 0.22 points out of the 0.25 highest

possible; 88 per cent. Social capital contributes the least followed by economic capital and human capital respectively.

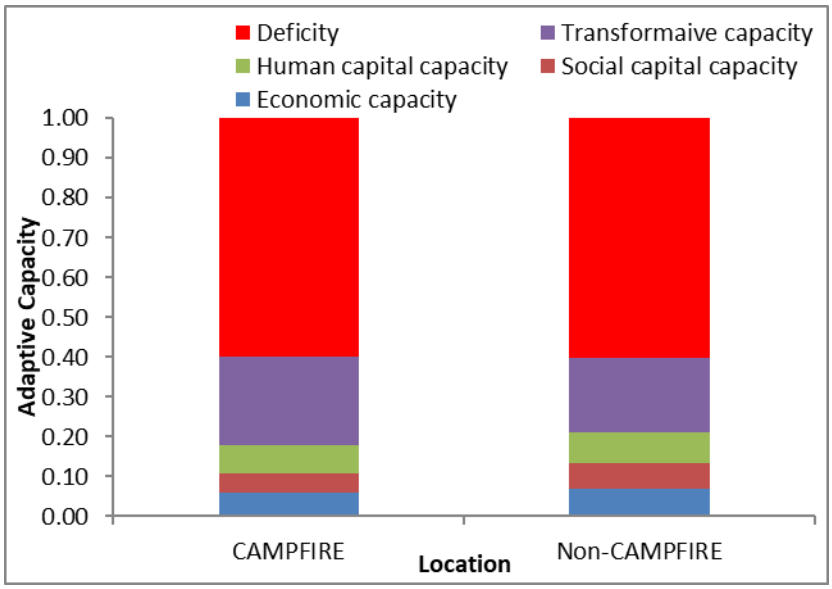

Figure 8: Adaptive capacity components (*Sources: Survey data December 2015)*

Access to public infrastructure in non-CAMPFIRE contribute less (0.19) than in CAMPFIRE communities (0.22) (Figure 9).

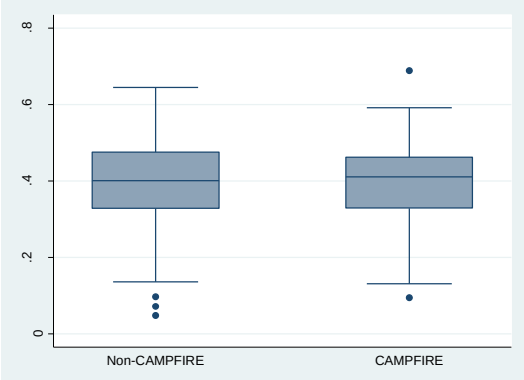

Figure 9: Adaptive Capacity Index by treatment and sub-components (*Sources: Survey data December 2015)*

The following section discusses the results of regression adjustments results showing the treatment effect on adaptive capacity.

3.11.2 CAMPFIRE programme Average Treatment Effect on the Treated (ATET)

Propensity score matching, regression adjustment and potential outcome means and regression discontinuity procedures are used to analyse the effects of the CAMPFIRE programme for each of the

adaptive capacity components. Propensity score matching and regression adjustment analyses were run, controlling for confounding factors or covariates such as household ethnicity, marital status, religion and whether the household has members in urban or outside the country. Results as discussed in the following sub-sections show that the programme effect is negative on social, economic and human capacities while positive for transformative/physical capacity. The programme however, has positive effect on the overall adaptive capacity. The results from propensity score and regression adjustment treatment effect analysis procedures are similar.

3.11.2.1 CAMPFIRE programme effect on average household social capital

i. Results from propensity score matching

To run the propensity scoring the covariates were tested for association with the treatment variable, CAMPFIRE, using logistic regression procedure. Results of the test show that the variable campfire is associated with variables displayed in Table 3-21. The variables were used to estimate propensity scores.

Table 3-21: Test of association with treatment variable: Logistic regression results

campfire	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Traditional	6.382	1.987	5.950	0.000	3.466	11.748
Karanga	0.127	0.073	-3.580	0.000	0.041	0.394
Apostolic	0.427	0.126	-2.890	0.004	0.239	0.761
Widow	0.103	0.055	-4.240	0.000	0.036	0.294
Sex of household head	0.237	0.110	-3.090	0.002	0.095	0.590
Christian gathering	16.654	17.546	2.670	0.008	2.112	131.317
Zezuru	0.399	0.167	-2.190	0.029	0.176	0.908
_cons	3.833	1.856	2.780	0.006	1.484	9.899

Table 3-22 shows that the propensity score is about 33% in non-CAMPFIRE and 65% in CAMPFIRE treatment groups.

Table 3-22: Summary of probability of selecting into campfire programme

campfire	Mean	Std. Dev.	Freq.
Non-CAMPF	0.331	0.222	207
CAMPFIRE	0.647	0.247	194
Total	0.484	0.283	401

Sources: Survey data December 2015

Table 3-23 below shows results of matching sample households in each treatment on the propensity score.

Table 3-23: Matching results

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Diaspora	Unmatched	0.015	0.029	-0.014	0.015	-0.910
	ATT	0.019	0.029	-0.010	0.022	-0.450
Urban	Unmatched	0.206	0.140	0.066	0.038	1.750
	ATT	0.204	0.136	0.068	0.052	1.300
Married	Unmatched	0.840	0.744	0.096	0.040	2.380
	ATT	0.816	0.796	0.019	0.055	0.350
Divorced	Unmatched	0.052	0.039	0.013	0.021	0.620
	ATT	0.039	0.068	-0.029	0.031	-0.930
Never married	Unmatched	0.015	0.014	0.001	0.012	0.080
	ATT	0.029	0.019	0.010	0.022	0.450
Widow	Unmatched	0.093	0.203	-0.110	0.035	-3.120
	ATT	0.117	0.117	0.000	0.045	0.000
Sex of household head	Unmatched	0.814	0.787	0.027	0.040	0.670
	ATT	0.825	0.825	0.000	0.053	0.000
Foreigners	Unmatched	0.072	0.068	0.005	0.026	0.180
	ATT	0.126	0.126	0.000	0.047	0.000
Karanga	Unmatched	0.021	0.155	-0.134	0.028	-4.810
	ATT	0.029	0.029	0.000	0.024	0.000
Korekore	Unmatched	0.665	0.469	0.196	0.049	4.030
	ATT	0.524	0.553	-0.029	0.070	-0.420
Other ethnicity	Unmatched	0.036	0.014	0.022	0.016	1.390
	ATT	0.058	0.019	0.039	0.027	1.440
Zezuru	Unmatched	0.057	0.159	-0.103	0.031	-3.330
	ATT	0.058	0.058	0.000	0.033	0.000
Apostolic	Unmatched	0.149	0.430	-0.280	0.043	-6.460
	ATT	0.262	0.262	0.000	0.062	0.000
Christian gathering	Unmatched	0.072	0.005	0.067	0.019	3.600
	ATT	0.010	0.010	0.000	0.014	0.000
No religion	Unmatched	0.067	0.092	-0.025	0.027	-0.910
	ATT	0.126	0.126	0.000	0.047	0.000
Pentecostal	Unmatched	0.119	0.188	-0.070	0.036	-1.940
	ATT	0.194	0.155	0.039	0.053	0.730
Protestant	Unmatched	0.108	0.126	-0.017	0.032	-0.540
	ATT	0.204	0.146	0.058	0.053	1.100
Roman Catholic	Unmatched	0.015	0.024	-0.009	0.014	-0.620
	ATT	0.029	0.049	-0.019	0.027	-0.720
Traditional	Unmatched	0.469	0.097	0.372	0.041	9.140
	ATT	0.175	0.175	0.000	0.053	0.000

Sources: Survey data December 2015

Using the common support procedure units that had propensity scores that lie outside of the range of the control group were excluded (Table 3-24).

Table 3-24: Common support

psmatch2: Treatment assignment	psmatch2: common support		
	Off support	On support	Total
Untreated	0	207	207
Treated	91	103	194
Total	91	310	401

Sources: Survey data December 2015

Ninety-one (91) households in the campfire treatment group had propensity scores that had values outside of the control group range and therefore could not find matches. Thus, 103 households were used to match with 207 households in the control group, with no replacement.

Using the propensity scores, 5 blocks or strata were generated with the indicated lower bound of each group (Table 3-25). The balancing property for each group is satisfied, and each block has the same mean; in the treatment and control groups, while individual units vary.

Table 3-25: Number of households in each block

Inferior of block pscore	Non-CAMPFIRE	CAMPFIRE	Total
0.045	61	4	65
0.2	66	30	96
0.4	41	42	83
0.6	10	24	34
0.8	15	94	109
Total	193	194	387

Sources: Survey data December 2015

Table 3-26 show the within strata variation for each of the adaptive capacity components and between treatment and counterfactual sub-groups.

Table 3-26: Mean capacities by treatment and counterfactual

	Social capacity		Economic capacity		Human capacity		
	Untreated (non-CAMPFIRE)	Treated (CAMPFIRE)	Non-CAMPFIRE	CAMPFIRE	Non-CAMPFIRE	CAMPFIRE	Non CAM
Blocks	mean	mean	mean	mean	mean	mean	mea
1	0.052	0.067	0.077	0.079	0.080	0.139	0.19
2	0.068	0.046	0.063	0.056	0.068	0.066	0.16
3	0.077	0.050	0.070	0.067	0.109	0.085	0.19
4	0.067	0.056	0.067	0.060	0.065	0.053	0.16
5	0.044	0.048	0.066	0.057	0.064	0.066	0.20
All	0.063	**0.049**	0.069	0.060	0.080	0.070	0.18

Sources: Survey data December 2015

Table 3-27 shows the average treatment effect of the programme on the subjects in the programme implementing areas. The table shows that the programme has significant negative effect on economic capacity and no impact on social and human capacities. Results also show that the programme significantly improves household physical or transformative capacities while it has no impact on the overall household impact.

Table 3-27: Propensity score matching results showing the ATET

Capacity	**Coef.**	**Std. Err.**	**z**	P>z	**[90% Conf. Interval**	
Economic capacity	-0.009	0.003	-2.530	0.011	-0.013	-0.003
Social capital	-0.014	0.006	-0.230	0.818	-0.012	0.009
Human capital	-0.010	0.009	-0.610	0.541	-0.020	0.009
Physical capital	0.038	0.013	2.350	0.019	0.009	0.053
Adaptive capacity	0.004	0.019	0.400	0.689	-0.024	0.039

Sources: Survey data December 2015

Household economic capacity for example drops by 0.009 points if the subject is under the programme while physical capacity significantly improves by 0.038 points.

ii. Results from regression adjustment

Social Capital

Table 3-28 shows the Potential Outcome Means of the social capital component. If none of the households in the sample were not treated to the programme then the expected average social capital capacity would be 0.062. If all households were treated to the programme the expected social capital capacity would be 0.051.

Table 3-28: Social Capital Potential Outcome Means

Social Capital	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
POmeans						
campfire						
Non-CAMPFIRE	0.062	0.004	15.300	0.000	0.054	0.070
CAMPFIRE	0.051	0.003	16.910	0.000	0.045	0.057

Sources: Survey data December 2015

Table 3-29 shows the average amount by which social capital is affected by the decision to implement CAMPFIRE programme.

Table 3-29: CAMPFIRE effect on social capital

Social Capital	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATE campfire (CAMPFIRE vs Non-CAMPFIRE)	-0.011	0.005	-2.170	0.030	-0.021	-0.001
Potential Outcome mean (POmean) campfire Non-CAMPFIRE	0.062	0.004	15.300	0.000	0.054	0.070

Sources: Survey data December 2015

The average social capital if all sample households were under the CAMPFIRE programme would be 0.011 less than the average of 0.062 that would occur if none of the households were under the programme.

Table 3-30 shows the average amount by which social capital of households under the programme are affected by the programme, ATET.

Table 3-30: Average treatment effect of the treatment programme on CAMPFIRE households

Social Capital	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATET campfire (CAMPFIRE vs Non-CAMPFIRE)	-0.011	0.007	-1.690	0.091	-0.024	0.002
Potential Outcome mean (POmean) campfire Non-CAMPFIRE	0.061	0.006	10.090	0.000	0.049	0.072

Sources: Survey data December 2015

The average social capital in this case is 0.011 less for CAMPFIRE households than the average of 0.061 that would have occurred if these households were not implementing the programme. Thus the programme has a negative effect on social capital.

Human capacity

Human capital potential outcome means are lower in the treatment group compared to the counterfactual groups (Table 3-31).

Table 3-31: Potential Outcome Means

Human Capital	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
POmeans campfire						
Non-CAMPFIRE	0.078	0.004	20.350	0.000	0.070	0.085
CAMPFIRE	0.076	0.004	18.410	0.000	0.068	0.084

Table 3-32 indicates the average treatment effect of the programme on household human capital.

Table 3-32: ATE of CAMPFIRE programme on household human capital

Human Capital	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATE						
campfire						
CAMPFIRE vs Non-CAMPFIRE	-0.002	0.005	-0.350	0.723	-0.012	0.009
POmean						
campfire Non-CAMPFIRE	0.078	0.004	20.350	0.000	0.070	0.085

Sources: Survey data December 2015

The average human capital if the full sample were to implement the programme would be 0.002 less than the average of 0.078 that would occur if none of the households were implementing the programme.

Table 3-33 shows the average treatment effect on the treated.

Table 3-33: ATET of CAMPFIRE programme on household human capital

Human Capital	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATET						
campfire						
CAMPFIRE vs Non-CAMPFIRE	-0.006	0.006	-1.020	0.309	-0.018	0.006
POmean						
campfire						
Non-CAMPFIRE	0.076	0.005	14.220	0.000	0.066	0.087

Sources: Survey data December 2015

The CAMPFIRE programme has a negative effect on household human capital; the outcome is less when the households implement the programme than if they do not.

Household economic capacity

The economic capacity potential outcome means are lower in the treatment subgroup compared to the counterfactual group (Table 3-34).

Table 3-34: Household economic capacity Potential outcome means

Economic Capacity	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
POmeans						
campfire						
Non-CAMPFIRE	0.069	0.002	39.160	0.000	0.065	0.072
CAMPFIRE	0.061	0.002	36.290	0.000	0.058	0.065

Table 3-35 shows the average treatment effect of the programme on physical capacity.

Table 3-35: ATE of CAMPFIRE programme on economic capacity

Economic capacity	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATE						
campfire						
CAMPFIRE vs Non-CAMPFIRE	-0.007	0.002	-2.920	0.004	-0.012	-0.002
POmean						
campfire						
Non-CAMPFIRE	0.069	0.002	39.160	0.000	0.065	0.072

Sources: Survey data December 2015

If all households were under the programme they would have less average economic capacity or capital by 0.007, than the average of 0.069 if they were not implementing the programme (Table 3-36).

Table 3-36: Average programme effect on the treated

Economic Capacity	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATET						
campfire						
CAMPFIRE vs Non-CAMPFIRE	-0.008	0.003	-2.810	0.005	-0.013	-0.002
POmean						
campfire						
Non-CAMPFIRE	0.068	0.002	27.860	0.000	0.063	0.072

Sources: Survey data December 2015

The economic capacity is 0.008 less when treated than the average of 0.068 that would have occurred if all households were not under the programme (Table 56).

Physical or transformative capacity

Table 3-37 shows the potential outcome means of household physical capital. Potential outcome for physical capacity is significantly higher for the treated sub-sample.

Table 3-37: Physical capital potential outcome means

Physical Capacity	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
POmeans						
campfire						
Non-CAMPFIRE	0.184	0.008	22.780	0.000	0.168	0.200
CAMPFIRE	0.223	0.005	47.220	0.000	0.213	0.232

Sources: Survey data December 2015

Tables 3-38 and 3-39 shows the average treatment effect and average treatment effect on the treated respectively of the programme on household physical capital. If all households were under the programme the outcome would be 0.039 higher than if they were all not under the programme (Table 3-38).

Table 3-38: Programme average treatment effect on physical capital

Physical Capital capacity	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATE						
campfire						
CAMPFIRE vs Non-CAMPFIRE	0.039	0.009	4.120	0.000	0.020	0.057
POmean						
campfire						
Non-CAMPFIRE	0.184	0.008	22.780	0.000	0.168	0.200

Sources: Survey data December 2015

On the other hand, the potential outcome means for the treated group would be 0.038 higher under treatment than if they were not treated (Table 3-39).

Table 3-39: Programme average treatment effect on the treated on household physical capacity

Physical capacity	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATET						
campfire						
CAMPFIRE vs Non-CAMPFIRE	0.038	0.013	2.960	0.003	0.013	0.064
POmean						
campfire						
Non-CAMPFIRE	0.183	0.012	14.930	0.000	0.159	0.207

Sources: Survey data December 2015

Overall household adaptive capacity

Table 3-40 indicates that potential outcome means for the treated would be higher under treatment than if not treated.

Table 3-40: Household Adaptive Capacity Potential Outcome means

Adaptive Capacity Index	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
POmeans						
campfire						
Non-CAMPFIRE	0.393	0.010	40.82	0	0.374	0.412
CAMPFIRE	0.411	0.009	45.48	0	0.393	0.428

Sources: Survey data December 2015

The potential outcome for non-CAMPFIRE is 0.39 or 39 per cent. That is, if all the sample households were not implementing the programme, the expected household adaptive capacity would be 39 per cent.

The potential Outcome means if all households were implementing the programme would have a value 0.41.

Associated regression equations are on Appendix B, where the coefficients for the equation labelled OME1 is the linear equation used to estimate the treated potential outcome mean, and OME0 estimates the non-treated potential outcome mean.

The average household adaptive capacity if all households were to implement the programme would be 0.018 points more than the average of 0.393 that would occur if none of the households were under the programme or treatment (Table 3-41).

Table 3-41: ATE Adaptive Capacity

Adaptive Capacity Index	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATE						
Campfire						
CAMPFIRE vs Non-CAMPFIRE	0.018	0.013	1.380	0.168	-0.007	0.043
POmean						
campfire						
Non-CAMPFIRE	0.393	0.010	40.820	0.000	0.374	0.412

Sources: Survey data December 2015

The programme increases the average household adaptive capacity by 0.012 points for the households currently implementing the programme than if they were not. However, the difference is not significant (Table 3-42).

Table 3-42: ATET of CAMPFIRE programme on household Adaptive Capacity

Adaptive Capacity Index	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ATET						
campfire						
CAMPFIRE vs Non-CAMPFIRE	0.012	0.016	0.780	0.438	-0.019	0.043
POmean						
campfire						
Non-CAMPFIRE	0.388	0.014	27.250	0.000	0.360	0.415

Sources: Survey data December 2015

3.11.3 Regression discontinuity results

Table 3-43 shows that CAMPFIRE is a significant factor in explaining variation in economic, social and physical capitals variation. A unit change in selection to CAMPFIRE reduces economic and social capital. However, CAMPFIRE treatment significantly increases transformative capacity. Migration of household members increases the economic and human capacities of the respective households. Having

a household member in the diaspora for example increases the economic and human capacities. Meanwhile having a household member in an urban area increases the economic and social capital adaptive capacity components.

