

THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

Exploring Livelihood Benefits from a Community-Based Conservation Area in South-Eastern Zimbabwe

Tanyaradzwa Chigonda

Lecturer, Department of Physics, Geography and Environmental Science,
Great Zimbabwe University, Masvingo, Zimbabwe

Abstract:

There is growing consensus that for protected areas to be more effective in conserving biodiversity, they must incorporate the livelihood needs of poor local communities they often share boundaries with. This study assesses livelihood benefits from a community-based protected area in south-eastern Zimbabwe. A questionnaire, key-informant interviews and unstructured non-participant observation were used to solicit perceived livelihood benefits from the community-conserved area to the local community. The study identified various livelihood benefits from the community conservation area to the local community including income enhancement, infrastructural development, education enhancement, community health promotion and environmental sustainability. The livelihood benefits from the conservation area have acted as an incentive for cooperation in the community conservation initiative, thereby proving that conservation and livelihoods goals are not necessarily divergent, but can jointly and successfully be pursued to the benefit of both nature and people.

Keywords: biodiversity, community-based conservation, CAMPFIRE, livelihood benefits, Mahenye

1. Introduction

Historically, protected areas have been viewed as islands of biodiversity conservation with little or no connection to nearby communities (Buta et al., 2014). Popularly known as the Yellowstone model or 'fortress' conservation, this exclusionary approach involved the creation of protected areas with strong prohibition on resource use as a defining feature (Adams and Hutton, 2007; Brockington et al., 2008; Bennett and Dearden, 2014; Buta et al., 2014).

Over the last few decades, biodiversity conservation has come to be seen as a variant of sustainable community development particularly in the rural areas of developing countries (Buta et al., 2014; Gurney et al., 2014; Meilby et al., 2014). Recent studies have shown that successful protected area management depends on the collaboration, involvement and support of local communities as most of these communities historically pre-date the protected areas, have pre-existing rights to resources in them and have often been adversely affected by their designation (Buta et al., 2014). The constant call in the current international conservation literature is that conservation areas cannot survive without meaningfully contributing to the livelihoods of the natural-resource dependent poor rural communities they often share boundaries with (McNeely and Miller, 1984; Mombeshora and Le Bel, 2009; Cronkleton et al., 2012; Romero et al., 2012; Kashwan, 2013; Gurney et al., 2014; Pinho et al., 2014; Zhang et al., 2014). In the growing literature at the interface of rural livelihoods improvement and conservation of natural resources, two overarching issues stand out: firstly, how and to what extent use of natural resources does, can, and should contribute to poverty alleviation and secondly, how and to what extent poverty alleviation and conservation are, and can be made, convergent rather than divergent goals (Sunderlin et al., 2005; Walpole and Wilder, 2008; Turner et al., 2012; Meilby et al., 2014).

The importance of biodiversity conservation and its linkages to global development issues has increased significantly since the 1972 Stockholm Conference on the Human Environment, where it was recognised that natural resources are essential assets on which economic growth must be based and that conservation and development are inextricably linked (Scherl et al., 2004). The fifth objective of the Bali Action Plan, born out of the 1982 World Congress on Parks and Protected Areas, further promoted the linkage between protected area management and sustainable development (McNeely and Miller, 1984; Scherl et al., 2004; Niedzialkowski et al., 2014). Recommendation 5 of the Bali Action Plan specifically recognised that people living in or near protected areas can support protected area management if they are taken into account in benefit sharing, are compensated for any losses incurred and are considered in planning and operations (Scherl et al., 2004).

The importance of integrating biodiversity conservation with sustainable socio-economic development was further underscored in 1987 in the report issued by the World Commission on Environment and Development, *Our Common Future* (Bravo, 2014; Holden et al., 2014). A more formal international commitment to the goals of conservation and development was forged at the 1992 United Nations Conference on Environment and Development (the Rio Earth Summit) when countries drafted the Convention on Biological Diversity (CBD) to address the loss of biodiversity (Scherl et al., 2004; Sachs et al., 2009; Glenn et al., 2010; Turner et al., 2012; Agol

et al., 2014; Holden et al., 2014). In its preamble, the CBD identified socio-economic development and poverty alleviation as overriding priorities of developing countries, while article 8 on in situ conservation calls on protected areas to conserve and sustainably use biological diversity to the benefit of adjacent communities (Scherl et al., 2004). The importance of sustainable environmental management to the livelihoods of the rural poor was further underscored in 2000 by the adoption of the Millennium Development Goals (MDGs) aimed at reducing poverty in the world's poorest countries by 2015 (Scherl et al., 2004; Upton et al., 2008; Sachs et al., 2009). Among the eight poverty-focused goals is MDG 7 which seeks to integrate sustainable development with national policies and also to reduce the degradation of natural resources (OECD, 2002; Scherl et al., 2004; Sachs et al., 2009). The UN Summit on Sustainable Development held in Johannesburg in 2002 was a follow-up to Rio. Biodiversity was further recognised as the foundation for sustainable development inseparably linked with economics and development (Jeffries, 2006; Holden et al., 2014). Furthermore, the Vth World Parks Congress held in Durban, South Africa, in September 2003 highlights the centrality of national parks and other protected areas for biodiversity conservation and sustainable development (IUCN, 2003; Scherl et al., 2004). With the theme 'Benefits Beyond Boundaries', it was emphasised that areas must be protected not against people, but for people, and should play a major role in achieving sustainable development and ensuring that they alleviate, and not exacerbate, poverty (IUCN, 2003; Scherl et al., 2004; Mombeshora and Le Bel, 2009; Niedziakowski et al., 2014).

In line with the above international biodiversity conservation trends towards incorporating the livelihood needs of local communities in conservation, and given the persistent failure of post-independence rural development policies in Zimbabwe (Bond, 1999; Scoones and Wolmer, 2003), many studies (Martin, 1986; Child, 1993; Bond, 1999; Bond, 2001; Murombedzi, 2001; Murphree, 2001; Mashinya, 2007; Frost and Bond, 2008; Rihoy et al., 2010; Fischer et al., 2011; Gandiwa et al., 2013; Harrison et al., 2014) have in the past three and a half decades looked at the possible role that natural resource conservation could play towards poverty alleviation in the country's rural areas. In this study, Iassessa community-based protected area (Mahenye) in terms of its livelihood benefits to the local community. While various researchers have written on conservation and development issues in the study area, none has exclusively focused on the livelihood benefits from the community-conservation area to the local community. It is therefore hoped that the narrow focus adopted in this study will help in bringing out deeper insights into the flow of livelihood benefits from the community-conserved area to the local community.

