Chapter 3

The socio-economic context of Human-Elephant Conflict (HEC) in rural areas of Mozambique

Abstract

Conservation efforts throughout the world are challenged by human-wildlife conflict. Such conflict also occurs throughout rural Mozambique. The efficiency of conflict mitigation may be improved when the socio-economic and political context is considered. Thus, understanding the effect of elephants on a household's lifestyle appears crucial. Here, I explore the demographic and socio-economic variables associated with human-wildlife conflict across Mozambique. A comparative assessment of the socio-economic profiles suggests that most households rely on subsistence farming by extracting or cropping from the land, primarily for their own purposes and this differed for households living inside and beyond protected areas. The reproductive parameters of households living inside and beyond protected areas were similar. Whilst mostly often elephants were responsible for crop damage beyond protected areas, rodents and insects were the primary agents responsible for food loss during storage inside these. Conflict with elephants appears not to be over food security, but is more about life styles being affected by the presence of elephants. I argue that efforts to mitigate HEC in rural areas of Mozambique should include strategies that improve household's livelihoods profiles.

Keywords: Households, demographic profile, economic profile, conflict profile, life styles, HEC, Mozambique

Introduction

In Mozambique, efforts to conserve elephants are marred by a noted increase in the reported incidences of human elephant conflict (HEC) (Dunham *et al*., 2010). While some incidences induce injuries or deaths for both species, reported losses of crops and livestock may be influenced by some socio-economic and political factors (see Hill, 2004; Dickman, 2010; Hartter *et al*., 2010). The 16% of Mozambique's area that have been set aside for conservation may not reflect the effectiveness of conservation, simply because most protected areas are inhabited by people that are legally permitted to extract natural resources from these areas. This may nullify conservation outcomes, especially as the Mozambican population is increasing at 2.2% per year (INE, 2009).

Some of the 22,144 elephants recorded during 2009 in Mozambique live beyond the boundaries of protected areas where they also come into conflict with people, a situation not different from protected areas, but where a numerical ratio favours people. Thus, people and elephants are coming into conflict both within and beyond protected areas, but more so within the proximity of protected areas (see Chapter 4).

Conflict conceivably has major consequences for rural people that depend on crops and natural resources for their existence. Solutions for such conflict require detailed information on the consequences thereof and on the environmental and social factors driving the conflict (see De Boer & Baquete, 1998; Hill, Osborn & Plumptre, 2002; Dickman, 2010). To cope with the stresses induced by unemployment, declining yields due to droughts or floods, declining water availability, declines in natural resources, households tends to adopt a mixture of livelihood strategies that may include diversification of lifestyle, claims for compensation and emigration (for details, see Chambers & Conway, 1991). In rural Mozambique, poverty and unemployment

are high, flood events and droughts are frequent, and reports on conflicts between people and wildlife are common (Dunham *et al*., 2010). Retaliatory killing of problem animals is commonly allowed (DNTF, 2009).

Human-wildlife conflict and, in particular human-elephant conflict (see Hoare, 1995; Hoare, 1999; Hoare & du Toit, 1999; Jackson *et al*., 2008), occurs through most of Mozambique, both within and beyond protected areas (see Chapter 4). Living in protected areas may be hazardous due to the presence of relatively large numbers of wildlife, while at the same time conferring benefits in terms of the proximity and availability of natural resources to subsidize food from the subsistence cultivation of crops. Living outside protected areas may be less hazardous, but return few natural resource benefits and make such people more reliant on subsistence farming. These two near opposing lifestyle may influence survival and reproduction. Given these different scenarios I expect that the socio-economic profiles, conflict with wildlife profiles, and demography of people living inside and beyond protected areas will differ. I therefore compared these variables based on information obtained through structured surveys conducted in four protected areas and in five non-protected areas. Given to the expected positive relationship between reproductive rates and resources availability (Sibly & Hone, 2002), I expected that (i) people inside protected areas would have bigger families than those living beyond; (ii) survival probability of children inside protected areas would be greater than outside these. Because both inside and beyond protected areas share similarities on the environment and lifestyle, (iii) the socio-economic profiles between them would be similar but, (iv) people inside protected areas would extract a greater variety of natural resources than those living beyond given my expectation on the "park effect", which prohibits a free resource exploitation. I also expected that (v) people living inside protected areas would experience more conflict with large

bodied wildlife than those living beyond, which would face primarily small animals and finally, (vi) fields would be more frequently destroyed inside than beyond protected areas.