Table 3-43: Regression analysis for overall adaptive capacity and adaptive capacity components

Independent variables	Overall adaptive capacity	Economic Capacity	Social Capacity	Human Capacity	Physical/transformative Capacity
Campfire	0.012	-0.007**	-0.017***	-0.005	0.041***
	(0.012)	(0.002)	(0.005)	(0.005)	(0.009)
Member in diaspora	0.081	0.028***	0.020	0.034*	-0.002
	(0.036)	(0.007)	(0.015)	(0.016)	(0.027)
Member in urban	0.037***	0.005*	0.015*	0.010	0.007
	(0.014)	(0.003)	(0.006)	(0.006)	(0.010)
Married	0.029	0.008	0.003	0.017	0.002
	(0.024)	(0.005)	(0.010)	(0.011)	(0.018)
Widow	-0.051*	0.003	-0.008	-0.034**	-0.012
	(0.025)	(0.005)	(0.011)	(0.011)	(0.019)
Household head Sex (Male)	0.016	-0.001	0.003	0.020**	-0.005
	(0.021)	(0.004)	(0.009)	(0.009)	(0.015)
Karanga	0.030	0.011**	-0.013	0.016*	0.016
	(0.018)	(0.004)	(0.009)	(0.008)	(0.013)
Traditional religion	-0.043***	-0.005*	-0.001	-0.024***	-0.01401
	(0.012)	(0.003)	(0.005)	(0.006)	(0.009)
Migration of main income earner	0.011	0.017**	0.016	0.023**	-0.037*
	(0.012)	(0.005)	(0.010)	(0.011)	(0.017)
_cons	0.365***	0.060***	0.059***	0.055***	0.191
	(0.023)	(0.005)	(0.010)	(0.010)	(0.017)
Prob>F	0.000	0.000	0.000	0.000	0.000
R-square	0.177	0.205	0.080	0.330	0.073
Obs	390	393	400	397	400

Sources: Survey data December 2015

3.12 Discussion and conclusion

The paper set outs first to determine the adaptive capacity of the sample households. Results show that households experience a set of shocks and stresses including climate and economic. Areas implementing wildlife programme experience a significantly higher share of shocks and stresses (41% compared to 37%). They also experience additional wildlife related shocks such as crop raids and livestock predation. Household adaptive capacity across the district is generally low (44%). Non-

CAMPFIRE implementing communities have a slightly higher adaptive capacity, 45% compared to 43.8% in CAMPFIRE areas. However, the difference between the overall adaptive capacity of households in CAMPFIRE areas and households in non-CAMPFIRE implementing areas is not significant, p=.427.

Significant differences emerge when analysis goes down to the different adaptive capacity components. The four adaptive capacity components that are analysed in the paper are human capital, economic capital, social capital and physical capital. Physical capital is the only component that is significantly higher in CAMPFIRE implementing communities, 88% compared to 76% for non-CAMPFIRE areas.. From the regression functional form the CAMPFIRE programme implementation significantly increases access to public service such as education and health. The result is particularly important as it reflects the impact of the programme on access to public services resulting from targeted investment in public goods and services. The programme has made investments in public infrastructure that improved the physical capital component of the household adaptive capacity.

On the other hand, the other three components were found to be significantly lower in communities implementing wildlife programmes. Regression results show that the wildlife programme significantly lowers the economic and social capacity components while there seem to be no effect on the human capital component. The result is a reflection of the investment trajectory in most communities implementing wildlife; less than 30 percent of wildlife income has been invested towards livelihoods, human and social capital. Thus, there are important components that CAMPFIRE may need to prioritise. For example, by increasing the level of investment in the other three components, namely livelihoods, human and social capital, might yield improvement in the specific adaptive capacity components.

In conclusion, the government of Zimbabwe initiated the Communal areas management programme for indigenous resources as a rural development instrument. The arrangement allows the engagement of private safari operators by communal people through their local authorities. Safari hunting became an economic driver to generating income, a proportion of which goes to the producer communities. Past assessments show that poverty has remained high (Dzingirai 2015). At the same time, these are areas that experience multiple layers of shocks and stresses including economic, political, social as well as environmental. This study argues that the assessments did not give due attention to what happens to the income that communities generate. Jones (2004) notes that across southern Africa a larger proportion of the generated income is invested in public infrastructure. This is where the answer lies, why poverty has remained persistently high in these marginal areas. The paper therefore sets out to investigate if such an investment configuration has had positive impact on the relevant livelihoods components.

Further interest is how the programme can be a tool to improve household adaptive capacity and related components. This is against a backdrop that adaptation has become an important tool for communities to positively overcome negative impacts caused by shocks and stresses (Brooks and Adger 2007). The

argument is that CBNRM programmes have the potential to improve capacities of communities to deal with recurrent shocks and stresses even though the initial design was targeted at improving wildlife biodiversity and reducing poverty (Taylor 2009, Murphre 2009, Hutton et al. 2005). Brooks and Adger 2007 argue that in building capacities, interventions need to know specific capacities to target; and the CAMPFIRE programme has the potential to do that. Results from this study confirm the need to know what capacities to address. The impact of the programme has not been uniform across the different components of adaptive capacity. This has largely been a result of skewed investment towards public infrastructure development (Jones 204). Results show that the programme has significantly improved physical capacity of the respective communities through access to and consumption of public infrastructure. This demonstrates that governments and interventions can model programmes to address specific adaptive capacity or livelihoods components sustainably. The study supports claims by the public investment theory; that investing in public infrastructure improve the consumption of public goods and services by households (Rajaram et al. 2014). However, in agreement with earlier studies the programme has failed improve other components of adaptive capacity and livelihoods. This is so because implementation on the ground has not put required investments towards other capacity components. The result is also consistent with public investment theory.

There has also been a shift from leaving public infrastructure development to market forces (UN 2018). Over the life span of the Millenum Development Goals very little infrastructure improvement was experienced, leading to rethinking and pushing public investment back to national and local governments (UN 2018). This is supported by results from this study that public investment can only be sustained through public funds, not private sector as they are profit oriented and therefore interested in quick returns. In the context of CBNRM publicly generated income has managed to sustain public infrastructure and physical capacity of the respective households and communities.

The study also shows that CBNRM can play a role in improving adaptation, though depending on the investment configuration. Adaptation has become a requirement for effective economic development (Thathsarani and Gunaratne 2017). CBNRM makes adaptations to be efficient at the individual level as costs are lower than benefits (Mendelsohn 2012). CBNRM allows public infrastructure developments to be funded at community level rather than direct contribution from households.

4 Chapter 4: Determinants and implications of the affect heuristic on subjects in community based wildlife management systems

By

Collen Matema[7], Edwin Muchapondwa[8], Jeanette Manjengwa[9]

4.1 Abstract

The objective of the paper is to explain people's behaviour and stated preferences in communities implementing wildlife programmes. The behaviours such as poaching and revenge killing of wild animals have emerged to be difficult to explain using expected utility theory. This paper argues that heuristic theory from psychology can explain some of the observed or stated human behaviour and stated preferences. The paper aims to determine whether subjects' past encounters with wild animals influence the development of negative feelings/ 'affect'; and whether the negative affect leads subjects (1) to engage in self-reported behaviours such as poaching and killing of wild animals and (2) to state preferences for community based wildlife programmes. Two models are developed; an $encounter \rightarrow affect \rightarrow behaviour$ *model and an* $encounter \rightarrow affect \rightarrow preference$ *model, which are then applied to subjects in Community Based Wildlife Management context in Zimbabwe.. Using both qualitative and survey methodologies subjects were asked to describe their feelings towards wild animals, how they relate especially with dangerous wild animals such as elephants, lions, buffaloes and their past encounters with the respective wild animals.*

Logistic regression results point to encounters with wild animals being statistically significant predictors of negative affect or feelings; which in turn is a key determinant of people engaging inpoaching and killing wild animals in revenge or as a deterrent from destroying fields, livestock, killing or injuring people. On the other hand, expected utility such as perceptions of

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benefit and employment especially in the wildlife industry significantly influence stated preference for wildlife-based programmes; and not negative affect or feelings. The conclusion is that a considerable fraction of decisions by subjects in Community Wildlife-Based programmes can be attributed to heuristics; negative wildlife encounters and associated feelings. Therefore working towards generating positive markers or anchors about wildlife among subjects can increase tolerance of wildlife. Furthermore, improving benefits or perceptions of benefits can increase preferences or willingness to accept wildlife-based programmes by producer communal people.

4.2 Introduction

In southern Africa farmers residing adjacent wildlife areas are confronted with problems of decisions about livelihoods. Wildlife has been pronounced as a critical and attractive economic option for communities in landscapes that have high value wildlife (Taylor 2009, Bandyopadhyay and Tembo 2010, Tembo *et al*. 2009, Murphree 2009, Cumming 1990). The areas have low agriculture potential due to erratic climate conditions and in most cases poor fragile soils Cumming 1990). At the household level, farmers practise dry land cropping which is vulnerable to climate extremes, and to wildlife destruction through crop raids (Harrison 2016). Thus, harvests are barely adequate to sustain them beyond the four months' post-harvest period. Households also practise livestock rearing which is relatively robust compared to cropping but is also vulnerable to predation by wild animals. The scenario logically makes wildlife-based livelihoods a better economic option to include in the livelihoods mix (Murphree 2000, 1994, 1992). Evidence show that wildlife income has improved capital investments in the respective areas though with less household level direct income or livelihoods positive impact (Jones 2004). The scenario presents an optimisation problem for the farmers who need to make decisions on what livelihoods options or mix to pursue, and whether to support wildlife-based programmes in their communities or not. I borrow heuristic theory from psychology. Heuristics are feelings triggered by past encounter, which influence intuitive behaviour (Pachur *et al*. 2012). The argument I put forward is that negative experiences trigger emotions that override the economic attractiveness of wildlife-based livelihoods option. I postulate that emotions contribute to the decision-making process. However, decisions driven by emotions are inconsistent with classical economic optimisation or utility theory, but logical from a heuristic psychological perspective. The hypothesis is that heuristic theory; offer a

useful explanation in understanding some of the human decision-making processes and decision outcomes.

Many optimisation problems in economics cannot be solved with standard preference methods due to discontinuities and the existence of multiple optima. Heuristic optimisation offers a credible solution in such cases (Slovic *et al*. 2004, Tversky and Kahneman 1973). As opposed to exact preference methods, which guarantee to give an optimum solution to problems, heuristic methods attempt to yield at least a good, though not necessarily optimum solution, *satisficing* (Keller *et al*. 2006, Evans 2006). Thus, in practical terms people often resort to heuristic methods to solve real optimization problems (Slovic *et al*. 2004, Grether and Plott 1979). Such cases are more likely to occur in communities implementing wildlife-based programmes where multiple optima exist and sub-optimal options are likely to be chosen; with decisions influenced partly by emotions, *affect*.

I use the affect heuristic mental models or experiential mode of thinking, to explain some of the seemingly inconsistent human behaviour in community based wildlife management regimes. The study helps to understand wildlife beneficiary communities in order to develop strategies that allow support of the development of common mental models that are compatible with sustainable wildlife management. The study uses community based wildlife programme, Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), implemented in Mbire district, Zimbabwe over the past three decades.

The heuristic or experiential mode is intuitive, automatic, natural, and is based upon images to which positive and negative affective feelings have been attached through learning and experience. This is opposed to the economic theory which is analytic, deliberative, and 'reason' based (Slovic *et al*. 2004, Slovic *et al*. 2002). This paper uses heuristic theoretical framework that describes the importance of experiences or *encounters.* The encounters evoke emotions or *affect.* These emotions or affect become readily available in the mind whenever similar encounters are met. The availability is referred to as *availability* heuristics. Such emotional states become reference points or *anchor* in guiding judgments and decisions. *Affect* means the subjective quality of goodness or badness experienced as a feeling state (Costa *et al.* 2017, Pachur *et al*. 2012). *Availability* is the use of readily available exemplars to make decisions concerning the future. The paper hypothesises that subjects in a wildlife landscape are at times guided by feelings generated during wildlife encounters and that their decisions might seem

logically inconsistent but are '*rational*' from a heuristic point of view. The following three hypotheses are tested:

Hypothesis 1. Negative ***encounters*** with wildlife influence negative emotions, ***affect*** towards wild animals

Hypothesis 2. Negative ***affect***, including the associated availability and anchoring heuristics determine Resource Degrading Behaviours that subjects in wildlife areas engage in.

Hypothesis 3. ***Stated Preferences*** of wildlife programmes are in part driven by past negative ***encounters*** with wild animals and generated feelings, ***affect***.

The paper does not demean or denigrate the analytic or expected utility theory, but offers an alternative explanation to economic behaviours that may seem inconsistent with logic and probability theory.

4.3 Analytic-heuristics debate

There are two broad theories of how the mind works; *logic and probability* on the one hand, representing the classical 'economic reasoning', and *heuristics* on the other, which defies the classical economic model. Classical theories in most disciplines such as economics, social science, psychology and philosophy are based on the assumption that people are '*rational*' or 'logical' (Harman 2013, Frank and Goodman 2012, Plott 1987). Since people are regarded as '*rational*' they are expected to act and behave according to the axioms of expected utility theory and reason according to the laws of logic or probability theories (Oaksford and Chater 2007).

Logic is a theory of perfect human reasoning and inference. Logic focuses on truth preservation. Mental logic and associated logic inspired systems view the mind in terms of its ability to solve syllogisms and maintain consistency between beliefs (Johnson-Laird 1983). Logic sees the mind as an intuitive logician (Schulan 2019, Gigerenzer 1991). Thus, from the classical economic view, a decision maker or the economic man is seen as one knowing perfect information and '*rationally*' making choices that bring the most utility. The economic man, *Homo oeconomicus,* is characterised as being motivated by self-interest and capable of making '*rational*' decisions. Economic theory of decision making, expected utility theory, was considered to be the major paradigm in decision making since the 1940s (Schulan 2019, Plous

1993, Schoemaker 1982). The model predicts how people would behave or make decisions if they followed certain axioms of 'rational' decision making. The main axioms of the expected utility theory are:

1) Alternatives order - Rational decision makers should be able to compare any two alternatives
2) Dominance - Rational decision makers do not adopt strategies that are dominated by other strategies
3) Cancellation - Choice between any of two alternatives depends only on outcomes that differ.
4) Transitivity – Consistence in the decision-making process. If Z prefers A to B, and B to C then it logically follows that Z should prefer A to C.
5) Continuity - Rational decision makers should always prefer a gamble between the best and worst outcome to a sure intermediate outcome if the odds of the best outcome are good enough, and
6) Invariance - Rational decision makers should not be affected by the way alternatives are presented (Von Neuman and Morgernstern 1964).

Yet in reality, these axioms seem to be violated with reference to wildlife based programmes.

Probability theory of economic decision making emerged in the mid-17th century, replacing 'logical certainty'. Probability theory came in as a more modest theory of 'rationality'. Probability theory acknowledges the fundamental 'uncertainty' of human conduct (Plous 1993). Unlike the logical theory, probability theory portrays the mind as solving a broader set of goals, performing 'inductive' rather than logical inference. It recognises that subjects to decision-making lack full information and that the information contains errors. Decision makers are therefore make risky bets rather than inferring true consequences from assumptions. Probability theory suggests that the mind is an 'intuitive statistician' (Alder 2020, Gigerenzer 1991), making choices based on the likelihood of future outcomes.

Problem arises when people's choices could not be explained by either logical or probability theories, violating the purported 'rationality' (Lieder *et. al*. 2018). A series of experiments that were conducted suggest that at times people's judgments or decisions systematically violate the laws of logic and probability theories. The deviations from the principles of logic and probability are known as cognitive biases (Lieder *et. al*. 2018). Such decision makers are

considered to be '*irrational, impulsive, unreasonable and passive*' according to the classical economic theory. These problems led researchers to search for alternative explanations when such cases are observed. Psychology (heuristics) became relevant in explaining human behaviour in such cases (, , Parpart *et al*. 2018, Pachur *et al.* 2012, Keller *et al.* 2006, Tversky and Kahneman 1973 & 1982).

Kahneman and Tversky first wrote about heuristics in 1973, directly confronting classical economic models of 'rational' decision-making. Since then, a field of study called '*Behavioural economics*' started to develop. Researchers started to use increasingly cognitive psychological techniques to explain deviations of economic decision making from classical economic theory. Behavioural economics attempt to understand the process of decision-making, and whether the assumptions of utility are good estimates of real behaviour (Parpart *et al*. 2018, Pachur *et al.* 2012, Camerer *et al.* 2004).

An unrealistic assumption about "rational decision maker" or economic theory is that rational actors make their choices in contexts which give them absolute information and details of the present situation, including opportunities and risks about the future (Parpart *et al*. 2018, Pachur *et al.* 2012, Kahneman 2002). Further evidence comes from research on framing and mental accounting. Framing and mental accounting is a process of grouping gains and losses into separate mental accounts that affect how decisions are made (Brendl *et al*. 1998). In mental accounting theory, framing means that the way a person subjectively frames a transaction in the mind, or, the way that a problem is presented, will determine the perception of utility expected (Thaler 1999) and therefore the eventual decision outcome (Parpart *et al*. 2018, Pachur *et al.* 2012).

Further developments reinforced the importance of subjectivity in decision making using the experiential system as the explanation for seemingly '*irrational*' decision making (Thaler 1999). The experiential system is assumed to be intimately associated with the experiences of affect heuristics. Affect refers to subtle feelings of which people are often unaware. For example, when a person responds to an emotionally significant event, the experiential system automatically searches its memory storage for related events, including their emotional associations or accompaniments. If the activated feelings are pleasant, they motivate actions and thoughts anticipated to reproduce the feelings. If the feelings are unpleasant, they motivate actions and thoughts anticipated to avoid the feelings (Ye *et al*. 2018; Pachur *et al*. 2012). The

experiential system is regarded as holistic, pleasure and pain oriented, were behaviour is mediated by feelings from past experiences of events. The mind encodes reality from the past in concrete images, metaphors, and narratives (Pachur *et al*. 2012). In support Bechara *et al.* (2000) argues that thought is made largely from images, broadly construed to include perceptual and symbolic representations. A lifetime of learning leads these images to become "marked" by positive and negative feelings linked directly or indirectly to somatic or bodily states. When a negative somatic marker is linked to an image of a future outcome, it sounds an alarm. When a positive marker is associated with the outcome image, it becomes a beacon of incentive. Bechara *et al.* (2000) hypothesise that somatic markers increase the accuracy and efficiency of the decision process. So, it is about both the frequency of events and how vivid the imprint is on the mind; and therefore how readily the image can be retrieved and used as the anchor for decision making.

Furthermore, behavioural economics literature also shows that when loss aversion is combined with narrow bracketing of decisions, there is a tendency to take decisions one at a time without considering the big picture. Subjects to this view can therefore have contradictions on the same issue depending on the context of the discussion. This is evident in asset returns (Benartzi and Thaler 1997), labour supply (Camerer *et al.* 1997) and the reluctance to sell losing stocks or properties (Odean 2002, 1998, Genesove and Mayer 2001) where the behavioural outcome contradicts 'logic or rationality'. I presume that behaviour on the short term may be triggered by feelings while on the long run will be guided by expected utility or vis-versa which may seem illogical from the classical economic theory.

However close analysis shows that there is a lot of rationality in both the classical economic and heuristic systems, and Seymour renamed rational system "analytic system" to differentiate it from other decision-making systems and revoke the claim that economic theory of rationality is the only 'rational' system (Slovic *et al*. 2004, 2002). Heuristics such as *affect*, *anchoring* and *availability* appear to be 'irrational' because they deviate from the standards of logic and probability which are used to assess rationality. Heuristics are reasonable compromises between error in judgment and the cost of computation, and hence is 'resource-rational'. This departs from the classical economic view that heuristics interfere with reason; but that heuristics are a part of the reasoning process. Furthermore, Bentham (1948) acknowledges that utility originated from an affective base, and that modern economics came to view utility as some dimensionless form of value that would be maximized by anyone obeying a few basic

principles of rational choice such as transitivity. This serves to acknowledge the importance of subjectivity in value judgement and therefore decision making.