2. Methodology

2.1. Case Selection

Mahenye ward is situated in south-eastern Zimbabwe (Figure 1). It lies in the extreme southern end of Chipinge District in Manicaland Province in Ndwuyyu communal land. The ward consists of a narrow wedge of land 210 km² in extent lying between the Save River in the west and the Rupembi River in the east, which also forms the border with Mozambique (Murphree, 2001). To the south across the Save River is the northern boundary of Gonarezhou National Park, the second largest protected area in Zimbabwe, and also the Sangwe Communal Land in Chiredzi District (Murphree, 2001; The Africa Resources Trust, 2002). The northern boundary of Mahenye is Mutandahwe ward, also in Ndwuyyu Communal Land. The current total population of Mahenye is approximately 5000 people from about 1000 households (Central Statistical Office, 2012).

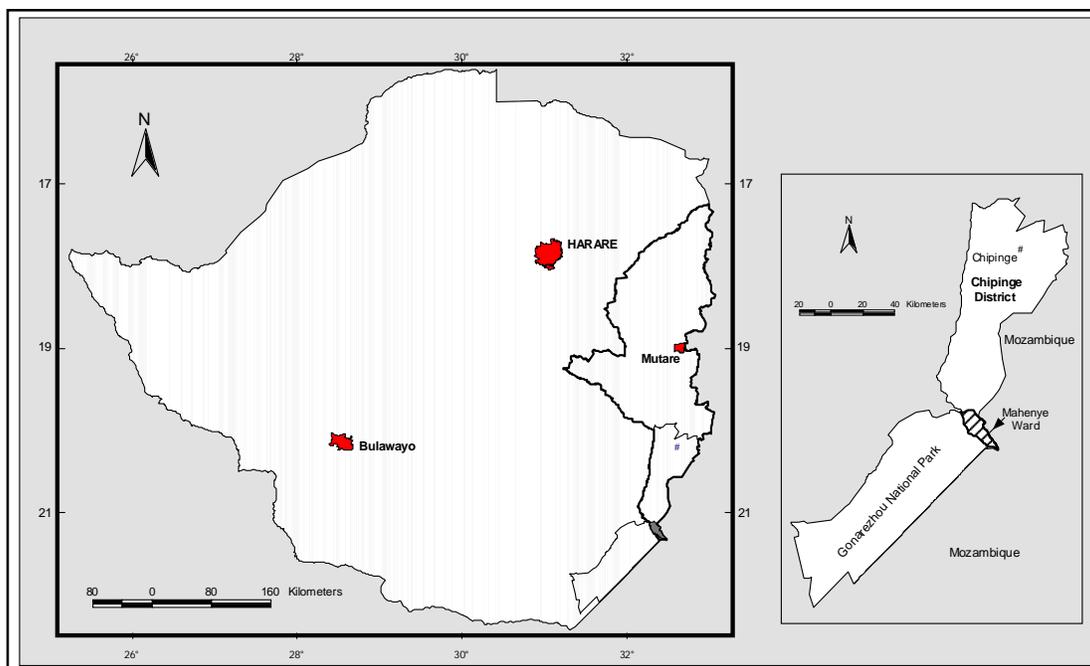


Figure 1: Location of Mahenye ward

The average annual rainfall for Mahenye is 450-500mm (Murphree, 2001). Such a low rainfall makes the ward unsuitable for farming with local communities growing crops and keeping livestock on a purely subsistence basis (Mashinya, 2007).

In the pre-colonial era, the Mahenye community originally settled in part of the area that is now under Gonarezhou National Park and relied on wildlife to meet their daily basic needs (The Africa Resources Trust, 2002; Balint and Mashinya, 2006). The Mahenye people were finally evicted in the 1960s during colonialism to make way for the expansion of Gonarezhou National Park. Colonialism ushered in state ownership of all wildlife both within and outside of protected areas with hunting now forbidden. The people were forced to resort to subsistence pastoralism and cropping which, however, were unsuitable for the hot and dry area (The Africa Resources Trust, 2002; Balint and Mashinya, 2006). The inevitable result was an increase in poaching activities by local communities in both Gonarezhou National Park and adjacent areas.

Mahenye is one of the first communities to be involved with the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), a nationwide community-based natural resource management initiative that started in the late 1980s to early 1990s in Zimbabwe to promote sustainable utilisation of natural resources in the wildlife-rich districts of the country. However, community-based natural resource management initiatives in Mahenye predate the CAMPFIRE Programme (Murphree, 2001), and are therefore, historically speaking, not a product of CAMPFIRE. An attempt to reduce conflicts between the Mahenye community and Gonarezhou National Park in 1982 resulted in an innovative arrangement which acted as a precursor to CAMPFIRE (Balint and Mashinya, 2006). Under this arrangement, the Mahenye community was allowed to earn some income from government-approved trophy hunting while the community, in return, agreed to reduce poaching activities (Balint and Mashinya, 2006). However, conflict between the Mahenye community and Chipinge Rural District Council hampered the successful implementation of the programme (Balint and Mashinya, 2006). The Mahenye CAMPFIRE project officially started in 1990 when Chipinge Rural District Council was granted appropriate authority to manage wildlife in the district on behalf of local communities.

The choice of Mahenye ward as a case for the investigation of livelihood benefits to local communities from a community-conserved area was influenced by the fact that the ward's experience with community-based natural resource management is one of the longest in the country. Such an experience, as shown earlier, antedates the national CAMPFIRE programme and can be traced back to 1982. This automatically makes Mahenye ward one of the best exemplars of community-based natural resource management in Zimbabwe and, arguably, the whole of southern Africa.

2.2. Instrument Design, Data Collection and Analysis

The survey adopted the mixed methods approach in data collection and analysis. de Vos et al., (2011) define mixed methods research as a type of research strategy in which both quantitative and qualitative approaches are used in data collection and analysis in a single study. Mixed methods research or triangulation provides strengths that offset the weaknesses of qualitative and quantitative research and therefore has the potential to provide better inferences, which brings with it greater validity (Bryman, 2008).

A questionnaire was used for collecting quantitative data from the residents of Mahenye. The questionnaire solicited for information on perceived livelihood benefits from the community-conserved area to the local community. The questions on the questionnaire were closed-ended so as to enable the collection of quantitative data.