Study Areas

This study was carried out in four officially protected areas (Maputo Elephant Reserve, Banhine National Park, Limpopo National Park, Chimanimani National Reserve) and in five unprotected areas (Futi, Magude-Moamba, Mágoè, Marrupa-Nipepe and Quiterajo) (Table 1 and Fig. 1). People densities varied (INE, 2009) and were lower in protected than non-protected areas, but the inverse was true for elephants (AGRECO, 2008, 2010). People planted crops in all areas, cleared natural vegetation to maintain their shifting agricultural systems, collected wood for the construction of houses, and collected wild fruits, honey and mushrooms to supplement their diets (Pereira *et al*., 2001; Kityo, 2004; Landry, 2009). Human and wildlife conflicts in general and in particular HEC have been reported from all these study sites (see Dunham *et al*., 2010). While Maputo Elephant Reserve, Limpopo National Park, Marrupa-Nipepe and Quiterajo are of particular concern (De Boer & Ntumi, 2001; Foloma, 2005; Garnier, 2006; Dunham *et al*., 2010, Chapter 4), some cases have been reported for the Magude-Moamba and Mágoè and few in Chimanimani National Reserve and Banhine National Park (AGRECO, 2008).

Methods

Structured questionnaire-based surveys to define demographic, economic and conflict profiles of people living in each of the study sites were conducted between 2007 and 2010. In total, 812 households from 100 villages were interviewed. The survey team made a single visit to each of

the villages and at least one Portuguese and a local language-speaking interviewer were present in each of the two-person teams that conducted the survey.

Prior to each interview, one of the team members briefly explained to the potential interviewee the aims of the study. Following this, the potential respondent was asked if he (she) agreed to participate in the survey. The interviews proceeded only when the respondent agreed to participate.

The survey focused on interviewing one member of a household (usually the husband). In the Nipepe study site, one interview was terminated by the wife in the household, five refused to participate, while in 10 households no family member could understand Portuguese or English and none of the team members could speak the local language. One of the teams did not succeed in interviewing one household in Banhine National Park, while in the Limpopo National Park, an entire village refused to participate.

Most villages were situated along roads and I spaced sampling points systematically along these. Interviews lasted 30 to 40 minutes and comprised a series of questions to obtain socio-economic information, details of problems the family faced with farming and wildlife, as well as demographic variables (see Appendix1). The questionnaire had five components: basic locality and survey information, questions on human demography (age of each family member, number of children alive, dead or that has emigrated), the economic profile of a household (e.g. what kind of items the household bought) and the conflicts that people may experience (e.g. what kind of animals affect crops and food stores).

Statistical analysis

I entered all the data from the study sites in SPSS spreadsheets for filtering and reduction (e.g. Field, 2009). I constructed a standing age distribution based on the living individuals in 5-year age classes separately for males and females. I also used the techniques of Ferreira and van Aarde (2008) to smooth the standing age distribution irrespective of whether people have left or not. I calculated the age at which women had their first baby and the interval between births. When a woman was over the age of 30 and the time since the birth of her last child exceeded her average birthing interval, I calculated age at last birth. I used Udevitz and Ballacheys' (1998) approach of assuming a stable age distribution (the smoothed age distribution for females) and an independent estimate of fecundity (half the inverse of the birth interval for the ages from first to last birth) to estimate intrinsic population growth. I calculated survival rates following Eberhardt (1988). I used a log-rank test (Krebs, 1999) to assess whether the calculated survival rates inside protected areas differed from those beyond protected areas.

Given that the samples from the nine study sites were independent from each other and differed in size, I thus followed a confidence interval approach (Hepworth, 1996; Fleiss *et al*., 2003) to calculate a 95% CI for positive respondents for each question. This approach, estimate the proportion *p* of the true population which may fall within a particular range, following the testing of *n* study sites each of *k* individuals interviewed with *x* responding positively to each specific question. The probability of a positive response is then $\pi = 1 - (1 - p)^k$, and the maximum likelihood estimator (MLE) is $\hat{\pi} = \frac{x}{n}$. A simple transformation shows the MLE of *p* to be (Hepworth, 1996):

$$\hat{p} = 1 - (1 - \hat{\pi})^{1/k}.$$

To test whether people living inside protected areas would extract a greater variety of natural resources than those living beyond, I calculated the total number of used resources and the proportion of the used resources based on the positive responses to the questionnaires. Further, I calculated the niche width as a number of resources used for subsistence by people living inside and beyond protected areas, following Hardesty (1975):

$$Niche\ width = 1/\sum_{i}^{n}(pi)^2$$

where, *pi* is the proportion of the total subsistence contributed by resource *i* and *n* is the total number of resources used for subsistence.