The work of Tversky and Kahneman (1973 & 1982) also show the importance of heuristics in decision making. They demonstrate how 'bounded' rational individuals employ heuristics such as availability, representativeness and anchoring to make judgments and how they use simplified strategies such as "elimination by aspects" to make choices. The importance of affect is being recognized increasingly by decision researchers. Epley and Gilovich (2006) for example argue that affective reactions to stimuli are often the very first reactions, occurring automatically and subsequently guiding information processing and judgment. Therefore, affective reactions serve as an orienting mechanism or an anchor, helping subjects to navigate quickly and 'efficiently' through a complex, uncertain, and sometimes dangerous situations (Epley and Gilovich 2006), and is referred to as intuition.

Further work on decision making recognize that experiential or heuristic, analytic and probability modes of thinking are continually active, interacting in what has been characterized as "*the dance of affect and reason*" (Slovic *et al*. 2004, 2002). Evidence suggests that slow analytic processes may compete with fast heuristic processes within contextualized reasoning. From a functional point of view, heuristic and analytic processes often seem to compete for control of behaviour (Thaler 1999). Thus, none of the systems is superior, none is always the best to use in any situation. Each of the systems is rational and combined they become robust in understanding complex decision-making situations and outcomes. In consequence there is not one determinate equilibrium that will obtain; but multiple equilibria mostly occur (Hertwig and Todd 2003). This insight is useful as it corrects several misunderstandings concerning heuristics: for example, that heuristics are always second-best strategies, that they are used only because of cognitive limitations, and that logic or probability is always the best way to solve a problem or come up with a *reasonable* decision.

4.4 Anchor, affect and availability heuristic framework

The availability heuristic is a mental shortcut that helps subjects make decisions based on how easy it is to bring something to mind. Availability-by-recall, a heuristic that exploits people's direct experience of occurrences of risks in their social network, conformed to people's responses best (Pachur *et al.* 2012). For example, one may assess the risk of heart attack among

middle-aged people by recalling such occurrences among one's acquaintances (Tversky and Kahneman, 1974). In 1973, Amos Tversky and Daniel Kahneman first studied this phenomenon and labelled it availability heuristic. In other words, people often rely on how easy it is to think of examples when making a decision or judgment. The heuristic thus assumes that people infer the distal criterion (i.e., event frequency) by exploiting a proximal cue namely, the mental availability of relevant instances (Pachur *et al*. 2012). There are many situations in which the availability heuristic is useful and accurate. For example, it is part of what makes people intuitively careful in dangerous situations (Jacoby *et al.* 1989, Wanke *et al*. 1995). If the subject can think of a similar situation that ended up badly for him/her or someone else, then s/he is more likely to be cautious and better protect him/herself (Tversky and Kahneman 1973). Thus, the availability heuristic relies on immediate examples that come to a subject's mind when evaluating a specific topic, concept, method or coming up with a decision. The availability heuristic operates on the notion that if something can be recalled, it must be important. Subsequently, under the availability heuristic people tend to weigh heavily on their judgments toward more recent information, making new opinions biased toward that latest news or any information that can quickly be recalled such as unpleasant encounters.

The availability of consequences associated with an action is positively related to perceptions of the magnitude of the consequences of that action. In other words, the easier it is to recall the consequences of something the greater those consequences are often perceived to be more likely to occur. One simplifying strategy people may rely on is the tendency to make a judgment about the frequency of an event based on how many similar instances are brought to mind (Tversky and Kahneman 1973).

On the contrary, other studies illustrate that manipulations intended to increase the subjective experience of ease of recall are also likely to affect the amount of recall. What campaigns and advertisement manipulate to get support, behaviour change and market dominance (Tversky and Kahneman 1973). Furthermore, this makes it difficult to determine if the obtained estimates of frequency, likelihood, or typicality are based on participants' phenomenal experiences or on a biased sample of recalled information. Tversky and Kahneman suggest that availability provides a natural account for the illusory-correlation effect. The strength of the association between two events could provide the basis for the judgment of how frequently the two events co-occur.

Tversky and Kahneman concluded that people answer questions like these by comparing the availability of the two categories and assessing how easily they can recall these instances. For example, repeated exposure to vivid violence leads to an increase in people's risk estimates about the prevalence say of crime and violence in the real world which subsequently affect their decision making.

Affect heuristics on the other hand are the type of feelings that are evoked with reference to something. It is closely linked to availability heuristic in that the most readily available are those that are linked strongly to emotions of pain first and pleasure at the second level (Evans 2006). People vividly remember events that have some strong emotional accompaniment which have vivid mental images or markers making them readily available in the mind. Thus, affect and availability are inextricably bound with affect, triggering the availability of cues. Remembered images are associated with *affect* (Evans 2006).

4.5 Empirical support for the heuristic theory

Whereas risk and benefit tend to be positively correlated in the world, they are demonstrably negatively correlated in people's minds and judgments. One study by Alhakami and Slovic (1994) finds that the inverse relationship between perceived risk and perceived benefit of an activity is linked to the strength of positive or negative affect associated with that activity. This result shows that people base their judgments of an activity, concept or technology not only on what they think about it but also on what they feel about it. If they like an activity, they are moved toward judging the risks as low and the benefits as high. If they dislike it, they tend to judge it as high risk and low benefit. According to this model, *affect* was demonstrated to come prior to, and directs judgments of risk and benefit (Alhakami and Slovic 1994). The conclusion is that if affective view guides perceptions of risk and benefit, providing information about benefit should change perception of risk and vice versa. For example, information stating that benefit is high for a technology such as nuclear power would lead to more positive overall *affect*, which would, in turn decrease perceived risk and the likely adoption of nuclear power usage (Alhakami and Slovic 1994).

In another study Finucane *et al*. (2000) conducted an experiment, providing four different kinds of information designed to manipulate affect by increasing or decreasing perceived benefit or by increasing or decreasing perceived risk for some three technologies. The predictions were

confirmed. Because by design there was no apparent logical relationship between the information provided and the non-manipulated variable, these data support the theory that risk and benefit judgments are influenced, at least in part, by the overall *affective* evaluation, which was influenced by the information provided. A second experiment by Finucane *et al*. (2000) finds that the inverse relationship between perceived risks and benefits increase greatly under time pressure, when opportunity for analytic deliberation was reduced. These two experiments demonstrate that *affect* influences judgment directly and is not simply a response to a prior analytic evaluation.

In another, the study sought to analyse the role of the availability heuristic in financial markets. The researchers defined and tested two aspects of the availability heuristic; outcome and risk availability. Outcome availability test looked at availability of positive and negative investment outcomes, while risk availability focused on availability of financial risk. On days of substantial stock market moves, abnormal stock price reactions to upgrades were observed to be weaker, than those to downgrades (Lee *et al*. 2008). These availability effects were shown to be significant even after controlling for event-specific and company-specific factors.

Similarly, research has pointed out that under the availability heuristic, humans are not reliable because they assess probabilities by giving more weight to current or easily recalled information instead of processing all relevant information. Since information regarding the current state of the economy is readily available, in one study researchers attempted to expose the properties of business cycles to predict the availability bias in analysts' growth forecasts. They show that the availability heuristic does play a role in analysis of forecasts and influence investments because of this (Lee *et al*., 2008).

Further work by Dreman *et al*., 2010 also shows that in effect, investors use availability heuristic to make decisions, and subsequently, '*may be obstructing their own investment success'*. It was shown that an investor's lingering perceptions of a terrible market environment may cause them to view investment opportunities through an exaggeratedly negative lens, making it less appealing to consider taking on investment risk. To illustrate, Franklin Templeton's annual Global Investor Sentiment Survey in the US asked individuals how they believed the SandP 500 Index performed in 2009, 2010 and 2011. Approximately 66 per cent of respondents stated that they believed the market was either flat or down in 2009, 48 percent said the same about 2010 and 53 percent also said the same about 2011. In reality, the SandP 500 saw 26.5 percent annual returns in 2009, 15.1 percent annual returns in 2010 and 2.1

percent annual returns in 2011, meaning lingering perceptions based on dramatic, painful events were impacting decision-making even when those events are over (Dreman *et al*., 2010).

Another factor that affects the availability heuristic in frequency and probability is exemplars. Exemplars are the typical examples that stand out during the process of recall. One example of the availability heuristic and exemplars is a study that showed that seeing a shark in the ocean has greater impact on the observers' memories than seeing a dolphin (Dreman *et al*., 2010). It was shown that if people see both sharks and dolphins in the ocean, they will be less aware of seeing the dolphins, because the dolphins had less impact on their memory. Due to the greater impact of seeing a shark, the availability heuristic can influence the probability judgement of the ratio of sharks and dolphins in the water.

Another example from the investment behaviour is the simple heuristic 1/N rule. It states that investors should allocate their money equally to N investment windows and results show that there is considerable empirical evidence for this heuristic. Approximately one half of people studied intuitively rely on this simple heuristic, and most consider only three or four funds to invest in, though criticised as 'unreasonable' by behavioural finance. One study compared the results of 12 optimal asset allocation policies with the results of the 1/N rule in seven allocation problems, such as allocating one's money to 10 American industry portfolios. The 12 policies included Bayesian and non-Bayesian models of optimal choice. Despite their complexity, none of the 12 policies could beat the 1/N heuristic on various financial measures (DeMiguel, Garlappi and Uppal 2006).

This raised the question about how a heuristic strategy can be better than an optimizing one. Results from a number of studies show that the optimization models performed better at data fitting, adjusting their parameters to the data of the past 10 or so years, than the simple heuristic did, but they performed worse at predicting the future (DeMiguel, Garlappi and Uppal 2006). Thus, they over fitted the past data. In contrast, the 1/N heuristic, which does not estimate any parameter, cannot over fit. Thus at issue is not computational intractability, but robustness. Note that 1/N is not generally superior to optimization or vice versa. The important question of when, in fact, it does better predict the future can be answered by studying the ecological rationality of a heuristic. Three relevant environmental features for the performance of 1/N are known: the predictive uncertainty of the problem, the number (N) of assets, and the size of the learning sample (DeMiguel, Garlappi and Uppal 2006).

Slovic *et al*. (2002) tested the limits of probability dominance heuristic by asking one group of subjects to rate the attractiveness of a simple gamble (7/36, win $9) on a 0–20 scale and asking a second group to rate a similar gamble with a small loss (7/36, win $9; 29/36, lose 5/c) on the same scale. The data were anomalous from the perspective of economic theory, but expected from the perspective of the affect heuristic. The mean response to the first gamble was 9.4. When a loss of 5/c was added, the mean attractiveness jumped to 14.9 and there was almost no overlap between the distribution of responses around this mean and the responses for the group judging the gamble that had no loss.

Just as good as reliance on economic theory can fail, *affect* can also mislead decision makers, if it was always optimal to follow our affective and experiential instincts, there would have been no need for the rational/analytic system of thinking to have evolved and become so prominent in human affairs. There are two important ways that experiential thinking can misguide subjects. One results from the deliberate manipulation of *affective* reactions by those who wish to control human behaviours as shown by advertising and marketing. The other results from the natural limitations of the experiential system and the existence of stimuli in the environment that are not amenable to valid *affective* representation (Lau and Redlawsk 2001).

4.6 Logistic Regression Models specification

The objective is to determine which predictor variables are statistically significant in explaining variation in feelings (***affect***) that subjects have towards wild animals, and whether ***affect*** is a valid predictor of subjects' behaviour (***resource_degrading_behaviour***) towards wildlife.

Because the response variables are dummy the logistic regression procedure was chosen to test the hypotheses that past encounters influence feelings developed towards wild animals, and that the feelings in turn influence the type of behaviour that subjects develop in relation to wild animals. The logistic regression or logit model is linear in the log. odds of the explained or dependent dummy variable (Equation 4.1).

$$\text{In}\left(\frac{Pr(Y=1|X)}{Pr(Y=0|X)}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 \qquad (4.1)$$

It is also common to interpret the results either by exponentiating co-efficients to yield odds ratios, or computing predicted probabilities. If an odds ratio is greater than one that means an increase in predictor variable X leads to an increase in the odds that the dependent variable equals one; an odds ratio less than one means that the odds of the dependent variable taking the value 1 are decreasing with an increase of the predictor variable X. The predicted probabilities can be calculated using the formula for the cdf to the standard logistic distribution:

$$Pr(Y = 1) = \frac{exp(\alpha+\beta_1 X_1+\beta_2 X_2)}{1+exp(\alpha+\beta_1 X_1+\beta_2 X_2)} \qquad (4.2)$$

The logistic regression is run first for ***affect*** variable as the dependent variable, with the variable ***encounter*** as the main predictor.

$$\text{In}\left(\frac{Pr(A=1|X)}{Pr(A=0|X)}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 \qquad (4.3)$$

$$Pr(A = 1) = \frac{exp(\alpha+\beta_1 X_1+\beta_2 X_2)}{1+exp(\alpha+\beta_1 X_1+\beta_2 X_2)} \qquad (4.4)$$

Where A is the dependent variable ***affect*** and X_1 represents the predictor variable encounter and X_2 other confounding factors or disturbances.

The second model had ***resource_degrading_behaviour*** as the dependent variable with ***affect*** as the main predictor variable X_1.

$$\text{In}\left(\frac{Pr(RDB=1|X)}{Pr(RDB=0|X)}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 \qquad (4.5)$$

$$Pr(RDB = 1) = \frac{exp(\alpha+\beta_1 X_1+\beta_2 X_2)}{1+exp(\alpha+\beta_1 X_1+\beta_2 X_2)} \qquad (4.6)$$

Where *RDB* is the resource degrading behaviour

We include more explanatory or predictor variables in each model to avoid a biased assessment of the impact of the main explanatory variable as a consequence of omitting other explanatory variables that are related to it. The variables are dummy ***education level, sex, marital status*** of the participant and continuous predictor variables ***household size*** and ***livestock units*** of sample households. In addition, another factor that is included is whether the participant resides in an area implementing community based wildlife management; CAMPFIRE, as a control variable

for expected utility. The assumption is that expected utility, CAMPFIRE will not be a significant predictor of ***affect*** for participants' wildlife resource related behaviour. This is against the implicit generalised view that subjects from CAMPFIRE areas would be more tolerant of wild animals as they realise a wide range of benefits from the programme. They are less likely to develop negative feelings towards wild animals as a result of negative encounters. Furthermore are less likely to end up engaging in resource degrading behaviours such as poaching and revenge killing. The assumption is that as long as negative encounters are allowed to happen, people's emotions will be evoked and will promote resource degrading behaviour rather than expected utility. This may not reflect stated programme preference which might be based on expected utility.

Hypotheses

We hypothesise that:

$$\boldsymbol{encounter \rightarrow affect \rightarrow preference}$$

$$\boldsymbol{expected\ utility \rightarrow preference}$$

$$\boldsymbol{encounter \rightarrow affect \rightarrow behaviour}$$

(1) encounters with wild animals trigger *emotions (negative affect)* and that the coefficient will be greater than 0
(2) the emotions become the more *available features* and therefore the main determinant of behaviours towards wild animals that will be assumed by subjects.
(3) Negative affect significantly determines wildlife programmes preference by subjects
(4) Perceptions of benefit does not influence people's stated preferences

Thus, the expectation is that the co-efficiencies of the socioeconomic characteristics to be zero.

$$\beta_1 = 0|X_1 \qquad (4.7)$$

and significantly greater than zero for both predictor variables *encounter* (X_1) and *affect* (X_1) as predictors in their respective models.

$$\beta_1 > 0|X_1 \qquad (4.8)$$

The key questions are:

(1) Do ***encounters*** with wild animals influence participants' emotions towards wild animals, ***affect***?
(2) Do the emotions, ***affect*** influence the subjects' behaviour towards wild animals (whether they engage in resource degrading or resource conserving behaviours)?
(3) Are preferences for wildlife based programmes influenced by perceptions of benefit or emotional encounters with wildlife

4.7 Methodology and research methods

Three hundred and ninety-nine)399) participants were randomly drawn from communities implementing CAMPFIRE and communities not implementing the programme. The sample had approximately one half of the subjects residing in CAMPFIRE implementing areas and the other one half residing in areas which were not implementing the programme but found in the same district and likely to hear about the programme.

The variables were elicited through a survey approach *(Appendix D) complemented by in-depth qualitative interviews (Appendix E).*. To establish the self-generated anchors from which subjects make adjustments the participants were asked to answer a series of ***self-generated anchoring*** questions (Ekman and Friesen 1986), in this case negative *affect* towards wildlife in general. Participants were asked if:

(1) they or any of their household members have been attacked by wild animals,
(2) whether they experienced livestock predation or crop raids by wildlife,
(3) the result of each wildlife encounter,
(4) whether there were any responses from the responsible institutions.

After this set of questions, each participant was asked to give their perception of and state their preference of the programme and their reaction after each event. The expectation is that those participants whose households experienced either human attack from wild animals, livestock predation or crop raids were likely to (*insufficiently*) adjust skewed towards their anchor value (negative encounter with wildlife) and therefore likely to have negative perceptions or report non-preference for the programme. To establish that negative encounters generated the anchor, after each participant's evaluation of the programme s/he was asked what comes to his or her mind first when they hear or think about the CAMPFIRE programme- ***availability***. Almost 100 per cent of participants in areas implementing the programme indicated that what immediately

comes to mind were crop raids, human attacks and livestock predation. This was in contrast with results from participants from non-CAMPFIRE areas where three quarters of the participants reported free access to health and education, assistance during drought years, and income for public investments. The study directly manipulates the availability of wildlife encounter events. Availability works because concrete (and imagined images) come tagged with affect (Slovic *et al*. 2002). Manipulation of such images evoke emotions in participants who should, as a result, perceive greater risks than participants who do not experience negative wildlife encounters (Keller *et al*. 2006a).

It is presumed that negative encounters are used as the anchor value in wildlife-based programmes; additional information (usually insufficient) is used to adjust from that value upwards. This (insufficient information) was tested by asking participants the amount of income that the programme has been generating over the past three years. A small proportion of participants had knowledge of the amounts and in the majority of cases they reported disproportionately low figures. This was triangulated by qualitative discussions where participants were allowed to explain in detail their interaction with wildlife and their evaluation of the programme thereafter (*Question guide in Appendix E)*. Indications were that discussing CAMPFIRE programme in implementing areas triggers negative emotions that would be used as the anchor for further evaluations by lay-people.

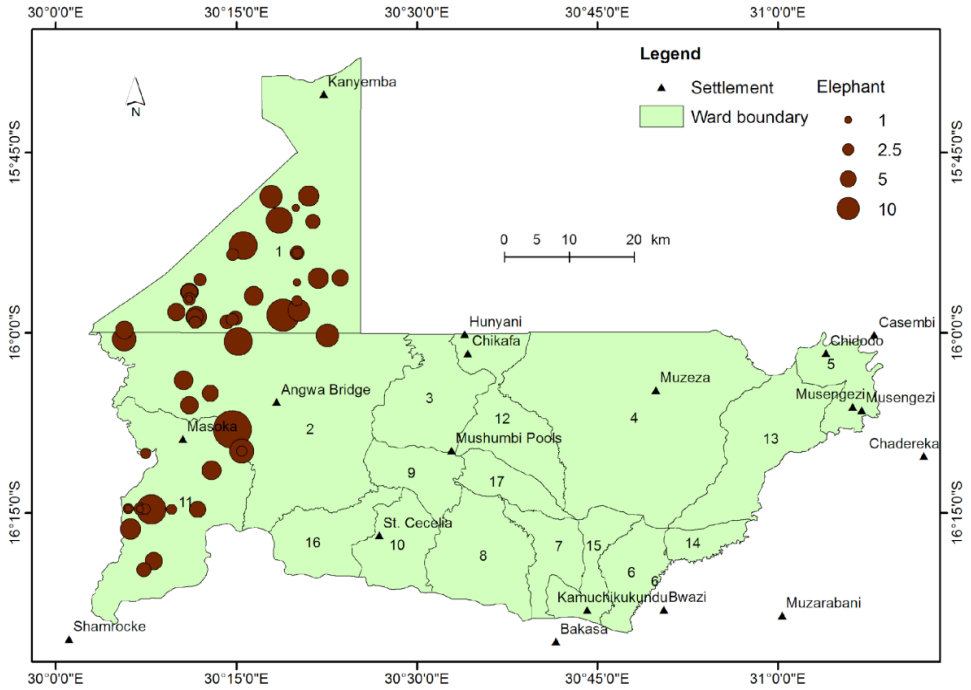
The dependent variable ***affect*** was obtained by asking each subject his or her general feelings towards wild animals that are found or occasionally visit their communities. The feelings were anger, hatred and tolerance. The ***affect*** variable was coded 1 if the subject indicates anger or hatred, and 0 otherwise. This was later followed by a series of questions about past encounters with wild animals. A variable ***encounter*** was generated coded as 1 if the participant's household experienced attack from wild animals, crop raids or livestock predation, and 0 otherwise. The subjects were further asked whether they participate or engage in poaching, revenge killing, assist poachers or participate in natural resources management. A variable ***resource_degrading_behaviour*** was generated coded as 1 if the subject report participating in poaching, revenge killing, assist poachers or does not participate in natural resources management activities, and 0 otherwise.