Interviews were also used to collect qualitative data from key informants. One of the weaknesses inherent in the questionnaire as a method of data collection includes its inability to allow for the probing of respondents so as to get deeper and richer data (Bryman, 2008; de Vos et al., 2011). In-depth interviews with key informants were therefore quite useful in addressing this weakness of the questionnaire as a data collection method. Targeted key informants included the Mahenye CAMPFIRE Committee Chairperson and committee members, resource monitors and the accounts clerk. Former CAMPFIRE committee chairpersons and committee members were also interviewed. The Chipinge District CAMPFIRE Coordinator and the Zimbabwe CAMPFIRE Association Coordinator were also interviewed so as to solicit their views on the CAMPFIRE project in Mahenye and the national CAMPFIRE programme in general. Interviews were also held with the traditional leadership in Mahenye, including the Chief and selected village heads. School authorities, a representative from the Mahenye Clinic, and the Agricultural Research and Extension officer for the area were also interviewed. Interviews were also held with a representative from Zambezi Hunters, the current hunter for the Mahenye CAMPFIRE project. A representative of the Chilo Lodge, which oversees ecotourism activities in Mahenye was also interviewed. Ecotourism, photographic hunting, and trophy hunting are the main sources of income for the Mahenye CAMPFIRE project.

The research also employed non-participant unstructured observation as a qualitative data collection method. Non-participant observation is where the observer observes but does not participate in what is going on in the social setting (Bryman, 2008). Observation proved quite useful as a means of verifying some of the information collected through the questionnaire and key-informant interviews.

Various secondary sources of information of relevance to the study were also accessed and analysed so as to help in meeting the objective of the study. The secondary data were corroborated with data obtained from the primary sources thus enabling the generation of more varied, and hence more valid, information upon which sound discussions and conclusions could be based.

The sampling frame for questionnaire interviews comprised the 1000 households of Mahenye ward. A total of 150 households, constituting 15% of the target population, were selected for questionnaire interviews. Simple random sampling was employed in drawing respondents into the sample. For key-informant interviews, purposive sampling was used to select suitable respondents to provide in-depth information on the livelihood benefits from the community-conserved area to the Mahenye community. Purposive sampling is a particular technique that aids the researcher in identifying individuals for interviewing according to the research topic and objectives (de Vaus, 2002). The snowballing technique was further used for identifying additional key informants through individuals already interviewed (Somekh and Lewin, 2005).

Responses from questionnaire respondents were computed into percentage frequencies. On the other hand, qualitative data was analysed by means of thematic analysis.

3. Results and Discussion

This section presents, analyses and discusses the results of the study. More specifically, the section examines the livelihood benefits from the Mahenye CAMPFIRE project to the local community. Various livelihood benefits from the conservation area to the community were identified and these are presented below.

3.1. Community and Household Income Enhancement

One of the identified livelihood benefits to the Mahenye community from the community conservation area was income enhancement. The enhancement of income in Mahenye has occurred at two levels, the community and household levels.

3.1.1. Community-Level Income Enhancement

The legal mechanism through which CAMPFIRE operates in Zimbabwe was the granting of appropriate authority to Rural District Councils (RDCs) through the amendment of the Parks and Wildlife Act (1975) in 1982 (Bond, 2001; Frost and Bond, 2008). While the principal service sellers in CAMPFIRE are the wildlife producing communities on whose land is wildlife, RDCs have been granted appropriate authority by government to receive and manage wildlife revenues on behalf of the wildlife producing communities as intermediaries (Frost and Bond 2008). This service is then bought by safari operators from the communities, through contracts with the RDCs, who then package it into hunting or ecotourism safaris and sell to safari hunters and eco-tourists as end-users (Frost and Bond, 2008). In other words, safari operators buy the rights to bring sport hunters and eco-tourists to their concession areas in the wildlife producing communities to hunt a set quota of animals or track, observe and photograph wildlife (Frost and Bond, 2008). CAMPFIRE allows revenues derived from wildlife through safari operators to be accrued by RDCs rather than central treasury, which in turn increases incentives for councils to invest in wildlife-based revenue-earning activities. The gross wildlife revenue received by District Councils is in turn allocated to wildlife producing communities, wildlife management activities and district council levies (Bond, 2001).

The Mahenye CAMPFIRE project started in 1990 when Chipinge Rural District Council was granted appropriate authority to manage wildlife in the district. The Mahenye community immediately set up a committee, the Mahenye CAMPFIRE Committee (MCC), responsible for carrying out management functions, employing local staff to monitor wildlife and its use, including poaching and the hunting activities of the hunter (Rihoy et al., 2010). The MCC board members are democratically elected once every two years at an open general meeting.

Community income enhancement from the CAMPFIRE project in Mahenye has occurred through various activities. The Mahenye community set aside a 15 000 hectare wildlife conservation area in which sport hunting and ecotourism activities take place. The sole source of community income during the early years of CAMPFIRE in Mahenye was sport hunting. Almost all CAMPFIRE revenue in Mahenye between 1990 and 1996 came from the sport hunting concession in Mahenye (The Africa Resources Trust, 2002). Between 1990 and 2000, Mahenye Ward received a total of US\$56 480 from sport hunting (The Africa Resources Trust, 2002; Murphree, 2001). The revenue generating potential of the Mahenye hunting concession is primarily dependent on trophy elephant, including a few other 'hunnable' species such as leopard, buffalo, bushbuck, grysbok and impala (Murphree, 2001). The hunting quota in Mahenye is set by the Parks and Wildlife Management Authority. The price paid by hunters for an elephant in Zimbabwe varies between US\$15 000 and US\$35 000 depending on trophy size. Fifty five percent of the revenue from sport hunting accruing to the RDC in the form of lease and trophy fees goes to Mahenye, Chipinge Rural District Council retains 41% of the hunting revenue while the CAMPFIRE Association, an umbrella body for all CAMPFIRE participating districts, gets the remaining 4%.

In spite of subsequent increases in elephant populations and trophy prices, it became clear that the capacity of Mahenye Ward to expand its sport hunting revenues was finite, with little scope for significant growth (Murphree, 2001). The leaders of the Mahenye CAMPFIRE project were early in seeing the need to diversify the ward's wildlife-related income in addition to sport hunting (Murphree, 2001). This ultimately led to the growth and development of ecotourism as another community income enhancing activity in the ward. In 1994, the Chipinge Rural District Council, on behalf of the people of Mahenye, signed a 10-year lease agreement with a private tourism operator, Zimbabwe Sun Hotels, for the construction of two tourist lodges, Mahenye Safari Lodge and Chilo Lodge, for game viewing and photographic safaris (Murphree, 2001; Rihoy et al., 2010). The two lodges accommodate a combined total of 44 guests. In return for the right to build in Mahenye, Zimbabwe Sun Hotel agreed to pay Chipinge Rural District Council 8% of its gross trading revenue in the first three years, 10% in the next three years and 12% in the remaining three years (Murphree, 2001). Chipinge Rural District Council would then channel 75% of the revenue to Mahenye Ward. Between 1997 and 2000, ecotourism generated a total of US\$ 38 642 for Mahenye. By 1997 the two lodges were generating twice the income from sport hunting and were responsible for more than tripling the overall CAMPFIRE income for Mahenye between 1997 and 2000 (Murphree, 2001).