I used the confidence interval for proportion calculator available at http://www.dimensionresearch.com/resources/calculators/conf_prop.html to determine the confidence interval level at 95%, given my study sample size of 310 and 502 and positive survey results on each of questions, for protected and non-protected areas respectively.

The theory of this procedure is based on the notion that my sample size of 812 respondents was drawn from a true population, and that the percentage of positive responses (proportion) I obtained from each question may differ from the true proportion. There is a likelihood (confidence level) that the true population proportion would fall within a particular range (confidence interval) around the proportion value yielded by my study sample.

I compared the responses in protected and non-protected areas using contingency table analyses (Zelen, 1971) to assess whether households living in protected areas would be larger, have greater survival probability of children, extract a greater variety of natural resources, but

experience more conflict with the large bodied wildlife than people living beyond these areas. I based the contingency table analyses on a two tailed Chi-square statistic without Yates correction (Haber, 1982; Yates, 1984), given the relatively large sample sizes that make little differences to correct Chi-square values.

Results

Human demographic profile of the rural households in Mozambique

The 812 households that responded and that could be included in the survey represented 5,037 individuals of which the age or year of birth was known for 4,129. Of these most were alive (♂♂: 1,926, ♀♀: 1,977), while respondents provided information on the age of 431 people (♂♂: 208, ♀♀: 223) that have died.

On average (± SE), women had their first baby at 21 ± 0.9 years and every 3.5 ± 0.2 years thereafter. Average age at last birth was 36 ± 1.7 years (Fig. 2). These reproductive parameters did not differ between beyond and protected areas (Table 2). Families living beyond and inside protected areas were of similar size (3.9±0.70 and 4.3±0.88, respectively).

Survival during the first year was 0.97 (3,262 births, 99 deaths before the age of 1) and this was not a function of the conservation status of the study site ($U_{4,4}$ = 3 000; p = 0.15). This analysis suggests that the rural population is growing at 2% per annum. However, once I accounted for the people alive that had left the study area *i.e.* emigration at 20.2% males and 21.7% females, the rural population declined at 3% per year.

Annual survival rates differed between inside and beyond protected areas (log-rank test, $\chi^2 = 47.94$, df = 1, p = 0.001; Fig. 2)

Economic profile of the rural households in Mozambique

Most (fequency±95%CI respectively, 68.1±3.2%) respondents were not employed and lead a subsistence lifestyle that involved seasonal crop-production. Some were self-employed (25±3.0%) with small businesses such as fixing bicycles, while even fewer were employed by government (3.7±1.3%) and private sectors (3.0±1.2%) (Fig. 3). With the exception of those employed by government and the private sectors, the employment profiles for people living in protected areas were similar to those living beyond protected areas (Fig. 3). Respondents did get employed by government and private sectors more often inside protected areas than beyond (χ^2 = 4.51, df = 1, p = 0.03; χ^2 = 6.20, df = 1, p = 0.01; government and private sectors respectively).

Most households did buy items of important use (sugar – 87.9±2.3%, salt – 85.6±2.4%, soap – 88.6±2.2% and matches – 70.1±3.2%), while several had luxury items such as stationary (44.6±3.4%), mirrors (44.3±3.4%) and a radio (40.2±3.4%). Bicycles were not commonly owned (19.5±2.7%) and were used to transport products to and from markets in the towns. Forty-two respondents had wheelbarrows and eight had fridges, while 15 owned a motorised vehicle (motor cycle or car). Socio-economic profiles for people living in and beyond protected differed significantly (Fig. 3; Table 3). For example, inside protected areas, most respondents did buy sugar (χ^2 = 12.16, df = 1, p = 0.0005); salt (χ^2 = 23.70, df = 1, p = 0.0001) and matches (χ^2 = 14.06, df = 1, p = 0.0002) more often than those beyond protected areas. Outside protected areas, luxury items such as stationary (χ^2 = 15.20, df = 1, p = 0.0001); mirrors (χ^2 = 47.58, df = 1, p =