Results

4.8 Descriptive statistics

4.8.1 Human attacks by wild animals

Mbire district is well endowed with wildlife with the more dangerous wild animals being the more visible. These are elephants followed by buffaloes, crocodiles, hippopotamus and lions. These are reported to have been responsible for most of the reported human wildlife conflicts. Map 5 shows the distribution of the elephant population in the district based on sightings. However, in 2018/2019 cropping season the elephant population was reported in almost all the wards in the district, making human wildlife conflict more prevalent across the entire district.



Map 5: Elephant distribution in Mbire district (source: Mbire Land Use Plan)

To assess human wildlife conflict, each participant in the sample indicated their experiences with relation to wild animals in their areas. Table 4-1 shows that about one half of the sample participants reported that their villages had experienced human attacks by wild animals. The highest proportion of attacks were experienced in villages implementing the CAMPFIRE programme. Table 4-1 also shows whether the participant's household had a member who was attacked by wild animals. Results show that about 15 percent of the sample households had at least a member who was attacked by wild animals. CAMPFIRE programme areas had the highest proportion of households that reported that their household members were attacked by wild animals.

Table 4-1: Experiences of human attacks by wildlife in the sample villages

	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Injuries in the village caused by wildlife						
Yes	30	***16.67***	168	***87.05***	198	***53.08***
No	150	83.33	25	12.95	175	46.92
Total	180	100	193	100	373	100
Household member attacked by wild animals						
Yes	11	***5.34***	50	***25.91***	61	***15.29***
No	195	94.66	143	74.09	338	84.71
Total	206	100	193	100	399	100

Sources: Survey data December 2015

The animals that were responsible for attacking people in the sample villages were buffaloes (20), followed by elephants (19) and snakes (17) out of the 61 cases reported. In non-CAMPFIRE programme areas there are no cases involving buffaloes and most of the reported cases were instigated by snakes. Also, in CAMPFIRE sample areas there are no reported cases involving crocodiles even though from the qualitative discussions there were few cases of crocodile attacks reported.

One-half of the wildlife victims reported in the study are participants in the programme. About 30 and 11 percent were children and spouses of the participants respectively. I hypothesise that participants with household members that fell victim to wildlife would use this as their anchor for the evaluation and perception of the programme. Memory of this past encounter would trigger emotions that also makes such events vivid and readily available in the subject's memory.

A higher proportion of the reported human attacks by wild animals took place in the season prior to the survey (39.3 per cent), followed by cases that happened more than four years (29.5 per cent). I presume that the period when the attack took place will not have any effect, as the emotions that are evoked will be the same. The images are readily available because of the emotions that they trigger.

Approximately one-half of the reported cases in the survey happened as the victims were guarding their fields. About a fifth of the cases happened at home and another fifth along the way from or to home. The location of the incidences are places were people in these rural settings spend their time. For example, they guard their fields every growing season and are at

home or on their way home from the fields and either way they are vulnerable to attack by wild animals.

In the 61 reported cases of wild animals attacking people, 31 of the cases the victims got injured, 25 escaped uninjured while the remaining 8 cases the victims got killed. All reported 8 deaths were in CAMPFIRE programme areas.

In Mbire there are a number of institutions tasked with assisting communities deal with problem animals, especially where there are reported threats towards humans. These institutions are the Rural District Council (RDC), National Parks department and community game scouts. The response includes scaring and eliminating the problem animal especially where it has attacked people. Survey results show that 57 percent of the cases were reported; 45 percent reported to community game scouts, 5 percent to RDC and 3 percent to Parks. Four cases of human deaths received assistance with burial, three cases of injuries got medical assistance, and two cases got some assistance with money. Personal communication with the RDC revealed that they at times help when they have the money but that in the majority of cases the Rural District Council face financial problems and end up failing to assist. The largest proportion of the cases went unreported because the participants reported that from experience there would be no responses.

Participants reported that the attacks on their household members or themselves evoked emotions; anger and hatred towards the different institutions tasked with the responsibility of protecting communities from such eventualities (Table 4-2). These include RDC, National Parks and even community game scouts and safari operators for CAMPFIRE implementing communities. The same emotions were also reported to have developed towards the animal species that instigated the attacks.

Table 4-2: Feelings evoked by wild animal attacks on humans

	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Feelings triggered towards responsible institutions by animal attack on humans						
Anger	3	27.27	29	58	32	52.46
Hatred	2	18.18	17	34	19	31.15
Tolerant	1	9.09	3	6	4	6.56
Fear	0	0	0	0	0	0
Feelings towards the animals just after the attack						
Anger	10	90.91	39	78	49	80.33
Hatred	3	27.27	27	54	30	49.18
Fear	1	9.09	12	24	13	21.31
Tolerant	1	9.09	2	4	3	4.92
Feelings towards the animals now						
Angry	7	63.64	32	64	39	63.93
Fear	3	27.27	21	42	24	39.34
Hatred	3	27.27	16	32	19	31.15
Tolerant	1	9.09	2	4	3	4.92

Sources: Survey data December 2015

Table 4-3 shows that in the majority of cases the victims of wildlife self-reported engagement in behaviours that are inconsistent with conservation.

Table 4-3: Self-reported behaviour

Behaviour	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Revenge killing	9	81.82	32	64.00	41	67.21
Nothing	1	9.09	15	30.00	16	26.23
Poaching	0	0.00	2	4.00	2	3.28
Assist poachers	0	0.00	0	0.00	0	0.00

Sources: Survey data December 2015

4.8.2 Crop raids

The majority of survey communities experience crop raids by wildlife, 93 per cent of respondents reported that they experience crop raids in their villages. All households in CAMPFIRE programme areas reported incidences of crop raids in their communities. Approximately 65 per cent of the households reported that crop raiding by wild animals happen every cropping season in their village while 14 per cent reported that it is a daily phenomenon in either the fields, garden or stored grain.

In CAMPFIRE implementing communities, elephants are the main crop raiding animals (90.8 per cent), meanwhile birds are the main crop raiders in non-CAMPFIRE programme

implementing communities. Crop raids across all the communities were reported as a seasonal occurrence (Table 4-4).

Table 4-4: Crop raiding animals

Crop raiding animal (324)	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Buffalo	0	0	65	35.14	65	20.06
Elephants	58	41.73	168	90.81	226	69.75
Baboons	68	48.92	132	71.35	200	61.73
Birds	83	59.71	16	8.65	99	30.56
Wild Pigs	13	9.35	87	47.03	100	30.86
Elands	36	25.9	1	0.54	37	11.42

Sources: Survey data December 2015

In the majority of cases, crop raids are severe leading to serious food shortages. Over 90 per cent reported food shortages because of crop raids. Approximately a third of the respondents reported experiencing financial problems because of cash crop raids with about 18 per cent reporting incurring debts or failing to service debts because of crop raids. Table 4-5 shows that a larger proportion of respondents felt indifferent towards raiding wild animals. About 18 per cent are tolerant of crop raiding animals with a larger proportion of non-CAMPFIRE respondents being more tolerant to crop raiding animals than CAMPFIRE respondents.

Table 4-5: Reported Feelings as a result of crop raids (Multiple response)

Feelings towards wild animals after crop raids	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Hatred	51	36.69	49	26.49	100	30.86
Angry	99	71.22	145	78.38	244	75.31
Tolerant	31	22.10	28	15.13	59	18.21

Sources: Survey data December 2015

Table 4-6 shows reported responses by subjects after they experienced crop raids. A larger proportion of respondents reported that they engaged in revenge killing after their crops were raided. A larger proportion of respondents in CAMPFIRE programme implementing communities reported revenge killing compared to respondents in non-CAMPFIRE programme communities.

Table 4-6: Resultant behaviour after the crop raids

Resultant behaviour after crop raids	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Revenge killing	53	38.13	80	43.24	133	41.05
Poaching	6	4.32	1	0.54	7	2.16
Assist poachers	6	4.32	0	0	6	1.85
Not participating in NRM	13	9.35	4	2.16	17	5.25
No effect	56	40.29	98	52.97	154	47.53

Sources: Survey data December 2015

The expectation is that respondents from CAMPFIRE communities would not engage in revenge killing as they derive income and other benefits from the programme. However, this is expected from a heuristic point of view as the response is driven more by feelings rather than expected utility.

4.8.3 Livestock predation

Table 4-7 shows that the majority of villages in both Non-CAMPFIRE and CAMPFIRE programme areas in the sample experience livestock predation. Approximately 96 per cent of respondents reported that their villages experience livestock predation; meanwhile two-thirds reported that their households experience livestock predation.

Table 4-7: Experiences of livestock predation in the respondents' village

Livestock predation in the village	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Yes	195	96.06	184	95.34	379	95.71
No	8	3.94	9	4.66	17	4.29
Total	203	100	193	100	396	100
Did household experience livestock predation						
Yes	133	64.56	125	64.77	258	64.66
No	73	35.44	68	35.23	141	35.34
Total	206	100	193	100	399	100

Sources: Survey data December 2015

Livestock predation frequency are reportedly high across the sample villages. Two fifths of the households reported that there is at least a report of livestock predation each year, about a sixth reported that predation happens every growing season while another sixth reported that it happens every month in their village. Approximately 12 per cent of the households reported that livestock predation in their villages is experienced every week while about 7 per cent reported that every day there is at least a case especially of poultry and goats.

Goats and poultry are the main victims of predation by wild animals.The main predators are hyenas, baboons and lions respectively (Table 4-8). Sixty-eight per cent of the reported household predation cases took place within the year.

Table 4-8: Livestock attacked and the predators

Livestock attacked	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Goats	71	53.38	81	64.8	152	58.91
Poultry	49	36.84	87	69.6	136	52.71
Cattle	70	52.63	1	0.8	71	27.52
Sheep	14	10.53	2	1.6	16	6.20
Donkeys	2	1.5	3	2.4	5	1.94
Livestock predators						
Hyena	103	77.44	32	25.6	135	52.33
Baboon	10	7.52	77	61.6	87	33.72
Lion	17	12.78	34	27.2	51	19.77
Jackal	3	2.26	26	20.8	29	11.24
Cheetah	0	0	11	8.8	11	4.26
Crocodile	0	0	1	0.8	1	0.39

Sources: Survey data December 2015

About one-half of respondents reported predation cases at the homesteads, followed by kraal (livestock pen) and grazing areas respectively. However, over 63 per cent of the cases were not reported. Twenty-one per cent of the cases were reported to the local problem animal control unity, 14 per cent to Rural District Council and 10 per cent direct to National Parks department.

Approximately 90 per cent of the reported cases did not receive attention because most cases are not reported. In two thirds of the cases respondents expressed anger and hatred towards the institutions responsible for problem animal control.

The assumption is that if people live in harmony with wildlife then they tolerate wild animal behaviour. Logically their feelings would not swing to hatred and anger, which might trigger resource degrading behaviours such as revenge killings. Table 4-9 shows that the largest proportion of people in areas where wildlife is found are angered by the predation behaviour of wild animals. About a third develop hatred for the wild animals that are involved in predation. Only a sixth of the people tolerate wildlife behaviour as their feelings are not triggered by predation.

Table 4-9: Reported feelings towards predators

Reported feelings towards predators soon after the incident	Non-CAMPF		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Angry	84	63.16	96	76.8	180	69.77
Hatred	45	33.83	34	27.2	79	30.62
Nothing	21	15.79	20	16	41	15.89
Sorry	1	0.75	3	2.4	4	1.55
Reported feelings towards predators now						
Angry	78	58.65	86	68.8	164	63.57
Hatred	43	32.33	32	25.6	75	29.07
Nothing	21	15.79	25	20	46	17.83
Fear	6	4.51	2	1.6	8	3.10

Sources: Survey data December 2015

Table 4-10 shows that close to one half of people whose livestock was attacked by wild animals are not triggered into undertaking resource degrading behaviours such as revenge killing, poaching, assisting poachers and non-participation in natural resources management activities.

Table 4-10: Reported behaviour towards wild animals after predation

Reported behaviour after livestock predation	Non-CAMPFIRE		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
Nothing	55	41.35	61	48.8	116	44.96
Revenge killing	56	42.11	54	43.2	110	42.64
Poaching	9	6.77	6	4.8	15	5.81
Non-participation in NRM	7	5.26	2	1.6	9	3.49
Assisting poachers	7	5.26	1	0.8	8	3.1

Sources: Survey data December 2015

For communities struggling to pull themselves out of poverty, high incidence of damage by wildlife contributes to animosity toward protected areas and wildlife, and opens the door for people to engage in revenge killing to get rid of problem animals and poaching for both income and consumption.

4.8.4 Stated preferences

Table 4-11 shows that a larger proportion of respondents in non-CAMPFIRE areas want the programme in their areas based on the reports they have heard about the programme. In contrast approximately 70 per cent of respondents from CAMPFIRE programme areas reported their dislike of the programme based on their experiences of the programme. However, in Ward 11

were the programme has been fairly successful and the community relatively small, about one half reported their dislike of the programme. In Ward 2 where the population is large and income from CAMPFIRE less than that of Ward 11 approximately 80 per cent of respondents expressed their dislike of the programme. In non-CAMPFIRE areas reports about the performance of CAMPFIRE programme were mixed.

Table 4-11: Stated preference of the CAMPFIRE programme

Status	Prefer CAMPFIRE		I don't prefer CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
CAMPFIRE	59	31.05	131	68.95	190	100
2	24	20.17	95	79.83	119	100
11	35	49.3	36	50.7	71	100
NON-CAMPFIRE	96	42.17	70	57.83	166	100
7	55	69.62	24	30.38	79	100
17	41	47.13	46	52.87	87	100
Total	155	43.54	201	56.46	356	100

Sources: Survey data December 2015

Respondents from non-CAMPFIRE programme areas envied the programme as they have heard that their peers were sending their children to school free of charge. Some have heard about the abundant wild meat that is distributed to households while others heard about people being killed by wild animals.

One-third of the sample households in CAMPFIRE areas reported that they benefited through education subsidy for their children. The majority of households in Ward 2 reported that they did not benefit from education subsidy for their children. Thus, there is possibility that the benefit stream that accrues to households has a bearing on the eventual behaviour of people towards wildlife and wildlands.

Three-fifths of the respondents, and also three fifths of each of the two wards prefer education subsidy to cash dividends. This indicates that a larger proportion do understand the implications that the more the cash dividends the less would be the education support, so prefer that income from CAMPFIRE be directed towards education subsidy than cash dividends. Thus, the question is can this also have influence over people's behaviour towards wildlife and wildlands as opposed to the wild animal encounters that the households may have experienced.

A larger proportion (58 per cent) of respondents reported that they prefer health subsidy to cash dividend. The trend is the same in both CAMPFIRE wards with approximately 60 per cent in

Ward 11 and 57 per cent in Ward 2. This indicates that they do value the public investments as it enables them to access health services. I presume that this preference will also influence positive environmental behaviour as there is a public health investment trend across the sample CAMPFIRE wards.

In reference to whether respondents felt that they can sponsor their children's education without support from CAMPFIRE, a larger proportion (60 per cent) in Ward 11 reported that they cannot while in Ward 2 70 per cent of respondents reported that they can sponsor their children's education without assistance from the CAMPFIRE programme. This reflects the relative historical role of the programme in education production in the two wards. In Ward 2 a number of public education investments have been made, however the ward has a large population size rendering the impact less widespread. In Ward 11 the population size is relatively small yet they get far more income from the CAMPFIRE programme compared to Ward 2; hence their investment in education has higher impact.

The trend in access to health is the same as with education. Respondents from Ward 2 feel that they have the capacity to sponsor their own health without assistance from the CAMPFIRE programme. In Ward 11 three fifths or 60 percent of respondents feel that they cannot have better access to health services without the CAMPFIRE programme. In addition, a larger proportion of respondents felt that they can have better access to food without the CAMPFIRE programme. However, in Ward 11 about one half of the respondents felt they cannot have better access to food without the programme.

Given the choice to choose between the CAMPFIRE programme and agriculture the largest proportion of respondents indicated that they prefer agriculture. Reasons from the qualitative interviews reports were that they have more control over agricultural proceeds compared to CAMPFIRE proceeds. There has not been demonstrable evidence to convince households to entirely depend on the programme for all household demands.

For the CAMPFIRE households it is unanimously agreed that agriculture is the more valuable livelihood compared to the CAMPFIRE programme. Only 5 per cent of respondents felt that the CAMPFIRE programme is more valuable than agriculture. It therefore follows that any investments that also support agriculture are likely to be most welcome.

The following section discusses the implication of benefits and encounters on people's behaviour towards wildlife. Living in harmony with wildlife entail that even when the wild animals act otherwise, they are likely to be tolerated.

4.9 Affective heuristics results

To understand the influence of household encounters with wild animals on participants' feelings towards wild animals, participants were asked their general feelings towards wildlife found in their areas. A participant was categorised as having affect if s/he indicated that s/he has hatred, anger and fear towards wild animals found in their areas. Table 4-12 shows that the largest proportion of the sample participants had negative feelings towards wildlife in their areas. The feelings towards wild animals were significantly different between participants from CAMPFIRE and non-CAMPFIRE communities. Above 85 percent of participants from CAMPFIRE areas had negative feelings towards wild animals compared to 60 percent in non-CAMPFIRE communities.

Table 4-12: Sample participants' feelings towards wild animals

Negative affect (hatred and anger)	Non-CAMPF		CAMPFIRE		Total	
	Freq.	%	Freq.	%	Freq.	%
0	85	41.26	28	14.51	113	28.32
1	121	58.74	165	85.49	286	71.68
Total	206	100	193	100	399	100

Pearson chi2(1) = 35.135 Pr = 0.000 - Source: Survey data December 2015

In trying to understand the source of the feelings the affect was analysed relative to reported encounters with wild animals; whether they have had their household members attacked, whether they experienced crop raids and livestock predation by wild animals. Results show that almost all participants who reported that their household experienced human attack by wild animals had feelings of hatred or anger towards the wild animals. About two thirds of households who did not experience attack from wild animals also reported feelings of hatred or anger towards wild animals (Table 4-13) having experienced human attack in their villages.

Table 4-13: Affect by household experiences of attacks by wild animals

Negative affect (hatred and anger)	Household experienced attack by wild animals					
	No		Yes		Total	
	Freq.	%	Freq.	%	Freq.	%
0	112	33.14	1	1.64	113	28.32
1	226	66.86	60	98.36	286	71.68
Total	338	100	61	100	399	100

Pearson chi2(1) = 25.253 Pr = 0.000 - Source: Survey data December 2015

When analysed using household experiences of crop raids the pattern is slightly different. A small proportion of participants that did not experience crop raids also have negative feelings towards wild animals (Table 4-14). Meanwhile a larger proportion of households that reported experiencing crop raids have negative feelings towards wild animals. About 15 percent of participants whose households experienced crop raids are tolerant of wild animals.