At the end of the 10-year contract in 2004, Zimbabwe Sun Hotel did not seek renewal of the lease agreement with Chipinge Rural District Council. The hotel firm cited the marked decline in tourist arrivals in the country since the start of the political crisis in 2000 as the reason for not renewing its lease agreement (Mashinya, 2007). The lease has since been taken over by River Lodges of Africa. Under the new 10-year lease agreement, the new management has been paying 10% of profits directly to the Mahenye community. Chilo Lodge has, however, been undergoing some renovations between 2010 and 2012 and the Mahenye community has not been getting anything during this time. Again, Mahenye Ward did not receive any money from the lodge in 2013 as, according to the management, it did not make any profit. The lodge needs a 45% occupancy in order to make profit, while occupancy in 2013 was

35%. The Mahenye Safari Lodge, which is located on Gayiseni Island in the middle of the Save River, has not been operating since 2008 as it was extensively damaged by flooding after a cyclone hit the area.

The Mahenye community has invested in various other income generating projects with the revenue received from sport hunting and ecotourism. These projects include a grinding mill, a shop, and a truck which is hired out to various clients. The CAMPFIRE clerk revealed that the income generated from the grinding mill ranges from US\$900-US\$1200 per month. The Mahenye community also owns a grocery shop which was constructed using CAMPFIRE revenue. Sometimes the shop is rented out at a rate of about US\$100 per month, while at times the shop is operated by the MCC. Another building is leased to a welder who pays US\$50 per month. The Mahenye community also purchased a Mazda T35 truck with CAMPFIRE income. The truck is used for transporting people to Chiredzi Town which is approximately 120 km from Mahenye, with each passenger paying US\$7 for a return trip. This service is quite important for Mahenye residents since there is a serious shortage of public transport in the area. The truck is also hired by various people in the community for the transportation of their goods.

3.1.2. Household-Level Income Enhancement

One of the ways in which CAMPFIRE has contributed to the enhancement of household income in Mahenye has been through household cash dividends derived from CAMPFIRE revenue. On average, the revenue allocated to household dividends between 1990 and 2000 was consistently around 50% of total CAMPFIRE revenue (The Africa Resources Trust, 2002). According to Muir-Leresche et al. (2003 cited in Mashinya 2007), dividends per household averaged between US\$10 and US\$30 per annum, which was 5 to 10% of average family income (Balint and Mashinya, 2006). The last household dividends were paid out in 2004. While significant, the household cash dividends were certainly not enough to act as an alternative income source to subsistence crop and livestock production but could only suffice as an additional source of household income. When compared to agricultural production, the household cash benefits from CAMPFIRE were merely supplementary to crop and livestock production (Bond, 1999).

Community conservation activities have also created employment opportunities in Mahenye thereby further enhancing household incomes. When asked whether they or any of their household members worked at the conservation area, 16.7% of questionnaire respondents said yes. In addition, 16% of these households had two household members with a conservation-related job, thereby further enhancing the income levels of such lucky households.

Chilo Lodge, the Mahenye CAMPFIRE project and the current hunter, Zambezi Hunters, were identified as the main sources of conservation-related employment for the residents of Mahenye. Chilo Lodge was the largest employer in Mahenye and employed a total of 35 employees. These included five security guards, five in housekeeping work, four gardeners, five in maintenance work, two bar attendants, three waiters, three cooks, three guides, two porters, one caretaker, one operations manager and one camp manager. All of the workers, with the exception of the two managers, were from within Mahenye Ward. This is because CAMPFIRE insists that first preference has to be given to locals whenever an employment opportunity arises. Outsiders are only considered when locals don't have requisite qualifications to fill a post. It is important to note that seven out of the 35 employees at Chilo Lodge were former poachers. In this case, employment creation by the community conservation area has acted as an effective incentive for biodiversity conservation.

The Mahenye CAMPFIRE project, run by the MCC, also employs a total of 12 permanent staff who are mainly employed to run various income-generating activities such as the grinding mill, the truck and the shop. Other locals employed by the Mahenye CAMPFIRE project include resource monitors, a clerk and night watchers and caretakers. The role of the resource monitors is to protect natural resources in Mahenye. They teach people to coexist with natural resources as these are the basis upon which CAMPFIRE exists.

The other source of conservation-related employment in Mahenye was the current hunter, Zambezi Hunters. The hunter employs a total of five locals as general cleaners, animal trackers and skimmers. The total number of local people in Mahenye that were employed by Chilo Lodge, the Mahenye CAMPFIRE project and Zambezi Hunters at the time of fieldwork was approximately 52 people. Considering that Mahenye Ward has an estimated total population of about 5 000 people, this number, 1% of the total population, is so small. There is certainly a need to create more conservation-related employment opportunities in Mahenye. However, it is important to note that these jobs, though few, could not have come had there been no CAMPFIRE in Mahenye.

Twenty four percent of questionnaire respondents with conservation-related employment were earning between US\$50 and 100; 32% were earning between US\$151 and 200; 28% were earning between US\$201 and 250; 12% were earning between US\$251 and 300, while the remaining 4% were earning between US\$301 and 350. The average monthly income for employees in conservation-related employment in Mahenye was US\$191, with a salary range of US\$300.

While the number of jobs offered by a protected area may be few, and the salaries offered modest, such jobs have some empirical evidence of having reduced poverty (Leisher et al., 2010; Bayliss et al., 2014; Liu et al., 2014), and may have significant multiplier effects in the rural economy as a whole (Leisher et al., 2010). Of concern with conservation jobs in the literature, however, has been the realisation that those hired tend to be the moderately poor to better off, while the poorest of the poor often rarely have the basic skills or the connections needed to secure a job in a protected area (Borgerhoff Mulder and Coppolillo, 2005; Leisher et al., 2010). In addition, locals are usually employed in positions requiring little or no skill, and these jobs often pay too little to lift a poor local person out of poverty, with better-paying jobs requiring higher skills often taken by outsiders (Borgerhoff Mulder and Coppolillo, 2005; Leisher et al., 2010). The results of this study therefore seem to agree with the literature, as most of the conservation-related jobs being generated for the residents of Mahenye through CAMPFIRE, appear to be those requiring low skills. As shown earlier, most people in Mahenye with conservation-related employment were employed as cooks, waiters, housekeepers, launderers, gardeners, resource monitors, shopkeepers and grinding mill operators among other low-skill occupations. However, in areas with limited

employment opportunities such as Mahenye, these low-skill and lowly-paid jobs can make a huge difference in the people's livelihoods. Since most of these workers only have working knowledge gained through in-house training, the various employers could help by sending for proper training those workers from the local community qualifying to enrol at colleges and other training institutions in the country. This may help local people secure the higher-paying conservation-related jobs often taken by better-qualified outsiders.