0.0001); radios (χ^2 = 37.32, df = 1, p = 0.0001) and bicycles (χ^2 = 12.43, df = 1, p = 0.0004) were bought more frequently than inside protected areas (Table 3)

People used wild plants for the construction of buildings (92.2±.1.8% of households), making of utensils (35.0±3.3%) and as firewood (95.7±1.4%) as well as food (78.6±2.8%) (Fig. 3). Some households used wild plants as medicine (42.6±3.4%), or for producing alcoholic beverages (12.0±2.2%). Other wild products (mushrooms, fruit, honey and fish) were primarily collected for household use (80.2±2.7%), although 19.2±2.7% of households sold wild products for cash. This reliance on natural resources beyond protected areas differed significantly from inside protected area. For instance, wild plants were mostly used as firewood and for alcohol inside than beyond protected areas (χ^2 = 6.86, df = 1, p = 0.009; χ^2 = 50.69, df = 1, p = 0.0001; firewood and alcohol, respectively). Beyond protected areas wild plants were mostly used as food (χ^2 = 11.87, df = 1, p = 0.0006) and utensils (χ^2 = 6.97, df = 1, p = 0.008) than inside protected areas.

Birds (17.0±2.6% of households) and mammals (31.0±3.2%) were the least common wild products that households collected (Fig. 3), but people living in protected areas did collect so more frequently fruit than those living beyond protected areas (χ^2 = 12.46, df = 1, p = 0.0004). They less frequently used fish, birds and animals (χ^2 = 34.76, df = 1, p = 0.0001; χ^2 = 5.05, df = 1, p = 0.02 and χ^2 = 7.76, df = 1, p = 0.005, respectively fish, birds and animals) than beyond protected areas. Wild products were mostly used inside protected areas for subsistence of the household (χ^2 = 83.60, df = 1, p = 0.0001), rather than for cash as was the case beyond protected areas (χ^2 = 21.96, df = 1, p = 0.0001). Relatively few resources were used inside compared to outside protected areas, but this was not significant (Two-tailed t-test; t = 0.94, df = 4, p = 0.40).

Most households (70.2±3.2%) only kept chickens, while goats were the second most commonly kept livestock (47.0±3.4%). Livestock was mostly kept for household purposes (59.5±3.4%), but at least 6.3±1.7% of households bartered livestock for other goods, while 40.2±3.4% of households sold livestock for cash. The keeping of livestock differed significantly between people living in and beyond protected areas (Fig. 3). For instance, keeping of livestock was mainly done inside protected areas (dogs: χ^2 = 36.09, df = 1, p = 0.0001; chickens: χ^2 = 20.10, df = 1, p = 0.0001; cattle: χ^2 = 65.82, df = 1, p = 0.0001; goats: χ^2 = 8.52, df = 1, p = 0.004; sheep: χ^2 = 19.55, df = 1, p = 0.0001; pigs: χ^2 = 7.33, df = 1, p = 0.007) for subsistence (χ^2 = 11.06, df = 1, p = 0.0009), while for cash beyond protected areas (χ^2 = 11.95, df = 1, p = 0.0005).

Farmers grew numerous crops, including cassava (35.7±3.3% of households), maize (64.7±3.3%), beans (36.1±3.3%) and groundnuts (23.0±2.9%) (Fig. 3). Mangoes and water melon were the most commonly grown fruit bearing plants that they cultivated (2.0±1.0% and 8.9±2.0% of households, respectively). Up to 72.0±3.1% of the households used crops for their own purpose, while 7.5±1.8% exchanged crops for something else and 29.4±3.1% sold crop products for cash. Agricultural activities for people inside and beyond protected areas differed (Fig. 3 and Table 3). Respondents living inside protected area reported more frequently maize (χ^2 = 104.25, df = 1, p = 0.0001), groundnuts (χ^2 = 39.45, df = 1, p = 0.0001), beans (χ^2 = 61.51, df = 1, p = 0.0001) and water-melon (χ^2 = 68.26, df = 1, p = 0.0001) than those from outside protected areas, who mainly grew rice (χ^2 = 68.21, df = 1, p = 0.0001). While agricultural activities for people living inside protected areas were mostly for subsistence of the households

(χ^2 = 21.28, df = 1, p = 0.0001), beyond protected areas people used crops for barter (χ^2 = 34.03, df = 1, p = 0.0001) and cash (χ^2 = 34.85, df = 1, p = 0.0001).