Table 4-14: Affect by households' experiences of crop raids from wild animals

Negative affect (hatred and anger)	Household experiences of crop raids from wild animals					
	No		Yes		Total	
	Freq.	%	Freq.	%	Freq.	%
0	63	84	50	15.43	113	28.32
1	12	16	274	84.57	286	71.68
Total	75	100	324	100	399	100

Pearson chi2(1) = 141.0511 Pr = 0.000 - Source: Survey data December 2015

Table 4-15 shows that feelings towards wild animals is significantly different between households that experience livestock predation and those that do not. About two thirds of participants whose households did not experience livestock predation have negative feelings towards wild animals while approximately 80 percent of participants whose households experience livestock predation also have negative feelings towards wild animals.

Table 4-15: Affect by household experiences of livestock predation

Negative affect (*hatred and anger*)	Household experiences of livestock predation					
	No		Yes		Total	
	Freq.	%	Freq.	%	Freq.	%
0	58	41.13	55	21.32	113	28.32
1	83	58.87	203	78.68	286	71.68
Total	141	100	258	100	399	100

Pearson chi2(1) = 17.638 Pr = 0.000 - Source: Survey data December 2015

The hypothesis that household encounters with wild animal determine the feelings that people develop was tested using the logistic regression procedure. The dependent variable '*affect'* coded as 1 for having negative feelings towards wild animals and 0 otherwise. The explanatory variables expected to influence the development of the feelings are (1) whether the household had at least a member who was attacked by wild animals, (2) whether the participant's household experienced crop raids and (3) livestock predation by wild animals. The other confounding factors that are included in the model are the participant's sex, marital status,

education level and whether the participant lives in a CAMPFIRE or non-CAMPFIRE community. The model results are presented in Table 4-16 together with the model test results.

Table 4-16: Affect model

Predictor variables	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Household Member Attacked	2.999	1.096	2.74	**0.006**	0.852	5.147
Crop raid	3.288	0.418	7.86	**0.000**	2.468	4.107
Livestock predation	0.313	0.326	0.96	0.337	-0.326	0.953
Campfire	0.461	0.343	1.34	0.179	-0.211	1.133
Household size	-0.074	0.072	-1.04	0.3	-0.214	0.066
Resident period	0.015	0.008	1.82	0.069	-0.001	0.032
Male	0.179	0.613	0.29	0.771	-1.023	1.380
Married	-0.189	0.623	-0.3	0.762	-1.410	1.0332
Secondary education	-0.560	0.333	-1.68	**0.092**	-1.211	0.092
Cattle	0.030	0.023	1.31	0.191	-0.015	0.075
Donkeys	0.181	0.254	0.71	0.475	-0.316	0.678
Shoats	0.011	0.016	0.68	0.496	-0.020	0.0413
Poultry	0.007	0.014	0.51	0.612	-0.021	0.035
_cons	-2.182	0.764	-2.86	0.004	-3.678	-0.685
	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Household Member Attacked	20.075	21.992	2.74	**0.006**	2.345	171.867
Crop raid	26.779	11.197	7.86	**0.000**	11.800	60.773
Livestock predation	1.368	0.446	0.96	0.337	0.722	2.592
Campfire	1.585	0.544	1.34	0.179	0.809	3.106
Household size	0.928	0.067	-1.04	0.300	0.807	1.068
Resident period	1.015	0.009	1.82	**0.069**	0.999	1.032
Male	1.196	0.733	0.29	0.771	0.360	3.976
Married	0.828	0.516	-0.3	0.762	0.244	2.810
Secondary education	0.571441	0.190044	-1.68	**0.092**	0.297774	1.096617
Cattle	1.030322	0.023523	1.31	0.191	0.985234	1.077472
Donkeys	1.198547	0.304062	0.71	0.475	0.728974	1.970597
Shoats	1.010694	0.015784	0.68	0.496	0.980226	1.042109
Poultry	1.007299	0.014427	0.51	0.612	0.979415	1.035977
Logistic regression model test results		Number of obs	=	399		
		LR chi2(9)	=	168.57		
		Prob > chi2	=	0.0000		
Log likelihood = -155.54155		Pseudo R2	=	0.3545		

Source: Survey data December 2015

The model is robust in explaining variation of *negative affect* within the sample; *p=0.0000* and explains approximately 35 percent of *negative affect* variations. Encounter with wild animals is a significant factor in explaining variation in *affect*. In addition, resident period is a statistically significant factor in determining *negative affect* development. Results show that if there is a unit increase in human attacks by wild animals the log odds of *negative affect*

developing increases 17 times more than the log odds of developing tolerance towards wild animals. The log odds or the ratio of the odds are much higher if there is a unity increase in crop raids, which triggers an odds ratio of approximately 27 times more than if the subjects do not experience crop raids. Results show that experiences of predation trigger less change in *negative affect* and is not statistically significant. The result might be so as the majority of subjects in communities with wildlife do not own livestock.

Table 4-17 and Figure 10 show that resource degrading behaviour is correlated with *negative affect.*

Table 4-17: correlation between resource degrading behaviour and negative affect

Resource degrading behaviour	Negative affect					
	No		Yes		Total	
	Freq.	%	Freq.	%	Freq.	%
No	107	94.69	119	41.61	226	56.64
Yes	6	5.31	167	58.39	173	43.36
Total	113	100	286	100	399	100

Pearson chi2(1) = 92.930 Pr = 0.000 - Source: Survey data December 2015

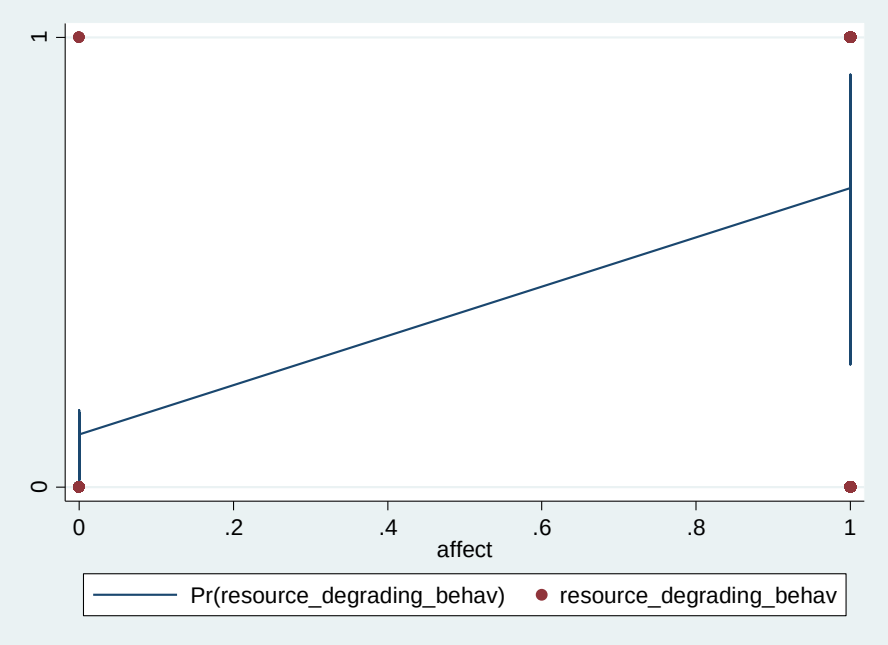


Figure 10: Predicted resource degrading behaviour and affect - *Source: Survey data December 2015*

People's behaviour towards wild animals is thus partly explained by reference to negative feelings that people have towards wild animals as a result of negative encounters. A unit increase in *negative affect* increases the likelihood of revenge killing and poaching (resource degrading behaviour) by subjects in spite of expected utility (Table 4-18).

Table 4-18: Logistic regression model

Response variable: Resource degrading behaviour

Independent variables	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Negative affect	3.230	0.436	7.38	0	2.365	4.075
_cons	-2.881	0.420	-6.87	0	-3.703	-2.059
	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Negative affect	25.027	10.920	7.38	0	10.641	58.861

Prob > chi2 = 0.000, Pseudo R2 = 0.203 - Source: Survey data December 2015

Table 4-19 shows that there are four factors which are important in explaining variation in people's behaviour towards wild animals. Negative feelings are the strongest factor in determining resource degrading behaviour. Being male reduces the likely revenge killing behaviour, meanwhile owning donkeys, having secondary level education and being married significantly increases resource degrading behaviour.

Table 4-19: Logistic and logit full models

Response variable: Resource degrading behaviour

Logit model

Explanatory variables	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Negative affect	3.385	0.459	7.38	**0.000**	2.486	4.284
Household size	-0.095	0.059	-1.62	0.105	-0.210	0.020
Resident period	0.002	0.007	0.34	0.734	-0.011	0.015
Male participant	-1.406	0.515	-2.73	**0.006**	-2.415	-0.397
Married	0.937	0.534	1.75	**0.079**	-0.110	1.984
Secondary education	0.473	0.283	1.67	**0.094**	-0.081	1.027
Cattle	-0.008	0.020	-0.39	0.695	-0.047	0.031
Donkeys	0.404	0.219	1.85	**0.065**	-0.025	0.832
Shoats	0.0129	0.012	1.09	0.274	-0.010	0.036
Poultry	0.00484	0.011	0.44	0.658	-0.017	0.026
Campfire	-0.17521	0.284	-0.62	0.537	-0.732	0.381
_cons	-2.47177	0.706	-3.5	0	-3.856	-1.087

Logistic model

Explanatory variables	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Negative affect	29.519	13.539	7.38	**0.000**	12.014	72.530
Household size	0.909	0.053	-1.62	0.105	0.811	1.020
Resident period	1.002	0.007	0.34	0.734	0.990	1.015
Male participant	0.245	0.126	-2.73	**0.006**	0.089	0.673
Married	2.553	1.364	1.75	**0.079**	0.896	7.274
Secondary education	1.606	0.454	1.67	**0.094**	0.923	2.794
Cattle	0.992	0.020	-0.39	0.695	0.954	1.032
Donkeys	1.497	0.328	1.85	**0.065**	0.975	2.299
Shoats	1.013	0.012	1.09	0.274	0.989	1.037
Poultry	1.005	0.011	0.44	0.658	0.984	1.0266
Campfire	0.839	0.238	-0.62	0.537	0.481	1.464

Logistic regression test	Number of obs	=	399
	LR chi2(11)	=	131.43
	Prob > chi2	=	0
Log likelihood = -207.31985	Pseudo R2	=	0.2407

Source: Survey data December 2015

4.9.1 Preference of wildlife programmes

Participants from CAMPFIRE communities were asked whether they would choose to implement CAMPFIRE if they were given the choice to choose between implementing and not implementing the programme. Table 108 appendix C show that subjects' perceptions of education and health benefits, as well as employment in the wildlife industry are statistically significant predictors of the subjects' preference of the CAMPFIRE programme. The model in

Table 108 appendix shows that a unity increase in perceived education benefits and employment in the wildlife industry increases the log. odds or ratio of the odds of choosing the programme. In other words, there is an increase in the likelihood of subjects preferring the CAMPFIRE programme over not having the programme. On the other hand, a unity change of subjects to perceiving themselves as able to access and fund better health services without the CAMPFIRE programme decreases the log. odds or ratio of the odds; there is a decrease in preference for CAMPFIRE programme. The model is able to explain approximately 43 percent of variation in the subjects' choice of whether to choose to implement the CAMPFIRE programme or not, given the chance (Table 4-20). The reduced model is able to explain only approximately 16 percent of variation in the subjects' choices (Table 8-1 Appendix C).

Table 4-20: Programme choice model test results

Logistic regression	Number of obs	=	116
	LR chi2(18)	=	65.2
	Prob > chi2	=	0
Log likelihood = -43.334851	Pseudo R2	=	0.4293

Source: Survey data December 2015

Table 4-21 presents the marginal effect or probability of positive outcome by specified covariates. Affect has no effect on the programme choice. The results show that ethnicity has the largest marginal effect. Being of the Doma origin has the highest effect in the likelihood of choosing the programme followed by remittances and employment in the wildlife industry respectively. Thus households receiving remittances and with a member who is employed in the wildlife industry are more likely to prefer the programme than those without.

Table 4-21: model on whether subjects would choose to implement the programme given the option

Variable	dy/dx	Std. Err.	z	P>z	[95%	C.I.]	X
affect	0.015872	0.14057	0.11	0.91	-0.25964	0.291379	0.784483
cattle	-0.04247	0.03122	-1.36	0.174	-0.10366	0.018714	2.12931
shoats	-0.00444	0.00586	-0.76	0.449	-0.01593	0.007059	9.85345
poultry	0.01062	0.0059	1.8	0.072	-0.00094	0.022177	11.7414
Wildlife employment	0.531786	0.14611	3.64	0	0.245409	0.818163	0.215517
Remittances	0.5983	0.20302	2.95	0.003	0.200394	0.996206	0.068966
Illness	-0.00808	0.12271	-0.07	0.947	-0.24859	0.23242	0.62069
Committee member	0.37796	0.26923	1.4	0.16	-0.14973	0.90565	0.068966
Korekore	0.416801	0.11033	3.78	0	0.200565	0.633038	0.681034
Doma	0.753833	0.0839	8.99	0	0.5894	0.918266	0.086207
Zezuru	0.064316	0.39645	0.16	0.871	-0.7127	0.841336	0.043103
Married	-0.08312	0.22863	-0.36	0.716	-0.53123	0.364996	0.862069
Secondary education	0.224232	0.1651	1.36	0.174	-0.09937	0.54783	0.25
Prefer education benefit	0.371926	0.15564	2.39	0.017	0.066886	0.676965	0.310345
Prefer cash to education subsidy	-0.46605	0.13221	-3.53	0	-0.72518	-0.20692	0.396552
Prefer cash to health subsidy	0.230737	0.16182	1.43	0.154	-0.08643	0.547901	0.413793
Better education without campfire	0.088787	0.15248	0.58	0.56	-0.21007	0.38764	0.637931
Better health without campfire	-0.44172	0.16142	-2.74	0.006	-0.75811	-0.12534	0.612069

Source: Survey data December 2015

Households that receive remittances probably are less affected by wildlife and are therefore less likely to reject the programme. While households with a member employed in the wildlife industry see the direct benefit of having the programme and therefore are more likely to choose the programme if given the choice to do so. The Korekore ethnicity has a higher probability of choosing the programme as well as those households whose members are in the programme committee. On the other end having livestock increases the probability of not preferring the programme. This is likely as the livestock are targets of predation by wild animals and therefore livestock owners see the loss compared to households without livestock.

4.9.2 Can stated preference explain self-reported resource degrading behaviour?

We further interrogated whether stated preference influence self-reported resource degrading behaviour such as killing wild animals in revenge or poaching. Results show that there is no relationship between stated programme preference and what people do (Table 4-22).

Table 4-22: Resource degrading behaviour programme preference model

Resource degrading behaviour	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Programme preference	0.515	0.318	1.62	0.105	-0.108	1.138
_cons	-0.377	0.265	-1.42	0.155	-0.897	0.142

Source: Survey data December 2015

Preferring the programme for example, does not guarantee that people will not be involved in poaching or in revenge killing. Cases of self-reported resource degrading behaviour is driven more by negative experiences that trigger *negative affect* and ultimately revenge killing. This result confirms our earlier result that *affect* does not influence programme preference but self-reported revenge killing and poaching. This explains the complexity of human behaviour and the seemingly inconsistence that seem to violate utility theory.

4.10 Conclusion and policy implication

In most of southern Africa wildlife is one of the focus for rural development. Policy makers at international, national and local level are all out lobbying for wildlife conservation and advocate for the active participation of the rural constituencies. During the initial stages of wildlife programmes in communal areas in Zimbabwe there has been massive support of the intervention from producer communities (Tchakatumba et al. 2019, Taylor 2009, Murphree 2009, Hutton *et al.* 2005). However, there has been reported cases of communities preferring to discard the programme, in other cases there are documented cases of increase in poaching and revenge killing of wild animals by members of the producer communities (Rihoy 2007). In addition, during the scoping stage of this study there were observed serious inconsistencies between benefits from the conservation programme and people's behaviours, perceptions and preferences of the programme, diverging from the classical utility theory. Therefore, the objective of this paper is to attempt using the heuristic theory to explain the divergence between benefits, and behaviour, perceptions and preferences. The key argument is that people's encounters with wild animals may explain some of the observed inconsistences through generating feeling of resentment which triggers anti-conservation behaviour, perceptions and preferences. I try to demonstrate the complexity in economic decision making and that there are other factors other than expected utility, in this case psychological, that determine people's behaviour in relation to wildlife conservation.

The study argues that heuristic theory can be used to explain some of the observed or stated human behaviour and stated preferences in communities implementing wildlife based programmes (Schulan 2019). The paper aims to determine whether subjects' past encounters with wild animals influence negative affect; and whether the negative affect leads subjects (1) to engage in self-reported behaviours such as poaching and killing of wild animals and (2) stated preferences towards community based wildlife programmes. Building on earlier work on heuristics, I develop an 'encounter-affect-behaviour-preference' model and apply it to subjects in Community Based Wildlife Management context in Zimbabwe. The premise is that subjects in wildlife areas experience negative encounters with wild animals which are likely to trigger emotions or negative affect that influence stated or observed behaviour, and stated or revealed preferences for wildlife-based programmes. The argument is that affect, anchoring and availability heuristics interact to influence people's preferences of programmes and their behaviour towards wild animal resources in their area.

In trying to understand the complexity in economic decision making the study used the logistic regression on randomly sampled households in Mbire district. The study demonstrates the complexity in wildlife conservation especially understanding people's behaviours and preferences. The study explains the seemingly inconsistencies that may be difficult to explain from a purely expected utility theory. The sample experience a wide range of wildlife encounters such as attacks by wild animals, crop raids and livestock predation. The sample benefit from wildlife conservation through the public infrastructure such as school and health facilities and the associated support system. The results show that encounters trigger affect which in turn trigger how people perceive wildlife programmes. However, affect does not explain variation in stated preferences. Expected utility tend to be a significant explanatory variable for stated programme preference.

Heuristics can therefore compliment the understanding of some decision patterns and behaviours that are inconsistent with economic theories of logic and probability. I therefore propose that working towards generating positive markers or anchors about wildlife among subjects can increase tolerance of wildlife; which can be achieved for example by instituting wildlife management systems that cater for problem animal control to reduce negative encounters, reducing evocation of affect and the associated resource degrading behaviours. Furthermore, improving benefits or perceptions of benefits can increase preference or willingness to accept wildlife-based programmes. Policies can be therefore deliberately crafted

to lessen the negative impacts generated by encounters, for example problem animal control policy that lessen incidents of negative encounters.

5. Chapter 5: Conclusion and policy implications

5.1 Findings

The study has examined the effects of the CAMPFIRE programme on education production and household adaptive capacity. It further explored the intricacies of decision making processes with regards stated behaviour and stated preferences. The thesis behind the investigation is that the design of the campfire programme allows rural development in a more flexible and sustainable way. It has the potential to address poverty and improve the adaptive capacities of marginal communities participating in wildlife conservation. The investigation was conducted against a backdrop that previous assessments of the programme has produced results that indicate that the programme has not led to expected improvements in livelihoods, except improving biodiversity (Taylor 2009, Murphree 2009, Hutton et al. 2005). Indications show poverty prevalence remaining high in marginal communities participating in similar programmes across southern Africa (UNICEF 2015, Rihoy 2007, Jones 2007, Muchapondwa 2003). However, this thesis argues that the assessments did not recognise that the investment configurations of wildlife incomes are skewed towards public infrastructure (Tchakatumba et al. 2019, Chigonda 2018, Jones 2007). It would be prudent therefore to appraise the programme from that angle. Thus, one would expect positive impact of the programme on components that are directly linked to public infrastructure development such as education, health and communication. In addition, the thesis also envision the programme to have the potential to improve adaptation as it can address some of the critical components of adaptation. Lastly, the study demonstrated how the programme can influence people's preferences and behaviours, and how the programme can be modelled to address some of the preference and behaviour issues. The thesis concludes that the campfire programme is an invaluable rural development tool that requires constant reconfiguration to address recurrent critical issues. It has for example survived the economic crisis in the country demonstrating its robustness or resilience to changing conditions (Tchakatumba et al. 2019).