The other way in which conservation has enhanced household incomes in Mahenye has been through the stimulation of business opportunities for the people. Seventy one percent of questionnaire respondents indicated that conservation had stimulated business opportunities in their area. Interviews with key informants also confirmed that conservation had stimulated business opportunities for the local people. The selling of crafts to tourists was identified as the main business opportunity that had been stimulated by conservation. There is the Mahenye Traditional Home Centre where tourists come to buy various craft products. In addition to promoting the selling of crafts to tourists, Chilo Lodge also hires some traditional dance groups from Mahenye to come and perform to tourists. This, in a small way, also adds to the household incomes of the dancers. However, several socio-cultural negative impacts of tourism have also been documented, including the erosion or dilution of local traditional cultural values and norms in host communities (Borgerhoff Mulder and Coppolillo, 2005; Jalani, 2012; Youdelis, 2013).

Some key informants in Mahenye also indicated that local people access foreign currency from tourists which they then trade on the parallel market for profit. However, this business opportunity, which thrived on hyperinflation, ceased to be lucrative since 2009 when government dumped the Zimbabwe dollar and adopted a multi-currency system.

The sustainable livelihoods framework identifies financial capital as one of a number of assets that are the platform or building blocks upon which livelihoods are generated (Bennett and Dearden, 2014; Scoones, 1998). The Mahenye community conservation area has certainly enhanced this livelihood asset at both community and household levels. This, as shown earlier, has occurred through sport hunting and ecotourism activities, employment creation, stimulation of business opportunities, household cash dividends and also through various other income generating projects that have been promoted by the Mahenye CAMPFIRE project.

3.2. Education Enhancement

One of the assets mentioned in the sustainable livelihoods framework, and from which livelihoods are generated, is human capital. Human capital has been identified as a key issue in processes of rural change as it is important for the successful pursuit of different livelihood strategies, with education and skills identified as some of the elements making up this form of capital (Scoones, 1998; Sánchez-Zamora et al., 2014). The Mahenye CAMPFIRE project has also contributed towards the enhancement of education in Mahenye which, in the long-term, will eventually have a bearing on the livelihood strategies of the people in the area. Education can be one of the most effective tools for lifting people out of poverty as it can open up vast opportunities for poverty stricken people.

CAMPFIRE-generated revenue has been used for the construction of two school blocks at Mahenye Primary School, with each block having two classrooms. In addition, a two-classroom block has also been constructed at Mahenye Secondary School, while another CAMPFIRE-funded block was still at slab level at the same school. CAMPFIRE has also constructed a teachers' house and a toilet at Mahenye Secondary School. However, one of the two classroom blocks at Mahenye Primary School that were built with CAMPFIRE funds had developed some cracks and needed major repairs. An interview with the School Head revealed that the building had been condemned and deemed unsafe by the Ministry of Primary and Secondary Education, though the school was still using it. Decades of rural development experience have proven that the provision of small-scale development-oriented services such as schools, health, roads, and water services are only useful if followed up with operational expenses such as rehabilitation and the technical training of beneficiaries (Borgerhoff Mulder and Coppolillo, 2005).

CAMPFIRE also used to pay fees for some disadvantaged but well-performing pupils at both Mahenye Primary and Secondary Schools. However, the bursaries have since been discontinued due to lack of funds.

While the Mahenye CAMPFIRE project has played some important roles in the enhancement of education in Mahenye, sentiments among various key-informants in the study site were that more still needed to be done. For example, there is only one teachers' house at Mahenye Secondary School while there are only four houses for 24 teachers at Mahenye Primary School, leaving an average of six teachers, and their families, to share a single house. In addition, there is no electricity at both schools which has resulted in high staff turnover, with some teachers transferring to schools with electricity.

While the conservation area has helped in improving education in Mahenye, more still needs to be done. It is important to note that only 18% and 16% of questionnaire respondents indicated that they were satisfied with the quality of education at Mahenye Primary and Secondary schools respectively. With only 7.3% of the questionnaire respondents indicating that they had completed secondary education, most residents in the study area are therefore not proceeding beyond primary-level education. It is also worth noting that education has some important implications on biodiversity conservation, especially where this is being done in conjunction with livelihoods goals. Education helps in shaping people's attitudes and beliefs that determine many activities that impact the environment, with educated people better able to understand the need for environmental management or for supporting conservation activities (Mjaaland, 2014). The other importance of education, as noted earlier, is that it can enable local people to secure higher-paying conservation employment often taken by more educated outsiders.

3.3. Community Health Promotion

The CAMPFIRE project has also committed various resources towards the improvement of health in Mahenye. CAMPFIRE has constructed toilets at Mahenye Clinic. In addition, CAMPFIRE extended the electricity supply line from Chilo Lodge to Mahenye Shopping Centre in 1996 at a cost of Z\$140 500 (Murphree, 2001). The electricity line was finally connected to Mahenye Clinic with

the help of CAMPFIRE. CAMPFIRE funds were also used in extending the telephone line and piped water from Chilo Lodge to Mahenye Clinic. The sister-in-charge at Mahenye Clinic noted that: "*The connection of the clinic to electricity, piped water and a telephone has helped very much in improving service delivery at the clinic*".

However, the sister-in-charge also pointed out that the clinic still faces many challenges, including shortages of drugs and lack of transport to ferry critical cases to referral centres like Chiredzi District Hospital 120 km away in Chiredzi Town or Saint Peters Hospital 200 km away in Chipinge Town. Some of the cases for which the clinic needs the referral centres include serious injuries from wild animal attacks and birth complications. While the clinic conducts HIV tests, it does not offer antiretroviral drugs (ARVs) and people have to go to the major hospitals for the drugs. Delays in the collection of ARVs have sometimes resulted in unnecessary HIV/AIDS-related deaths. The sister-in-charge also indicated that the clinic urgently needed a waiting-mothers shelter. In addition, the clinic is not secured with a fence, resulting in trespassing by goats. CAMPFIRE could help in solving some of the above challenges the clinic is facing.

The other way in which CAMPFIRE has contributed to community health in Mahenye is through the regular provision of game meat to residents. After a safari hunting exercise, the hunter only takes the hides and trophies leaving the meat for the community to share. The meat could be the only source of protein for many poor households in the area. In addition, the regular supply of game meat to residents has helped in reducing poaching.