Results from the study show that the programme reinvested a larger proportion of the conservation income into public goods provisioning confirming findings by Jone (2007). - Most notable were investments in education, health and road infrastructure. As such, the study finds out that welfare dimensions that are closely related to public infrastructure development improved as a result of programme implementation, than if they were not implementing the programme. CAMPFIRE programme for example improved education production by 12 per

cent compared than if the programme was not implemented. Children were observed to transit at the right age-for-grade if under the programme than if they were not because there are no economic barriers to enrollment. However, there are more facets to education production than participation, but it is the first step to ensuring access to education before we could include the other education production measures.

However, results from education production function show that socio-economic inputs or characteristics are significant factors in explaining variation in education production in CAMPFIRE implementing areas than in non-programme implementing areas. In other words, children of the better resourced household tend to have higher education production that less resourced households. The expectation was that the provision of public provision of education through infrastructure development and support system would reduce the influence of household inputs on education production. Children for example would transit equally in school irrespective of their household resource status. The results show that this is not true. Therefore, while public investments of the programme improve education production, it needs to be configured to address skewedness between the less and better resourced households. Generally, the programme remains a relevant instrument that can be used to influence different welfare dimensions depending on the objective function of the policy makers at the different levels. Results that show that conservation programmes have not improved livelihoods need to start from the where the conservation income is re-invested.

This is also further illustrated by the results of paper 2, which shows that there is positive potential outcome means for households' physical capacity than all the other household adaptive capacity dimensions. Social capital, economic capital and human capital potential outcomes under the programme are negative than if the households were not implementing the programme. The average social capital index for example is 0.011 or 1.1 per cent less for CAMPFIRE households than the average of 0.061 or 6.1 per cent that would have occurred if these households were not implementing the programme. The human capital capacity index for programme implementing households is 0.006 less than 0.076 if they were not implementing the programme. The economic capacity index is 0.008 less when treated than the average of 0.068 that would have occurred if the programme implementing households were not under the programme. However, on physical capacity the potential outcome would be 0.038 higher than 0.183 if the programme implementing households were not implementing. On the overall household adaptive capacity index, the potential outcome is 0.012 higher than 0.388 that would obtain if the programme implementing households were not implementing.

In summary, to have positive impact on the different aspects of household adaptive capacity, income from the conservation programme should be directed towards improving the conditions that enables the realisation of the relevant welfare dimension or household adaptive capacity component. One would not expect all welfare dimensions or adaptive capacity dimensions to be positively influenced by the conservation programme if there is no significant investment of the income towards each of the relevant dimensions. The results show that the direction of the investment would be the direction of the positive welfare or adaptive capacity outcome.

Results of Cobb-Douglas or education production function confirm that the CAMPFIRE programme variably affects the individual components of adaptive capacity; negatively on household social, economic capacities, and positively on household physical capacity with no significant effect on human capacity and overall household adaptive capacity. The results also show that there are other covariates that have significant influence on household capacities, such as having a household member out of the country, or in an urban area, being a widow, or some ethnicity such as being Karanga and traditional religion. Having a household member in the diaspora for example improves household economic and human capacity, while traditional religion tends to have negative effect on all household adaptive capacities.

The study further realises that the economic decision process under community wildlife based programmes is complex. Logistic regression results point to encounters with wild animals being statistically significant predictors of negative *affect*; which in turn is a key determinant of resource degrading behaviours such as poaching and killing of wild animals. The killings are emotional responses to revenge for or deter wild animals from destroying fields, livestock, killing or injuring people. On the other hand, the thesis finds perceptions of benefit, and employment in the wildlife industry to influence preference for wildlife-based programmes; and not the negative affect. The conclusion is therefore that a considerable fraction of decisions by subjects in Community Wildlife-Based programmes can be attributed to *heuristics*; negative wildlife encounters and associated feelings. However, negative affect does not influence preferences for wildlife-based programmes but expected utility. Heuristics can therefore compliment the understanding of some decision patterns and behaviours that are seemingly inconsistent with classical economic theories of logic and probability.

Results from the three papers show how programme design can affect specific components of systems. Programme impact assessments should be designed with a clear understanding of the implementation modalities, not just the original objective. Wildlife programmes for example,

were initiated with a wide range of objectives some of which were not achieved due the manner in which the implementation is done (Mudzengi 2020, Shereni 2020, Tchakatumba *et al.* 2019, Chigonda 2018). In the case under study, the original design did not spell out specific configuration of wildlife income. During implementation, it became prudent to invest a larger proportion of income in public infrastructure when household dividend approach became untenable (Jone B. T. 2007). The programme ended up having less impact on household economics, poverty and other social aspects. Impacts that are more positive were realised on livelihoods aspect bound to public goods provision such as education and physical household capacity.

Furthermore, the results demonstrated the need to select impact assessment procedures that allow for comparison of different treatment regimes. The use of treatment-effect procedures allow for in-depth understanding of programmes or interventions impacts. This further improves understanding the implication of the design on beneficiaries programme preference and behaviours. Because less benefits accrue directly to households, it has less effect cognitively. The more cognitively available exemplars of wildlife programmes are the negative encounters with wild animals. Thus the slow analytical processes compete with fast heuristic processes, and will also interfere with quick assessment which may yield results that are at variance with people's aspirations. There is need to ground our assessments, design them well and not hurry them. For example, people tend to weigh their judgments heavily toward more recent information, making new opinions biased toward latest news or any information that can quickly be recalled such as unpleasant encounters (Dreman *et al*., 2010).

5.2 Policy implication of the results

A number of policy implications can be drawn from results of this study. At the onset community based wildlife programmes are demonstrably important in the livelihoods of the respective communities. However, programme impact can be enhanced for specific livelihoods or economic components if there is a deliberate effort to direct the investment in the direction of the intended components. For example, an improvement in education production is a result of deliberate investment towards education infrastructure and support system thereof. The same result was obtained with reference to adaptive capacity. The programme demonstrably improved household physical capacity, which shows results of deliberately investing in public capital or infrastructure. The local authority instituted a policy for a larger proportion of income to be invested in public infrastructure. The policy has yielded positive results in relation to the policy objective function. The other components have low ratings as investments by the

programme towards the components are low, 30 per cent is devoted to all the other components. Therefore, policy decisions about how income from wildlife business is utilised has implications on specific livelihoods components thereof. This demonstrates that policy makers can make deliberate decisions to influence specific livelihoods and economic components through structuring wildlife programmes investment portfolios. In this case, the policy makers can deliberately reconfigure conservation income investment portfolio towards human capacity development, for example by putting more resources to vocational trainings and adult literacy.

Policy implications for paper 3 relates how issues beyond economics can be relevant in improving economic outcomes. The study therefore proposes that working towards generating positive markers or anchors about wildlife among beneficiary subjects can increase tolerance of wildlife. This can be achieved for example by instituting wildlife management systems that cater for problem animal control to reduce negative encounters, reducing evocation of affect and the associated resource degrading behaviours. People resort to revenge killing because they have had negative encounters with wildlife. Therefore, by reducing the likelihood of such encounters it would also reduce the likelihood of subjects engaging in acts that are not conservation friendly. Furthermore, improving benefits or perceptions of benefits can increase preference or willingness to accept wildlife-based programmes. Beneficiary subjects need to be actively involved and informed so that they realise the benefit stream accruing to the community that they are a part of. A larger proportion of subjects who were interviewed for example were not even aware of how much their communities were realising from conservation programme.

5.3 Future research direction

Results from this research suggest that ‘we can only reap where we sow’. One could not expect positive effects of conservation programmes if they do not invest in the relevant objective functions. As such there is need for further evidence to demonstrate the assertion. There in need to find different contexts where conservation income has been used differently from the case under this study. For example, where larger proportions of income have been invested in improving human capacity or economic assets and examine whether the same positive impact on the components is obtain. This would enhance the ability of policy makers and beneficiary communities to make informed decisions relative to their visions.

The study further proposes that there is need for more studies around the role of non-economic factors in determining economic outcomes. The role of heuristics for example has been demonstrated to be significant in explaining some of the seemingly inconsistent human behaviour and stated preferences. However, more studies need to be done to buttress this claim, and from a number of case studies in different landscapes, countries and continents.

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6. Appendix A for paper 1

Table 6-1: The five internally homogeneous groups or blocks identifiable into which 428 observations were assigned

Inferior of block of propensity score	Control	Treatment	Total
0.0828849	32	8	40
0.2	99	42	141
0.4	38	23	61
0.6	25	68	93
0.8	10	83	93
Total	204	224	428

Source: Survey data December 2015

Table 6-2: Propensity score model

Estimation of the propensity score						
Iteration 0: log likelihood = -300.60003						
Iteration 1: log likelihood = -231.85148						
Iteration 2: log likelihood = -228.19675						
Iteration 3: log likelihood = -227.98653						
Iteration 4: log likelihood = -227.98277						
Iteration 5: log likelihood = -227.98277						
Probit regression	Number of obs = 434					
Log likelihood = -227.98277	LR chi2(8) = 145.23					
	Prob > chi2 = 0.0000					
	Pseudo R2 = 0.2416					
Campfire	Coefficient	Standard error	z	P>z	[95% Conf. Interval]	
Sex of child	0.102	0.136	0.75	0.456	-0.166	0.369
Cross wildlife area	0.775	0.151	5.14	0	0.479	1.070
Doma	0.317	0.265	1.2	0.232	-0.203	0.837
Number of goats/sheep owned	-0.012	0.008	-1.53	0.126	-0.027	0.003
Number of poultry owned	-0.001	0.010	-0.06	0.955	-0.021	0.020
Employed in wildlife industry	2.140	0.530	4.03	0	1.100	3.179
Distance to school	0.000	0.000	-4.51	0	0.000	0.000
Cross a river	1.066	0.152	7.03	0	0.769	1.364
Constant	-4.288	0.668	-6.42	0	-5.598	-2.978

Source: Survey data December 2015

Table 6-3: Matched groups characteristics

	Matched groups					
Household characteristics	1	2	3	4	5	Matched sample average
	Mean					
Participation rate in education	0.74	0.77	0.80	0.69	0.74	0.75
Number of cattle	3.85	3.23	2.95	1.08	0.97	2.29
Number of donkeys	0.40	0.03	0.30	0.18	0.16	0.16
Number of goats/sheep	8.00	4.12	4.57	2.12	4.17	4.12
Number of poultry	7.98	4.94	5.79	3.71	6.69	5.46
Child age (years)	11.55	11.29	11.84	9.96	10.27	10.88
Distance to school (km)	5,088	2,639	4,526	3,684	2,506	3,335
Education expenditure (USD)	46.13	30.41	40.38	14.72	18.29	27.24
Residence period (years)	19.70	22.61	23.74	45.10	22.99	27.36
Household size	5.83	5.43	5.87	6.27	5.49	5.72
Head Years In School	5.54	6.73	6.18	5.91	6.60	6.33
	Proportion					
Girls	62.50	53.19	62.30	53.76	38.71	52.34
Orphan	5.00	6.30	6.60	3.20	2.15	4.67
Education assistance	14.29	6.79	6.67	12.22	19.78	11.46
Diaspora	0.00	0.71	0.00	0.00	0.00	0.23
Urban	17.50	21.28	16.39	12.90	30.11	20.33
Head sex: female	35.00	24.11	13.11	9.68	13.98	18.22
Doma	0.00	3.55	3.28	17.20	12.90	8.18
Karanga	5.00	12.77	9.84	2.15	4.30	7.48
Korekore	70.00	47.52	60.66	50.54	64.52	55.84
Zezuru	15.00	15.60	16.39	8.60	1.08	10.98
Apostolic	62.50	33.33	24.59	22.58	23.66	30.37
Christian gatherings	0.00	1.42	0.00	7.53	13.98	5.14
No religion	2.50	13.48	9.84	5.38	3.23	7.94
Pentecostal	12.50	9.22	21.31	9.68	15.05	12.62
Roman Catholic	0.00	0.71	1.64	3.23	2.15	1.64
Traditional religion	7.50	19.15	31.15	36.56	27.96	25.47
Wildlife wage labour	7.50	6.38	3.28	10.75	20.43	10.05
Non-Agricultural wage labour	40.00	25.71	42.62	32.97	44.09	35.06
Cross river	10.00	10.64	78.69	97.85	86.02	55.61
Cross wildlife area	7.50	17.73	32.79	54.84	80.65	40.65

Source: Survey data December 2015

Table 6-4: Inputs in the production of education outputs; children participation in education 1 ***Source: Survey data December 2015***

Education production input	Coefficient	Standard error	t	P>t	Beta
CAMPFIRE (=1)	0.103	0.031	3.32	**0.001**	0.258
Socioeconomic inputs					
Socio-demographic inputs					
Child sex (0=female 1=male)	-0.038	0.018	-2.13	**0.034**	-0.096
Child's age	-0.009	0.003	-3.14	**0.002**	-0.147
Orphan (=1)	-0.024	0.092	-0.26	0.794	-0.026
Double orphan (=1)	0.083	0.104	0.79	0.428	0.079
Household resident period	-3.205	9.431	-0.34	0.738	-0.015
Household size	-0.006	0.005	-1.08	0.279	-0.053
Household head sex (1=female 2=male)	-0.007	0.027	-0.24	0.809	-0.013
Household head years in school	0.010	0.003	3.55	**0.000**	0.189
Ethnicity					
Doma	0.049	0.045	1.08	0.280	0.064
Karanga	0.140	0.046	3.06	**0.002**	0.190
Korekore	0.104	0.033	3.1	**0.002**	**0.258**
Zezuru	0.108	0.043	2.51	**0.012**	0.175
Foreigners	0.086	0.045	1.93	**0.054**	0.123
Religion					
Apostolic	-0.029	0.072	-0.41	0.685	-0.068
Christian gatherings	-0.109	0.081	-1.34	0.181	-0.121
Muslim	0.095	0.093	1.02	0.308	0.075
No religion	-0.008	0.077	-0.1	0.919	-0.010
Pentecostal	0.076	0.074	1.02	0.308	0.126
Protestant	0.033	0.074	0.44	0.657	0.057
Traditional	-0.003	0.072	-0.04	0.968	-0.006
Household assets					
Cattle	-0.001	0.003	-0.38	0.702	-0.031
Donkeys	0.006	0.014	0.44	0.664	0.020
Goats/sheep	0.002	0.001	1.97	**0.05**	0.149
Poultry	0.004	0.001	3.06	**0.002**	0.153
School inputs					
Primary school fees	0.004	0.003	1.2	0.230	0.094
Secondary school fees	0.000	0.001	-0.42	0.675	-0.030
Cross river to school	-0.019	0.022	-0.85	0.397	-0.046
Distance to school	7.970	4.210	1.9	0.059	0.105
Cross wildlife area to school	-0.108	0.021	-5.01	**0**	-0.267
Constant	0.929	0.111	8.35	0	.
Education output: children participation rate in education					
R-square = 0.266, Adjusted R-square =0.210 n=425					

Table 6-5: Inputs in the production of education outputs; children participation in education

Participation in education	Coefficient	Standard error	t	P>t	Beta
Socioeconomic inputs					
Socio-demographic inputs					
Child sex	-0.036	0.017	-2.06	**0.040**	-0.090
Child age	-0.010	0.003	-3.52	**0.000**	-0.160
Orphan	-0.030	0.090	-0.33	0.738	-0.032
Double orphan	0.083	0.101	0.82	0.415	0.079
Household resident period	-5.751	9.151	-0.62	0.537	-0.028
Household size	-0.005	0.005	-0.92	0.360	-0.043
Household head sex	0.010	0.027	0.37	0.713	0.0191
Household head years in school	0.011	0.003	3.94	**0.000**	0.205
Ethnicity					
Doma	0.047	0.044	1.07	0.287	0.062
Karanga	0.113	0.045	2.55	**0.011**	0.154
Korekore	0.105	0.033	3.25	**0.001**	0.262
Zezuru	0.084	0.042	2.02	**0.044**	0.137
Religion					
Foreigners	0.066	0.043	1.51	0.131	0.094
Apostolic	0.003	0.070	0.05	0.963	0.006
Christian gatherings	-0.065	0.079	-0.82	0.411	-0.072
Muslim	0.080	0.090	0.88	0.378	0.063
No religion	0.015	0.075	0.2	0.838	0.020
Pentecostal	0.086	0.072	1.2	0.232	0.143
Protestant	0.038	0.072	0.53	0.596	0.066
Traditional religion	0.023	0.070	0.33	0.741	0.049
Assets					
Number of Cattle	-0.003	0.003	-1.31	0.19	-0.103
Number of donkeys	0.0133	0.013	1	0.317	0.045
Number of goats	0.003	0.001	2.61	**0.009**	0.192
Number of poultry	0.004	0.001	2.8	**0.005**	0.138
School inputs					
Primary fees	0.022	0.012	1.85	**0.065**	0.590
Secondary fees	0.001	0.001	2.03	**0.043**	0.157
Cross river to school	-0.022	0.022	-1	0.317	-0.054
Distance to school	1.132	4.121	2.74	**0.007**	0.149
Cross wildlife area to school	-0.088	0.021	-4.17	**0.000**	-0.219
Masoka (CAMPFIRE)	0.482	0.188	2.57	**0.011**	0.998
Angwa (CAMPFIRE)	0.296	0.067	4.43	**0.000**	0.672
Hambe/Majongwe (comparison)	0.264	0.070	3.78	**0.000**	0.554
Intercept	0.418	0.211	1.98	**0.049**	.
Education output: children participation rate in education **R-square = 0.316, Adjusted R-square =0.260 n=425**					

Source: Survey data December 2015

7. Appendix B for paper 2

The table below shows the potential outcomes for the treatments.

Table 7-1: Potential Outcomes by treatment and covariates in the regression model

Adaptive Capacity Index	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
POmeans						
campfire						
Non-CAMPFIRE	0.392884	0.009625	40.82	0	0.374019	0.411749
CAMPFIRE	0.410646	0.00903	45.48	0	0.392948	0.428344
OME0						
Member in diaspora	0.085169	0.034296	2.48	0.013	0.017949	0.152388
Member in urban	0.011923	0.023984	0.5	0.619	-0.03509	0.058931
Married	0.07774	0.025321	3.07	0.002	0.028112	0.127369
Divorced	0.088521	0.037148	2.38	0.017	0.015713	0.161329
Never married	0.075667	0.050553	1.5	0.134	-0.02341	0.174748
Household Head Sex	0.027213	0.027024	1.01	0.314	-0.02575	0.080178
Buja	0.010359	0.04265	0.24	0.808	-0.07323	0.093952
Doma	-0.07041	0.076759	-0.92	0.359	-0.22086	0.080033
Foreigners	-0.03956	0.042148	-0.94	0.348	-0.12217	0.043045
Karanga	-0.01229	0.028398	-0.43	0.665	-0.06795	0.043369
Korekore	-0.0337	0.025402	-1.33	0.185	-0.08349	0.016084
Zezuru	-0.01906	0.031317	-0.61	0.543	-0.08045	0.042316
Apostolic	0.00166	0.027369	0.06	0.952	-0.05198	0.055302
Christian gathering	-0.05263	0.030484	-1.73	0.084	-0.11237	0.007122
Muslim	0.091665	0.040905	2.24	0.025	0.011493	0.171837
No religion	0.068796	0.031567	2.18	0.029	0.006926	0.130666
Pentecostal	0.043744	0.028797	1.52	0.129	-0.0127	0.100184
Protestant	0.098409	0.033823	2.91	0.004	0.032118	0.1647
Roman catholic	0.013682	0.063607	0.22	0.83	-0.11099	0.138349
_cons	0.302853	0.035698	8.48	0	0.232886	0.37282
OME1						
Member diaspora	0.032743	0.021765	1.5	0.132	-0.00992	0.075401
Member urban	0.05957	0.013201	4.51	0	0.033697	0.085443
Married	0.086049	0.031675	2.72	0.007	0.023968	0.148131
Divorced	0.028526	0.037655	0.76	0.449	-0.04528	0.102329
Never married	0.043007	0.04944	0.87	0.384	-0.05389	0.139909
HOH Sex	-0.00294	0.020296	-0.14	0.885	-0.04272	0.036841
Doma	-0.02954	0.021414	-1.38	0.168	-0.07151	0.012428
Foreigners	0.02497	0.027621	0.9	0.366	-0.02917	0.079106
Karanga	0.104987	0.031855	3.3	0.001	0.042552	0.167421
Korekore	0.016849	0.015652	1.08	0.282	-0.01383	0.047526
Zezuru	0.029875	0.034328	0.87	0.384	-0.03741	0.097156
Apostolic	0.058665	0.021294	2.75	0.006	0.016929	0.1004
Christian gathering	0.055838	0.025664	2.18	0.03	0.005537	0.106139

No religion	0.001032	0.022156	0.05	0.963	-0.04239	0.044457
Pentecostal	0.058538	0.018019	3.25	0.001	0.023222	0.093854
Protestant	0.033332	0.01965	1.7	0.09	-0.00518	0.071845
Roman catholic	0.183967	0.017643	10.43	0	0.149388	0.218545
_cons	0.272562	0.028789	9.47	0	0.216137	0.328987

Source: Survey data December 2015

8. Appendix C for paper 3

Table 8-1: Determinants of programme preference

campfire choice	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
affect	0.082	0.739	0.11	0.911	-1.366	1.531
cattle	-0.218	0.172	-1.27	0.204	-0.554	0.119
shoats	-0.023	0.030	-0.76	0.446	-0.081	0.036
poultry	0.054	0.030	1.81	**0.071**	-0.005	0.114
Wildlife employment	2.428	0.775	3.13	**0.002**	0.908	3.947
Remittances	2.782	1.390	2	**0.045**	0.056	5.507
Illness	-0.041	0.626	-0.07	0.947	-1.269	1.186
Committee member	1.629	1.168	1.39	0.163	-0.660	3.918
Korekore	2.790	0.867	3.22	**0.001**	1.090	4.490
Doma	4.389	1.256	3.5	**0**	1.928	6.850
Zezuru	0.310	1.810	0.17	0.864	-3.238	3.858
Married	-0.401	1.040	-0.39	0.7	-2.439	1.637
participan~c	1.046	0.740	1.41	0.157	-0.404	2.496
Prefer education benefit	1.742	0.733	2.38	**0.017**	0.305	3.179
Prefer cash to education subsidy	-2.841	1.061	-2.68	**0.007**	-4.920	-0.761
Prefer cash to health subsidy	1.146	0.817	1.4	0.161	-0.456	2.748
Better education without campfire	0.470	0.833	0.56	0.572	-1.161	2.102
Better health without campfire	-2.167	0.828	-2.62	**0.009**	-3.790	-0.544
_cons	-2.905	1.521	-1.91	0.056	-5.886	0.075
Logistic regression		Number of obs	116			
		LR chi2(18)	65.2			
		Prob > chi2	0			
Log likelihood = -43.334851		Pseudo R2	0.4293			

Source: Survey data December 2015

Table 8-2: Reduced model of campfire preference

Dependent variable: campfire programme choice =1

Predictors	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Education benefit	1.059	0.430	2.46	**0.014**	0.216	1.903
Can have better access to health without campfire	-1.128	0.415	-2.72	**0.007**	-1.942	-0.314
Employed in wildlife industry	1.206	0.477	2.53	**0.011**	0.271107	2.141
_cons	-0.685	0.354	-1.94	**0.053**	-1.378	0.008
	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Education benefit	2.883955	1.241039	2.46	**0.014**	1.24078	6.7032
Can have better access to health without campfire	0.323615	0.134363	-2.72	**0.007**	0.143421	0.730202
Employed in wildlife industry	3.339439	1.59256	2.53	**0.011**	1.311415	8.50368

Logistic regression model test results	Number of obs	=	128
	LR chi2(3)	=	25.53
	Prob > chi2	=	0.0000
Log likelihood = -69.600344	Pseudo R2	=	0.155

Source: Survey data December 2015

9. Appendix D: Household questionnaire:

CBNRM Public investments, access to services, adaptation to environmental risks and perceptions on CBNRM

Consent

Purpose: We are conducting an academic survey to learn about the impact of public investments on household access to education and health, household ability to deal with environmental risks and people's perception of the CAMPFIRE programme. This research has been approved by the Commerce Faculty Ethics in Research Committee.

Selection: Your household has been randomly selected to participate in an interview that includes questions on topics such as your family background, household expenditures, food consumption and assets, experiences with shocks and wildlife. Your responses will be combined with responses from approximately 400 other households from the district. **Benefits and compensation:** We cannot and do not guarantee or promise that you will receive any benefits from this study. No compensation, monetary or otherwise, can be offered for your participation as this may be seen as coercing your participation.

Confidentiality: If you are willing to participate in this study and give your verbal consent, we will not disclose your household's information to any other entity not directly related to this academic research.

Voluntary participation: Participation in this study is voluntary. If you decide not to participate in this study, your decision will not affect your future relations with the research institutions or its personnel. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without penalty. The interview would take approximately one hour.

Contacts: Should you have any questions regarding the research please feel free to contact the researcher on: **Collen Matema; +263 776 800 287 0R +277 631 387 093**

A	Location		
A1	Ward number		
A2	Ward name		
A3	Enumeration Area		
A4	Village name		
A5	Name of nearest primary school		
A6	Distance to nearest primary school		_____Km ___hr ____minutes -8=Don't Know (DK) -9=Refused
A7	Primary school user charges	School fees	USD _____
A8		School levy	USD _____
A9	Name of nearest secondary school		
A10	Distance to nearest secondary school		_____Km ___hr ____minutes -8=Don't Know (DK) -9=Refused
A11	Secondary school user charges	School fees	USD _____
A12		School levy	USD _____
A13	Name of nearest health centre		
A14	Distance to nearest health centre		_____Km ___hr ____minutes -8=Don't Know (DK) -9=Refused
A15	Health fees	Under 5 years	USD _____
A16		Children 5-12	USD _____
A17		Children 13 -17	USD _____
A18		Adults	USD _____
B	**CAMPFIRE STATUS**		
B1	Is the ward implementing CAMPFIRE?		0=No 1=Yes -8=DK -9=Refused
B2	If yes when did it start? (Year)		_____ -8=DK -9=Refused
B3	Is the village implementing CAMPFIRE?		_____ -8=DK -9=Refused
B4	If yes average yearly income since 2009? Ward level		USD _____ -8=DK -9=Refused
B5	Is the household affiliated to/a member of CAMPFIRE?		0=No 1=Yes -8=DK -9=Refused
B6	How much dividends did you get last year/season?		0=No 1=Yes -8=DK -9=Refused
B7	Are you or any member of your household in the CAMPFIRE committee?		0=No 1=Yes -8=DK -9=Refused
B8	Current position of any household member in the CAMPFIRE		0=None 1=chairperson 2=vice chairperson 3=treasurer 4=resource monitor 5=committee member -8=DK -9=Refused

B9	Where you or any member of your household in the CAMPFIRE committee before?	0=No 1=Yes -8=DK -9=Refused
B10	Position of any household member in the CAMPFIRE before.	0=None 1=chairperson 2=vice chairperson 3=treasurer 4=resource monitor 5=committee member -8=DK -9=Refused
C	**Household demographic information**	
C1	How many years has household lived in the area?	-8=DK -9=Refused
C2	Household size (Number of household members)	-8=DK -9=Refused
C3	Are there any members of the household in the Diaspora?	1=Yes 0=No
C4	Are there any members of the household in an urban area?	1=Yes 0=No
C5	Household head name	-8=DK -9=Refused
C6	Household head gender	1=Male 2=Female
C7	Marital status	1=Married 2=Never married 3=Divorced/separated 4=Widowed -8=DK -9=Refused
C8	Household ethnicity	1=Korekore 2= Doma 3= Zengeretsi 4=Foreigners (Zambia/Moza) 5=Zezuru 6. Karanga -8=DK -9=Refused
C9	What is the religion of the head of household head?	0= None 1=Roman Catholic 2=Protestant 3=Pentecostal 4=Apostolic sect 5=ZCC 6=Christians gatherings 7=Muslim/Islam 8=Traditional 9=Other -8=DK -9=Refused
C10	Household head education level (years in school)	0=Never Attended 1=Primary 1, 2=Primary 2 3=Primary 3, 4=Primary 4, 5=Primary 5, 6=Primary 6, 7=Primary 7, 8=Form 1 9=Form 2, 10=Form 3, 11=Form 4 12=Form 5 13=Form 6 14 = some college/university -8=DK -9=Refused
Household member roaster [repeat for each member]		
C11	Name of household member	
	Relationship to head of household	1= Spouse 2=Son/daughter of head and spouse 3=Son /daughter of head 4= Son/daughter of spouse 5=Mother/father of head/ spouse 6=Sister/brother of head/spouse 7=Foster child

		8=Grand child 9=Other relatives 10=Non-relatives -8=DK -9=Refused
C12	Sex	1=Male 2=Female -8=DK -9=Refused
C13	Age (birthday and month for U18)	_____years -8=DK -9=Refused
C14	If below 18 year, Is …'s father alive	0=No 1=Yes -8=DK -9=Refused
C15	If below 18 year, Is …'s mother alive	0=No 1=Yes -8=DK -9=Refused
D	**Education**	
D1	Has (NAME) ever been to school?	0=No 1=Yes -8=DK -9=Refused **if no skip to C18**
D2	What are the years spent in school if (NAME) above 17/education level	1=Primary 1, 2=Primary 2 3=Primary 3, 4=Primary 4, 5=Primary 5, 6=Primary 6, 7=Primary 7, 8=Form 1 9=Form 2, 10=Form 3, 11=Form 4 12=Form 5 13=Form 6 14 = some college/university -8=DK -9=Refused
D3	If (NAME) above 17 but did not complete what was the reason?	1=no school fees 2=no school uniform 3=no stationery 4=ill 5=no food 6=river flooded 7=family tragedy 8=family events 9=school too far 10=had no interest 11=to help with domestic work 12=no teachers 13=poor performance 14=other
D4	If above 5 and never been to school can …. read and write?	0=No 1=Yes -8=DK -9=Refused
D5	Why is (NAME) not attending school? (multiple)	1=no school fees 2=no school uniform 3=no stationery 4=ill 5=no food 6=river flooded 7=family tragedy 8=family events 9=school too far 10=had no interest 11=to help with domestic work 12=no teachers 13=poor performance 14=wild animals 15=other
	If 5-17 is (NAME) attending school (2015)	0=No 1=Yes -8=DK -9=Refused
D6	If no can (NAME) Read and write Skip	0=No 1=Yes -8=DK -9=Refused
D7	Which level was (NAME) this 2015?	0=Primary 0, 1=Primary 1, 2=Primary 2 3=Primary 3, 4=Primary 4, 5=Primary 5, 6=Primary 6, 7=Primary 7, 8=Form 1 9=Form 2, 10=Form 3, 11=Form 4 12=Form 5 13=Form 6 14=Tertiary
D8	Which level was (NAME) in, last school year 2014?	0=Primary 0, 1=Primary 1, 2=Primary 2 3=Primary 3, 4=Primary 4, 5=Primary 5, 6=Primary 6, 7=Primary 7, 8=Form 1

		9=Form 2, 10=Form 3, 11=Form 4 12=Form 5 13=Form 6 14=Tertiary 15=not in school
D9	Had (NAME) skipped school in 2015?	0=No 1=Yes -8=DK -9=Refused
D10	How often did (NAME) skip school?	1= every week 2=every month 3=every term 4=once a year
D11	If (NAME) skipped school what were the reasons? multiple	1=no school fees 2=no school uniform 3=no stationery 4=ill 5=no food 6=river flooded 7=family tragedy 8=family events 9=school too far 10=had no interest 11=to help with domestic work 12=no teachers 13=poor performance 14=wild animals 15=other
D12	Which school was/is (NAME) attending?	-8=DK -9=Refused
D13	How far is the school that (NAME) is attending /attended?	_____Km ___hr ____minutes
D14	If different from nearest school why is (NAME) not attending the nearest school?	1=was refused 2=expensive 3=river 4=wildlife 5=poor service 6=no teachers -8=DK -9=Refused
D15	If 5-17 does (NAME)cross a river to get to school?	1=Yes 0=No -8=DK -9=Refused
D16	If 5-17 does (NAME) cross wildlife area to get to school?	1=Yes 0=No -8=DK -9=Refused
D17	If 5-17 how much did you spent on education last year for (NAME)?	-8=DK -9=Refused
D18	If (NAME) 5-17 School fees + levies (include owing)	USD _____-8=DK -9=Refused
D19	If (NAME) 5-17 School fees amount owing	USD _____-8=DK -9=Refused
D20	If (NAME) 5-17 School uniforms	USD _____-8=DK -9=Refused
D21	If (NAME) 5-17 School stationery	USD _____-8=DK -9=Refused
D22	If CAMPFIRE ward, what direct assistance did (NAME)got from CAMPFIRE 2015?	0=None 1=fees USD___, 2=stationery USD___ 3=uniform USD___ 4=exam fees USD___ -8=DK -9=Refused
D23	If 5-17 Has (NAME) got education assistance from other programmes (other than CAMPFIRE)?	0=None 1=fees USD___, 2=stationery USD___ 3=uniform USD___ 4=exam fees USD___ -8=DK -9=Refused
D23	If 5-17 what was (NAME)'s mark/no. subjects passed last term? (no. passed/total subjects)	
E	**Health**	
E1	Has (NAME) suffered any illness in the past 12 months	1=Yes 0=No -8=DK -9=Refused
E2	If yes, how many times has (NAME) been ill in the last 12 months?	
E3	How many times has (NAME) visited the local clinic in the last 12 months	
E4	If no visits or visits less than number of illnesses for (NAME) what were the reasons for not seeking medical treatment from the local clinic?	1=Financial(user fees) 2=Financial (drugs/prescriptions) 3=Financial (transport cost) 4=Not my choice 5=Staff not hospitable 6=Facility had no drugs 7=Facility had no/inadequate staff 8=No information about services -8=DK -9=Refused
E5	Has (NAME) received medical attention on each visit?	1=Yes 0=No -8=DK -9=Refused

E6	**Cost/out of pocket payments**	
E7	What were the direct – total user fees (12 months) for (NAME)	USD _____
E8	Direct – drug cost/other (12 months) for (NAME)	USD _____
E9	Indirect – transport cost (12 months) (NAME)	USD _____
E10	If reported ill in the last 12 months Has (NAME) suffered diarrhoea in the past two weeks	1=Yes 0=No -8=DK -9=Refused
E11	Did (NAME) receive medical treatment for the diarrhoea?	1=Yes 0=No -8=DK -9=Refused
E12	Stunting/wasting (under 5) for (NAME)	Height: _____-8=DK -9=Refused
E12		Weight:_____ -8=DK -9=Refused
END OF ROASTER		

F	**ADAPTATION: Asset index**		
F1	How many of the following does your household own?		
F2	Cattle	_____-8=DK -9=Refused	
F3	Donkeys	_____-8=DK -9=Refused	
F4	Goats/sheep	_____-8=DK -9=Refused	
F5	Chickens	_____-8=DK -9=Refused	
F6	Hoes and axes	_____-8=DK -9=Refused	
F7	Ploughs and cultivators	_____-8=DK -9=Refused	
F8	Type of dwellings	1=Brick and thatch 2=Brick and iron/asbestos sheets 3=pole, dagga and thatch	
G	**ADAPTATION: Livelihood sources (livelihoods diversity index)**		
	Livelihoods source		**Income/equivalent in (USD) 1=1month 2=4 months 3=6 months 4= season 5=12months**
G1	What is the household's primary/main livelihood? **(CODE Page 6)**		
	Other livelihoods Do you or any of your household engage in any of the following?		
G2	Own crop production/sales	0=No 1=Yes	
G3	Own livestock production/sales	0=No 1=Yes	
G4	Agricultural wage labour (casual, temporary, seasonal, contract)	0=No 1=Yes	
G5	Non-agricultural wage labour (casual, temporary, seasonal, contract)	0=No 1=Yes	
G6	Salaried, permanent (agricultural)	0=No 1=Yes	
G7	Salaried, permanent (non-agricultural)	0=No 1=Yes	
G8	Sale of wild/bush products (e.g., honey, game meat)	0=No 1=Yes	
G9	Handicrafts	0=No 1=Yes	
G10	Own formal business (non-agricultural e.g. shop)	0=No 1=Yes	

G11	Informal trader (agricultural products)	0=No 1=Yes	
G12	Informal trader (non-agricultural products)	0=No 1=Yes	
G13	Remittances	0=No 1=Yes	
G14	Begging	0=No 1=Yes	
G15	Retired with pension	0=No 1=Yes	
G16	Other (specify)	0=No 1=Yes	
H	**Adaptation [adaptive capacity]**		
H1	Have you noticed any significant changes in weather patterns between the decades 1980s/1990s/2000s decades?	0=no 1=yes	
H2	If yes what changes have you observed? Select all that apply.	1= Increased no. of seasons without enough rainfall 2= Rainfall starts late and ends early 3= Rains come earlier than they normally should 4= Increased floods 5= Extremes in temperature (very cold/hot)	
H3	What do you think are their causes? [multiple]	1=climate change 2=deforestation, 3=bad farming methods, 4=not following tradition, 5=other (specify) -8=don't know	
H4	**Shocks, Stresses and Response**		
H5	In the past 12 months did your household experience (shock/stress)?		How did you cope? Enter from code list all that apply (page 7)
H6	Floods	0=No 1=Yes	
H7	Dry spells/variable rainfall	0=No 1=Yes	
H8	Drought	0=No 1=Yes	
H9	Deforestation	0=No 1=Yes	
H10	Livestock diseases	0=No 1=Yes	
H11	Crop diseases and pests	0=No 1=Yes	
H12	Reduced soil productivity	0=No 1=Yes	
H13	livestock predation	0=No 1=Yes	
H14	Crop raids	0=No 1=Yes	
H15	Attack by wild animals	0=No 1=Yes	
H16	Food price fluctuation	0=No 1=Yes	
H17	HIV/AIDS	0=No 1=Yes	
H18	Diarrheal outbreaks	0=No 1=Yes	
H19	Chronic illness (malaria, TB)	0=No 1=Yes	
H20	Migration of main income earner	0=No 1=Yes	
H21	Unemployment/ underemployment	0=No 1=Yes	