Some of the key elements of human capital include the ability to labour, good health and physical capability important for the successful pursuit of different livelihood strategies (Scoones, 1998; Sanchez-Zamora et al., 2014). By contributing towards health improvement in Mahenye, the community conservation area is thus helping the community in realising one of the key livelihoods-sustaining assets cited in the sustainable livelihoods framework.

3.4. Infrastructural Development

The CAMPFIRE project in Mahenye has, albeit indirectly, also contributed to infrastructural development in the ward. In particular, the ecotourism venture by Zimbabwe Sun Hotels provided an opportunity for infrastructural development in Mahenye. This included the erection of a 45km electricity supply line from the national grid at Quinton Bridge to the lodges, upgrading of the gravel road from Quinton Bridge to the lodges, extension of a telephone line and installation of a water treatment and reticulation system (Murphree, 2001). An airstrip was also built near the lodges for the emergency evacuation of critical medical cases. The construction of the lodges and the ancillary infrastructure resulted in a capital investment of Z\$24.9 million in Mahenye (Murphree, 2001).

While the infrastructural development was primarily meant for tourists, the Mahenye community has also benefited immensely from these developments. For example, the Mahenye community had for years asked Chipinge Rural District Council to upgrade the gravel road without success, yet it is an important link to the Chiredzi-Mutare highway. In addition, and as shown earlier, the electricity grid, telephone line and water reticulation system at the lodges were eventually extended to Mahenye clinic. Most business premises at Mahenye Shopping Centre are also now connected to the national grid. Access to safe drinking water by Mahenye residents has also improved as they get tap water from the clinic for domestic use. It is important to note that the above infrastructural developments in Mahenye could not have materialised without the community conservation initiative. The infrastructural developments have gone a long way in enhancing socio-economic development in Mahenye which has been hampered by the geographic isolation of the area.

3.5. Environmental Sustainability

The majority of households in Mahenye heavily rely on natural resources for their sustenance, with 84.7% of questionnaire respondents rating their reliance on natural resources between very strong and strong. One of the key components on the assets 'pentagon' of the sustainable livelihoods framework from which many people in developing countries derive their livelihoods is natural capital (Scoones, 1998). Conservation activities in Mahenye have helped in maintaining the ecological integrity of the area thereby preserving the natural resource base upon which many people depend for survival.

CAMPFIRE has promoted the conservation of natural resources among the residents of Mahenye Ward. A resource monitoring system has been put in place involving resource monitors who ensure that there is no abuse of natural resources by residents. Activities such as hunting, cutting down of trees, livestock grazing and collection of resources in the officially protected wilderness area (where photographic and hunting safaris are conducted) are strictly prohibited and attract various fines. Even in areas outside the wilderness area, reckless use of resources, including random and unselective cutting down of trees, can attract fines. It was observed that the vegetation in the wilderness area, and even in areas surrounding people's homesteads and fields was lush and dense, which is testimony to the success of the biodiversity conservation initiatives in Mahenye. Various key informants noted that the livelihood benefits from the conservation area had acted as an incentive for cooperation in the community conservation initiative.

When asked whether the conservation-related livelihood benefits were a tool for community development in their area, 77.3% of questionnaire respondents in Mahenye said yes. This shows that most people in the study area regarded the conservation-related livelihood benefits their community was receiving as a form of community development. However, some key informants also noted that the livelihood benefits from CAMPFIRE had significantly declined since 2000, partly as a result of the political and economic crisis in the country. The questionnaire respondents who viewed the conservation-related livelihood benefits as a tool for community development were further asked whether these benefits had brought adequate development to their area. Of these, only 19.8% said the conservation-related livelihood benefits had brought adequate development to their area, with the remaining 80.2% indicating that the livelihood benefits had not brought adequate development. Similar sentiments were expressed by the majority of the key informants who noted that, while the community conservation area had contributed towards the upliftment of their livelihoods, the protected area still needed to do more for there to be adequate development. Many of the key informants indicated that the conservation area could

bring more meaningful development by funding irrigation, livestock rearing and the promotion of drought-resistant crop varieties. It is important to note that aridity is one of the major constraints to farming in Mahenye.

Questionnaire respondents who did not regard the conservation-related livelihood benefits as a tool for community development (n = 34) were further asked to identify alternative community development activities that they wanted the conservation area to promote or fund in their community. Seventy four percent of them indicated that the conservation area should fund irrigated crop production, all indicated that the conservation area should fund livestock rearing, 41.2% said the conservation area should develop the rural service centre, while 91.2% indicated that the conservation area should fund infrastructural development projects. As revealed earlier, the majority of key informants who viewed conservation as a tool for community development also indicated that the conservation area needed to fund projects such as irrigation and livestock rearing for there to be adequate development in their area. The results therefore suggest that most people in Mahenye want the conservation area to support agricultural activities for there to be meaningful development, in addition to infrastructural development. With aridity identified as one of the main challenges to farming in Mahenye, provision of irrigation infrastructure or drought resistant crop varieties could be a crucial starting point by the conservation area. The sustainable livelihoods framework notes that, for development agencies to be more effective, they need to first characterise the vulnerability context in the areas they intend to operate so that they can have an insight into the kinds of factors that have potential to negatively impact on people's livelihoods (Scoones, 1998; Ashley and Carney, 1999).

4. Conclusion

The study has shown that the Mahenye community conservation initiative has brought various livelihood benefits to the local people. Such benefits include community and household income enhancement, education enhancement, health promotion, infrastructural development and environmental sustainability. The livelihood benefits from the conservation area have acted as an incentive for cooperation in the community conservation initiative, thereby proving that conservation and livelihoods goals are not necessarily divergent, but can successfully and jointly be pursued to the benefit of both nature and people.

While the majority of questionnaire respondents and key informants indicated that the livelihood benefits from the community conservation area were a tool for community development, many of them also noted that the benefits were not adequate, requiring the conservation area to fund irrigation development, livestock rearing and infrastructural development. It is important for members of the Mahenye community, or any other community jointly pursuing conservation with development goals, to note that biodiversity conservation areas should not be viewed as panacea to all their socio-economic challenges. The burden of socio-economic development is the official responsibility of central government while the primary role of protected areas is to protect biodiversity. Therefore, local communities should appreciate the few livelihood benefits that protected areas may sustainably afford without compromising their ecological integrity. In other words, livelihood benefits from protected areas should best be viewed as supplementary add-ons to other livelihoods strategies. Reopening of the Mahenye Safari Lodge, which was damaged by a cyclone in 2008, could boost employment opportunities for the local people. However, with ecotourism on the decline since 2000 due to the current political and economic crisis in the country, the only other way to increase livelihood benefits from CAMPFIRE in Mahenye and similar areas would be to increase the trophy hunting quota for the area, particularly that of elephant. However, such an option is highly unlikely as the Parks and Wildlife Management Authority indicated that the annual elephant sport hunting quota for the Mahenye hunting concession, currently pegged at six, cannot sustainably be increased at the present moment.