H22	Death of main income earner	0=No 1=Yes	
H23	Other shock/stress	0=No 1=Yes	

	Codes for Q E1
1	Own crop production/sales (communal/resettlement)
2	Own livestock production/sales (communal/resettlement)
3	Agricultural wage labor (casual, temporary, seasonal, contract)
4	Non-agricultural wage labor (casual, temporary, seasonal, contract)
5	Salaried, permanent (agricultural)
6	Salaried, permanent (non-agricultural)
7	Sale of wild/bush products (e.g., honey, charcoal)
8	Handicrafts
9	Homemaker/housewife (unpaid)
10	Childcare/domestic work (paid)
11	Other self-employment/own business (non-agricultural)
12	Informal trader (agricultural products)
13	Informal trader (non-agricultural products)
14	Remittances
15	Unable to work due to illness/handicap
16	Unemployed
17	Retired with pension
18	Retired without pension
19	Child/student
20	Other (specify)
-8	DK
-9	Refused

	G4-21 Coping Strategies		
	LIVESTOCK, CROPS AND LAND HOLDINGS		**TO GET MORE FOOD OR MONEY**
1	Send livestock in search of pasture	17	Take up new wage labour
2	Sell livestock	18	Sell household items (e.g., radio, bed)
3	Slaughter livestock	19	Sell productive assets (e.g., plough, water pump)
4	Lease out land	20	Take out a loan from an NGO
	Crop related	21	Take out an loan from a bank
5	Cultivate on river beds	22	Take out a loan from CAMPFIRE

6	Irrigate	23	Take out a loan from friends or relatives
7	Grow small grains/drought resistant	24	Send children to work for money (e.g., domestic service)
8	Stopped cultivating some years	25	Receive money or food from family members within
9	Contract farming	26	Joined round tables
	MIGRATION	27	Receive food aid from the government
10	Migrate (only some family members)	28	Receive food aid from an NGO
11	Migrate (the whole family)	29	Participate in cash-for-work
12	Send boys to stay with relatives or other HH	30	Participate in food-for-work
13	Send girls to stay with relatives or other HH	31	Use money from savings
	COPING STRATEGIES TO REDUCE	32	Receive money from a relative from outside of
14	Take children out of school	33	Hunting
15	Move to less expensive housing		**FAITH BASED RESPONSE**
16	Reduce food consumption	34	Joined a church
		35	Changed church
-8	DK	36	Moved out of church
-9	Refused	37	Consulted traditional healers
0	Nothing	38	Bought good luck charms
		39	Other (specify)

	Adaptiveness	**KG**
H22	Household weekly cereal consumption in a bad year (kg)	
H23	Household normal weekly cereal requirement (kg) *Adaptiveness*	
H24	Calculate yearly cereal requirement per capita (kg) *Adaptiveness*	
H25	Cereal production in a good rainfall year(kg) *Adaptiveness*	
H26	Amount from other sources in a good rainfall year (kg) *Adaptiveness*	
H27	Cereal production in a bad rainfall year(kg) *eg 2014/5 Adaptiveness*	
H28	Amount from other sources in a bad year(kg) *eg 2014/5 Adaptiveness*	

I	**IMPROVED LIVELIHOOD PRACTICES (Capacity building)**	
I1	Have you or anyone in your household ever received any vocational (job) or skill training?	1. Yes 2. No **(Skip to I3)** -8 DK -9 Refused
I2	Who provided the vocational skills training? **Select all that apply**	1. Government 2. Council 3. NGO 4. CAMPFIRE 5. Private sector 6. Religious Organization 7. Others (specify)_____ -8 DK -9 Refused

I3	Have you or anyone in your household ever received any business development training?	1. Yes 2. No **(Skip to I5)** -8 DK -9 Refused
I4	Who provided the business development training? **Select all that apply**	1. Government 2. Council 3. NGO 4. CAMPFIRE 5. Private sector 6. Religious Organization 7. Others (specify) -8 DK -9 Refused
I5	Have you or anyone in your household ever received any natural resource management training?	1. Yes 2. No **(Skip to I7)** -8 DK -9 Refused
I6	Who provided the natural resource management training? **Select all that apply**	1. Government 2. Council 3. NGO 4. CAMPFIRE 5. Private sector 6. Religious Organization 7. Others (specify) -8 DK -9 Refused
I7	Have you or anyone in your household ever received agriculture inputs (seed, fertiliser)?	1. Yes 2. No **(Skip to I9)** -8 DK -9 Refused
I8	Who did you receive the agriculture inputs from? **Select all that apply**	1. Government 2. Council 3. NGO 4. CAMPFIRE 5. Private sector 6. Religious Organization 7. Others (specify) -8 DK -9 Refused
I9	Have you or anyone in your household ever received adult education (literacy or numeracy or financial education)?	1. Yes 2. No **(Skip to I11)** -8 DK -9 Refused
I10	Who did you receive the education from?	1. Government

	Select all that apply	2. Council 3. NGO 4. CAMPFIRE 5. Private sector 6. Religious Organization 7. Others (specify) -8 DK -9 Refused
COLLECTIVE ACTION		
I11	In the past 12 months, have you or any member of your household worked with others in your village to do something for the benefit of the community?	1. Yes 2. No **(Skip to I13)** -8 DK -9 Refused
I12	What activities did you participate in to benefit the community? [**SELECT ALL THAT APPLY**] [PROBE]	1. Protecting crop land from flooding 2. Protecting structures from flooding/landslides 3. Soil conservation (terracing, gully improvement, bunds) 4. Reforestation 5. Improving access to drinking water 6. Improving access to electricity 7. Improving access to health services 8. Improving road quality 9. Forming cooperative 10. Promoting tourism to improve local economy 11. Other (specify) -8 DK -9 Refused
FORMAL SOURCES OF SOCIAL SUPPORT		
I13	Has your household received any kind of assistance from the government, an NGO, company, or religious/ or any organization during the last 12 months?	1. Yes 2. No **(Skip to I16)** -8 DK
I14	Who provided the assistance? **Select all that apply**	1. Government 2. Council 3. NGO 4. CAMPFIRE 5. Private sector 6. Religious Organization 7. Others (specify) -8 DK -9 Refused
I15	What types of support were received? **(Read list) – match the assistance to organisations**	1. Food aid 2. Food-for-work 3. Cash-for-work 4. Housing materials

	Select all that apply	5. Ag/livestock inputs 6. Installed water points 7. Install latrine 8. School fees 9. Unconditional cash transfer 10. Other (specify) -8 DK -9 Refused
INFORMAL SOURCES OF SOCIAL SUPPORT		
I16	If your household had a problem and needed money or food urgently, who WITHIN THIS COMMUNITY could you turn to for assistance? **Select all that apply**	1. Close family member [ordinary] 2. Family member [in CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I17	If your household had a problem and needed money or food urgently, who OUTSIDE THIS COMMUNITY could you turn to for assistance? **Select all that apply**	1. Close family member [ordinary] 2. Family member [in CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I18	Who WITHIN THIS COMMUNITY would you help if they needed food or money urgently? **Select all that apply**	1. Close family member [ordinary] 2. Family member [in CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I19	Who OUTSIDE THIS COMMUNITY would you help if they needed food or money urgently ?**Select all that apply**	1. Close family member [ordinary]

		2. Family member [CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I20	In the past 12 months, have you helped anyone **IN THIS COMMUNITY** to recover after a shock?	1 Yes 2 No **(Skip to I22)** -8 DK -9 Refused
I21	In the past 12 months, **who IN THIS COMMUNITY have you helped** to recover after a shock, such as by sharing or giving food, money, supplies/materials, livestock, or labour?	1. Close family member [ordinary] 2. Family member [CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I22	In the past 12 months, have you helped anyone **OUTSIDE OF THIS COMMUNITY** to recover after a shock?	1 Yes 2 No **(Skip to I24)** -8 DK -9 Refused
I23	In the past 12 months, **who OUTSIDE OF THIS COMMUNITY have you helped** to recover after a shock, such as by sharing or giving food, money, supplies/materials, livestock, or labour?	1. Close family member [ordinary] 2. Family member [CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I24	In the past 12 months, **has anyone IN THIS COMMUNITY helped you** with food, money, supplies/materials, livestock, or labour?	1 Yes 2 No **(Skip to H26)** -8 DK -9 Refused

I25	In the past 12 months, **who IN THIS COMMUNITY has helped you** with food, money, supplies/materials, livestock, or labour?	1. Close family member [ordinary] 2. Family member [CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I26	In the past 12 months, **has anyone OUTSIDE THIS COMMUNITY helped you** with food, money, supplies/materials, livestock, or labor?	1 Yes 2 No **(Skip to I28)** -8 DK -9 Refused
I27	In the past 12 months, **who OUTSIDE THIS COMMUNITY has helped you** with food, money, supplies/materials, livestock, or labor?	1. Close family member [ordinary] 2. Family member [CAMPFIRE committee] 3. Family member [employed safari/campfire] 4. Extended family 5. Non-relative in your ethnic group 6. Non-relative in a different ethnic group 7. Nobody -8 DNK -9 Refused
I28	Do you or does anyone else in your household know a staff member of an NGO?	1. Yes 2. No **(skip to I30)** -8 DK -9 Refused
I29	How do you (or another household member) know the NGO staff member? Is he or she a…	1. Family member or relative 2. Friend 3. Neighbor 4. Acquaintance -8 DK -9 Refused
I30	Could you ask the NGO staff member to help your family or community if help was needed?	1. Yes 2. No -8 DK -9 Refused

Participation in Community Decision making	**Are any of the following groups active in your community?** **READ EACH GROUP OUT LOUD** **1. Yes** **2. No** **-8 DK** **-9 Refused** **{if not=1 skip to next group}**	**Are you or any members of your household participating in this group?** **1. Yes** **2. No** **-8 DK** **-9 Refused** **{if not=1 skip to next group}**	**How actively do you or hh member participate in group's decision-making?** **1=leader** **2=Very active** **3=Active** **4=Not active**
	J1	**J2**	**J3**
a. Farmer groups (crops)			
b. Livestock production groups			
c. Savings / credit groups			
d. Community forest and rangeland users group			
e. Disaster Risk Reduction/Climate Change Adaptation committee			
f. Water users· group			
g. Trade or business associations			
h. Area land committee			
i. Charitable group (helping others)			
j. Mutual Help group (burial society)			
k. Civic group (“improving community”)			
l. Religious group			
m. Women’s group			
n. Youth group			
o. In-school, out-of-school clubs			

K	Dietary diversity scoring tool – food security/adaptiveness						
	In the past **24 hours and 7days** how many times have you or any of your household members eaten the following						
Group variety	**Food group**	**Tick if consumed**		**Frequency**		**Weighted contribution of each**	
		24 hrs	7days	24 hrs	7days	24 hrs	7days
	A. Cereals						
3	1. Sorghum						
	2. Maize						
	3. Rice						
	B. Roots						
2	4. Cultivated						
	5. Wild						
	C. Leaves						
2	6. Cultivated						
	7. Wild						
	D. Cucurbits						
1	8. (manhanga)						
	E. Legumes						
2	9. Cultivated						
	10. Wild						
	F. Fruits						
2	11. Cultivated						
	12. Wild						
	G. Animal protein						
6	13. Domestic						
	14. Game meat						
	15. Fish						
	16. Insect						
	17. Dairy/milk						
	18. Eggs						
18	**TOTAL SCORE**						

L	Encounters: Wild animal attacks	
L1	Have you or any member of your households been attacked by a wild animal?	0=No 1=Yes
L2	Which animals?	1=Lions 2=Hyena3=Leopard/cheetah 4=Baboons 5=Jackal 6=Crocodiles 7=Hippopotamus 8=Snakes Other (Specify) _____
L3	If yes who was attacked?	1=self 2=wife 3=child 4=brother 5=sister 6=father 7=mother 8=non-relative 9=other
L4	When did this happen? (years)	
L5	Where did this happen?	1=fields 2=at home 3=way to service centre 4=Other (specify) ___
L6	What were the results of the attack?	1=injury 2=death 3=escaped without injury 4=Other (specify) ___
L7	To whom did you report the incident?	0=did not report 1=PAC 2=RDC 3=National Parks 4=Police 5=Traditional leaders (Chief/village head) 6=Other (specify) ___
L8	What help did you get?	0=None 1=Burial assistance 2=Medical fees 3=Transport expenses 4=Compensation (food) 5=Compensation (money) 6=other (specify) _____
L9	What do you feel towards the people you reported to?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
L10	If you did not report what was the reason?	0=no particular reason 1=no need to 2=are not helpful 3=Other (specify) ____
L11	What were your feelings towards animals after the attack/s?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
L12	What do you feel now towards the animals when you think or see them?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
L13	What things do at times do that you think are caused by the wild animal attacks that you or your household members encountered?	1=revenge killing 2=poaching 3=assisting poachers 4=non-participation in NRM 5=other (specify) ____

M	Encounters: Crop raids	
M1	Have you experienced crop raids by wild animals?	0=No 1=Yes
M2	Which animals?	1=Elephants 2=Buffaloes 3=Baboons/monkeys 4=Elands/zebra/ 5=Birds 6=wild pigs 7=Hippopotamus 8=Others (Specify)
M3	When did this happen? (years)	
M4	How serious were the crop raids?	0=not serious 1=serious 2=very serious
M5	What were the results of the crop raids?	1=not enough food 2=not enough cash 3=incurred debts 4=could not pay debts 5=Other (specify) ___

M6	To whom did you report the incidents?	0=did not report 1=PAC 2=RDC 3=National Parks 4=Police 5=Traditional leaders (Chief/village head) 6=Other (specify) ___
M7	What help did you get?	0=None 1=Compensation (food) 2=Compensation (money) 3=other (specify) _____
M8	What do you feel towards the people you reported to?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
M9	If you did not report what was the reason?	0=no particular reason 1=no need to 2=are not helpful 3=Other (specify) ____
M10	What were your feelings towards animals after the crop raids?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
M11	What do you feel now towards the animals when you think or see them?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
L12	What things do you at times do that you think are caused by the crop raids that you experienced?	1=revenge killing 2=poaching 3=assisting poachers 4=non-participation in nrm 5=other (specify) ____

N	**Encounters: Livestock predation**	
	Have you experienced livestock predation?	0=No 1=Yes
N1	Which animals?	1=Lions 2=Hyena3=Leopard/cheetah 4=Baboons 5=Jackal 6=Crocodiles 7=Hippopotamus 8=Snakes 8=Other (Specify) _____
N2	When did this happen? (years)	
N3	Where did this happen?	1=fields 2=at home 3=Grazing area 4=Other (specify) ___
N4	What were the results of the attack?	1=livestock injury 2=death 3=escaped without injury 4=Other (specify) ___
N5	To whom did you report the incident?	0=did not report 1=PAC 2=RDC 3=National Parks 4=Police 5=Traditional leaders (Chief/village head) 6=Other (specify) ___
N6	What help did you get?	0=None 1=Compensation (food) 2=Compensation (money) 3=other (specify) _____
N7	What do you feel towards the people you reported to?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
N8	If you did not report what was the reason?	0=no particular reason 1=no need to 2=are not helpful 3=Other (specify) ____
N9	What were your feelings towards animals after the livestock predation/s?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)
N10	What do you feel now towards the animals when you think or see them?	1=hatred 2=angry 3=sorry 4=fear 5=nothing 6=other (Specify)

N11	What things do you at times do that you think are caused by the livestock predation you experienced?	1=revenge killing 2=poaching 3=assisting poachers 4=non-participation in nrm 5=other (specify) ____

O	**Do the following happen in your community/village?**	**0=No 1=Yes**	**How often?** 1=every day 2=within a week 3=within a month 4=each growing season 5=within a year
O1	Crop raids		
O2	Livestock predation		
O3	Human attacks by wild animals (Injury)		
O4	Human deaths by wild animals		

END of questionnaire: THANK YOU!!

10. Appendix E: KII guide

Question Guides for in-depth interview

Purpose: We are conducting an academic survey to learn about the impact of public investments on household access to education and health, household ability to deal with environmental risks and people's perception of the CAMPFIRE programme. This research has been approved by the Commerce Faculty Ethics in Research Committee.

Selection: Your household has been randomly selected to participate in an interview that includes questions on topics such as your family background, household expenditures, food consumption and assets, experiences with shocks and wildlife. Your responses will be combined with responses from approximately 400 other households from the district.

Benefits and compensation: We cannot and do not guarantee or promise that you will receive any benefits from this study. No compensation, monetary or otherwise, can be offered for your participation as this may be seen as coercing your participation.

Confidentiality: If you are willing to participate in this study and give your verbal consent, we will not disclose your household's information to any other entity not directly related to this academic research.

Voluntary participation: Participation in this study is voluntary. If you decide not to participate in this study, your decision will not affect your future relations with the research institutions or its personnel. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without penalty. The interview would take approximately one hour.

Contacts: Should you have any questions regarding the research please feel free to contact the researcher on: **Collen Matema; +263 776 800 287 0R +277 631 387 093**

A. Livelihoods/practices (allow participants to narrate their stories-detailed)

- **Life history** – where born, parents/family livelihoods pursuits – livelihoods changes over the years, migrations (if any) and reasons.

- Current livelihoods - sources of income and food (agriculture, hunting, gathering, tree harvesting (commercial or subsistence), other non-timber - where, how, with what results-sustainability,

– Which one is the main for income and for food?

– What are the main challenges/shocks you face earning a living? Why? Probe for as many as the interviewee can remember

– How are you addressing each of the challenges? Is it helping? Why/why not? Probe for CAMPFIRE programme related responses to challenges.

B. Quick questions (do not allow much time – will be repeated at the end of the interview)

CAMPFIRE is good 1= Yes 0= No

CAMPFIRE should be stopped 0=No 1=Yes

C. Experiences/encounters

- Wildlife encounters (*crop raids/livestock predation/human attack [communities for experts* – probe for as many encounters – for each encounter probe:
    - How it happened – narratives of the incidences - [where -when -the process –who were involved -
    - With what results on households – injuries, deaths, crop destruction, etc
    - What did they do after each incident – report to who? Initial reaction –narratives-what exactly was said?
    - With what results – feelings (then) towards 1. Animals 2. People etc
      General feelings developed during each of the encounters described above.
      General feelings now after the encounters
      What first comes into mind when you think of (name of animal/Parks/council/CAMPFIRE [HEURETICS] – feelings that come without having to reason – feeling of pain, hatred, fear, joy, appreciation/thankful, etc
    - What is the frequency of crop raids/predation/deaths/injury in the community?

D. Encounters with: (Probe for emerging relations (good/bad)) – either after a hwc or other platforms – meetings-social- etc

a. Parks – Narratives
b. Council – Narratives
c. CAMPFIRE committee – Narratives

General feelings developed during each of the encounters.

General feeling now after the encounters

What first comes into mind when you hear the word – Parks/council/CAMPFIRE [HEURETICS] – feelings that come without having to reason – feeling of pain, hatred, fear, joy, appreciative, thankful, etc

E. Benefit stream from CAMPFIRE: probe for benefits and how they are framed /perceived

Ask – and allow detailed narratives

-what is CAMPFIRE?

-How did it start/when? Probe for a detailed description of the process

-who started it and how were the communities involved –was s/he involved - probe whether they were consulted, and the processes involved in the consultation – their evaluation of the consultation – was it adequate in their view – who then made the decision to start its implementation?

-how is the programme run – who makes decisions and on what?

-as an individual/household how do you participate in the programme? Are you satisfied that you are contributing as much as you would have wanted to – are there any hindrances to your wanting to contribute

-how do you benefit from the programme [direct/indirect] – cite and narrate all the incidences that you benefited – and feelings associated each benefit episode (anger, fear, appreciative, disgruntled etc) – are the feelings persistent and why?

-are you satisfied with the benefits you are getting from the programme – if not what do you think should be done to meet your specific needs

F. Divergent economic behaviours

[-Can be extracted from livelihoods activities interrogated earlier]

G. Repeat these questions at the end of the interview

CAMPFIRE is good 1= Yes 0= No

CAMPFIRE should be stopped 0=No 1=Yes

What is good performance in relation to CAMPFIRE? Allow the explanation to be as detailed as the possible [probe for more explanations – examples etc]