5. References

- i. Adams, W.M. & Hutton, J.(2007). People, parks and poverty: political ecology and biodiversity conservation. *Conservation and Society* 5: 147–183.
- ii. Agol, D., Latawiec, A. E. & Strassburg, B. B. N. (2014). Evaluating impacts of development and conservation projects using sustainability indicators: opportunities and challenges. *Environmental Impact Assessment Review* 48: 1–9.
- iii. Anstey, S. (2009). Beacon and barometer: CBNRM and evolutions in local democracy in southern Africa. In B. B., Mukamuri, Manjengwa, J. M. & Anstey, S. (Eds.), *Beyond proprietorship: Murphree's law on community-based natural resource management in southern Africa*. (pp. 41–57). Harare: Weaver Press.
- iv. Ashley, C. & Carney, D. (1999). *Sustainable livelihoods: lessons from early experience*. London: Department for International Development.
- v. Balint, P.J. & Mashinya, J. (2006). The decline of a model community-based conservation project: governance, capacity, and devolution in Mahenye, Zimbabwe. *Goeforum* 37: 805–815.
- vi. Bayliss, J., Schaafsma, M., Balmford, A., Burgess, N. D., Green, J. M. H., Madoffe, S. S., Okayasu, S., Peh, K. S. H., Platts, P. J. & Yu, D. W. (2014). The current and future value of nature-based tourism in the Eastern Arc Mountains of Tanzania. *Ecosystem Services* 8:75–83.
- vii. Bennett, N.J. & Dearden, P. (2014). Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy* 44: 107–116.
- viii. Bond, I. (1999). CAMPFIRE as a vehicle for sustainable rural development in semi-arid communal lands of Zimbabwe: incentives for institutional change. Ph.D. thesis, University of Zimbabwe, Harare, Zimbabwe.
- ix. Bond, I. (2001). CAMPFIRE and the incentives for institutional change. In Hulme, D. & M. Murphree. (Eds) *African wildlife and livelihoods: the promise and performance of community conservation*. (pp. 227–243). Oxford: James Currey Ltd.
- x. Borgerhoff Mulder, M. & Coppolillo, P. (2005). *Conservation: linking ecology, economics and culture*. Princeton: Princeton University Press.

- xi. Bravo, G. (2014). The human sustainable development index: new calculations and a first critical analysis. *Ecological Indicators* 37: 145–150.
- xii. Brockington, D., Duffy, R. & Igoe, J. (2008). *Nature unbound: conservation, capitalism and the future of protected areas*. London: Earthscan.
- xiii. Bryman, A. (2008). *Social research methods*. 3rd Edition. Oxford: Oxford University Press.
- xiv. Buta, N., Holland, S. M. & Kaplanidou, K. (2014). Local communities and protected areas: the mediating role of place attachment for pro-environmental civic engagement. *Journal of Outdoor Recreation and Tourism* 5-6: 1–10.
- xv. Central Statistical Office. (2012). *Zimbabwe census, 2012: preliminary report*. Harare: Central Statistical Office.
- xvi. Child, B.A. (1993). Zimbabwe's CAMPFIRE programme: using the high value of wildlife recreation to revolutionise natural resource management in communal areas. *Commonwealth Forestry Review* 72: 284–296.
- xvii. Cronkleton, P., Pulhin, J. & Saigal, S. (2012). Co-management in community forestry: how the partial devolution of management rights creates challenges for forest communities. *Conservation and Society* 10(2): 91–102.
- xviii. de Vaus, D. (2002). *Surveys in social research*. 5th Edition. London: Routledge.
- xix. de Vos, A.S., Strydom, H., Fouche, C. B. & Delpont, C. S. L. (2011). *Research at grass roots: for the social sciences and human service professions*. 4th Edition. Pretoria: Van Schaik Publishers.
- xx. Fischer, C., Muchapondwa, E. & Sterner, T. (2011). A bio-economic model of community incentives for wildlife management under CAMPFIRE. *Environmental Resource Economics* 48: 303–319.
- xxi. Frost, P.G.H. and Bond, I. (2008). The CAMPFIRE programme in Zimbabwe: payments for wildlife services. *Ecological Economics* 65(4): 776–787.
- xxii. Gandiwa, E., Heitkönig, I. M. A., Lokhorst, A. M., Prins, H. H. T. & Leeuwis, C. (2013). CAMPFIRE and human-wildlife conflicts in local communities bordering northern Gonarezhou National Park, Zimbabwe. *Ecology and Society* 18(4): 7. <http://dx.doi.org/10.5751/ES-05817-180407>
- xxiii. Glenn, H., Wattage, P., Mardle, S., Van Rensburg, T., Grehan, A. & Foley, N. (2010). Marine protected areas-substantiating their worth. *Marine Policy* 34: 421–430.
- xxiv. Gurney, G.G., Cinner, J., Ban, N. C., Pressey, R. L., Pollnac, R., Campbell, S. J., Tasidjawa, S. & Setiawan, F. (2014). Poverty and protected areas: an evaluation of a marine integrated conservation and development project in Indonesia. *Global Environmental Change* 26: 98–107.
- xxv. Harrison, E.P., Stringer, L. C., & Dougill, A. J. (2014). The importance of the sub-district level for community-based natural resource management in rural Zimbabwe. Sustainability Research Institute Paper No. 69, School of Earth and Environment. Leeds: The University of Leeds Press.
- xxvi. Holden, E., Linnerud, K. & Banister, D. (2014). Sustainable development: our common future revisited. *Global Environmental Change* 26: 130–139.
- xxvii. IUCN. (2003). *Recommendations: Vth IUCN World Parks Congress*. Durban: IUCN.
- xxviii. Jalani, J.O. (2012). Local people's perception on the impacts and importance of ecotourism in Sabang, Palawan, Philippines. *Procedia - Social and Behavioural Sciences* 57: 247 – 254.
- xxix. Jeffries, M.J. (2006). *Biodiversity and conservation*. 2nd Edition. London: Routledge.
- xxx. Kashwan, P. (2013). The politics of rights-based approaches in conservation. *Land Use Policy* 31: 613–626.
- xxxi. Leisher, C., Sanjayan, M., Blockhus, J., Kontoleon, A. & Larsen, S. N. (2010). Does conserving biodiversity work to reduce poverty? In Roe, D. (Ed) *Linking biodiversity conservation and poverty alleviation: a state of knowledge review*. (pp. 29–47). Montreal: CBD Technical Series No. 55, Secretariat of the Convention on Biological Diversity.
- xxxii. Liu, J., Qu, H., Huang, D., Chen, G., Yue, X., Zhao, X. & Liang, Z. (2014). The role of social capital in encouraging residents' pro-environmental behaviors in community-based ecotourism. *Tourism Management* 41: 190–201.
- xxxiii. Martin, R.B. (1986). *CAMPFIRE*. Harare: Department of National Parks and Wildlife Management.
- xxxiv. Mashinya, J. (2007). *Participation and devolution in Zimbabwe's CAMPFIRE programme: findings from local projects in Mahenye and Nyaminyami*. Ph.D. thesis. University of Maryland, College Park, USA.
- xxxv. McNeely, J.A. & Miller, K. R. (1984). *National parks, conservation and development: the role of protected areas in sustaining society*. Washington DC: Smithsonian Institution Press.
- xxxvi. Meilby, H., Smith-Hall, C., Byg, A., Larsen, H. O., Nielsen, Ø.J., Puri, L. & Rayamajhi, S. (2014). Are forest incomes sustainable? Firewood and timber extraction and productivity in community managed forests in Nepal. *World Development* 64(Supplement 1): S113–S124.
- xxxvii. Mjaaland, T. (2014). Having fewer children makes it possible to educate them all: an ethnographic study of fertility decline in north-western Tigray, Ethiopia. *Reproductive Health Matters* 22(43):104–112.
- xxxviii. Mombeshora, S. & Le Bel, S. (2009). Parks-people conflicts: the case of Gonarezhou National Park and the Chitsa community in south-east Zimbabwe. *Biodiversity Conservation* 18: 2601–2623.
- xxxix. Muir-Leresche, K., Bond, I., Chambati, W., & Khumalo, A. (2003). *An analysis of CAMPFIRE revenue generation and distribution: the first decade (1989-2000)*. Harare: World Wide Fund for Nature Southern Africa Regional Programme Office.
- xl. Murombedzi, J.C. (2001). Committees, rights, costs and benefits: natural resource stewardship and community benefits in Zimbabwe's CAMPFIRE programme. In Hulme, D. & Murphree, M. (Eds.), *African wildlife and livelihoods; the promise and performance of community conservation*. (pp. 244–255). Oxford: James Currey Ltd.

- xli. Murphree, M. (2001). Community, council and client: a case study in ecotourism development in Mahenye, Zimbabwe. In Hulme, D. & M. Murphree. (Eds.) African wildlife and livelihoods; the promise and performance of community conservation. (pp. 177–194). Oxford: James Currey Ltd.
- xlii. Niedziałkowski, K., Blicharska, M., Mikusiński, G., & Jedrzejewska, B. (2014). Why is it difficult to enlarge a protected area? Ecosystem services perspective on the conflict around the extension of the Białowieża National Park in Poland. *Land Use Policy* 38: 314–329.
- xliii. OECD (Organisation for Economic Cooperation and Development). (2002). Sustainable development strategies: a resource book. Paris and New York: OECD and UNDP.
- xliv. Pinho, P.F., Patenaude, G., Ometto, J. P., Meir, P., Toledo, P. M., Coelho, A. & Young, C. E. F. (2014). Ecosystem protection and poverty alleviation in the tropics: Perspective from a historical evolution of policy-making in the Brazilian Amazon. *Ecosystem Services* 8: 97–109.
- xlv. Rihoy, L., Chirozva, C. & Anstey, S. (2010). People are not happy: crisis adaptation and resilience in Zimbabwe's CAMPFIRE programme. In Nelson, F. (Ed.), *Community rights, conservation and contested land: the politics of natural resource governance in Africa*. (pp. 174–201). London: Earthscan.
- xlvi. Romero, C., Athayde, S., Collomb, J., DiGiano, M., Schmink, M., Schramski, K. & Seales, L. (2012). Conservation and development in Latin America and southern Africa: Setting the stage. *Ecology and Society* 17(2): 17–29.
- xlvii. Sachs, J.D., Baillie, J.E.M., Sutherland, W.J., Armsworth, P.R., Ash, Beddington, N. J. & Blackburn, T.M. (2009). Biodiversity conservation and the millennium development goals. *Science* 325(5947): 1502–1503.
- xlviii. Sánchez-Zamora, P., Gallardo-Cobos, R. & Ceña-Delgado, F. (2014). Rural areas face the economic crisis: analysing the determinants of successful territorial dynamics. *Journal of Rural Studies* 35:11–25.
- xlix. Scherl, L.M., Wilson, A., Wild, R., Blockhus, J., Franks, P., McNeely, J. A. & McShane, T. O. (2004). Can protected areas contribute to poverty reduction? Opportunities and limitations. Gland: IUCN.
1. Scoones, I. & Wolmer, W. (2003). Introduction: livelihoods in crisis: challenges for rural development in southern Africa. *IDS Bulletin* 34(3): 1–14.
- li. Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. *IDS Working Paper* 72.
- lii. Somekh, B. and Lewin, C. (2005). *Research methods in the social sciences*. London: SAGE Publications.
- liii. Sunderlin, W.D., Angelsen, A., Belcher, B., Burgess, P., Nasi, R., Santoso, L. & Wunder, S. (2005). Livelihoods, forests and conservation in developing countries: an overview. *World Development* 33(9): 1383–1402.
- liv. The Africa Resources Trust. (2002). The Mahenye community conservation initiatives: best practice case study in community conservation. Harare: The Africa Resources Trust.
- lv. Turner, W.R., Brandon, K., Brooks, T. M., Gascon, C., Gibbs, H. K., Lawrence, K. S., Russell, A., Mittermeier, R. A., & Selig, E. R. (2012). Global biodiversity conservation and the alleviation of poverty. *Bio Science* 62(I): 85–92.
- lvi. Upton, C., Ladle, R., Hulme, D., Jiang, T., Brockington, D., & Adams, W. M. (2008). Are poverty and protected area establishment linked at a national scale? *Oryx*, 42, 19–25.
- lvii. Walpole, M. & Wilder, L. (2008). Disentangling the links between conservation and poverty in practice. *Flora and Fauna International* 44(4): 539–547.
- lviii. Youdelis, M. (2013). The competitive (dis)advantages of ecotourism in Northern Thailand. *Geoforum* 50:161–171.
- lix. Zhang, J., Fu, M., Zhang, Z, Tao, J., & Fu, W. (2014). A trade-off approach of optimal land allocation between socio-economic development and ecological stability. *Ecological Modelling* 272: 175–187.