The niche width of wild plants and wild products were relatively wide compared to those for bought items, livestock production and agriculture, but the niche width of wild resources from beyond protected areas was similar to that from inside these (Two-tailed t-test; t = 0.94, df = 4, p = 0.40).

Conflict profile of the rural households in Mozambique

My survey focused on defining wildlife conflict in the context of several other factors that may also influence people's lives. Only few incidences of an animal (elephant, crocodile, lion and snakes) causing injury or death to a family member were noted (Fig. 3). Injury or death to a family member due to animals were significantly higher inside than beyond protected areas (χ^2 = 23.12, df = 1, p = 0.0001). Deaths due to diseases (24.1±2.9% of households) were common in the villages and similar for people living in and beyond protected areas (χ^2 = 0.13, df = 1, p = 0.71).

Houses were damaged by wind (16.1±2.5%) or rain/flood (6.9±1.7%) (Fig. 4). On 14 occasions did elephants damage houses, while in four cases monkeys and baboons were also responsible (Fig. 5). While events of wind were more common inside protected areas than beyond (χ^2 = 6.94, df = 1, p = 0.008), floods were more so beyond protected areas than inside (χ^2 = 5.71, df = 1, p = 0.02). Damage due to animals (e.g. elephants, monkeys and baboons) did not differ between inside and beyond protected areas (χ^2 = 0.15, df = 1, p = 0.70).

In terms of critical resources, droughts (29.6±3.1% of households) were most commonly noted as affecting water supplies (Fig. 4). Pollution of water (6.4±1.7%) and mechanical problems as well as distance to water (2.6±1.1%) were also noted as factors that influenced water supplies mainly more inside protected areas than beyond (χ^2 = 7.29, df = 1, p = 0.007; for pollution) while distance did so frequently outside protected areas (χ^2 = 5.21, df = 1, p = 0.02). Only 13.4±2.3% of households reported that their water supply was affected by animals, and in those cases elephants, crocodiles, bush pigs, cattle and hippopotamuses were identified as culprits (Fig. 5). Water supply damages by animals were more common outside than inside protected areas (χ^2 = 6.06, df = 1, p = 0.02).

Food stores of houses were damaged by fire and wind (< 2% of households), as well as animals (27.2±3.0%) (Fig. 4). Damaged by animals inside and beyond the parks was similar, but wind damage inside and beyond protected areas differed (χ^2 = 11.52, df = 1, p = 0.0007). With regards to animals, the key culprits were rats/mice (17.4±2.6% of households) and insects (mostly beetles) (8.5±1.9%) (Fig. 5), which were similar between inside and beyond protected areas (χ^2 = 0.75, df = 1, p = 0.39; χ^2 = 2.23, df = 1, p = 0.14 for insects and rats/mice, respectively). Damage due to monkeys were common inside protected areas (χ^2 = 5.16, df = 1, p = 0.02).

Disease was the most prominent factor damaging livestock (26.4±3.0% of households), but 12.9±2.3% of respondents also noted animals as a livestock damaging factor (Fig. 4). Damage to livestock due to disease, floods and drought were more common inside than beyond protected areas (disease: χ^2 = 15.33, df = 1, p = 0.0001; floods: χ^2 = 4.88, df = 1, p = 0.03; drought: χ^2 = 6.05, df = 1, p = 0.01). Lions, elephants, monkeys, and birds of prey were key

culprits, while four respondents had problems with baboons and crocodiles. Elephants were mostly considered as problematic inside protected areas (χ^2 = 23.07, df = 1, p = 0.0001) while lions were mainly reported as problematic beyond protected areas (χ^2 = 9087, df = 1, p = 0.002).

In terms of agricultural production, animals (71.1±3.1% of households) played a more important role compared to damages they caused to family, homes and critical resources (Fig. 4) and these were similar inside and beyond protected areas (χ^2 = 1.74, df = 1, p = 0.19). Elephants were the primary culprit (40.8±3.4% of households), followed by bush pigs (17.7±2.6), monkeys (11.6±2.2%), baboons (8.0±1.9%), rats/mice (6.9±1.7% of households) and hippopotamuses (1.6±0.9%) (see Fig. 5). Rats/mice and baboons were significantly more problematic inside than outside protected areas (χ^2 = 25.23, df = 1, p = 0.0001; χ^2 = 28.87, df = 1, p = 0.0001 for rats/mice and baboons, respectively) while elephants and bush pigs did so more outside than inside protected areas (χ^2 = 76.16, df = 1, p = 0.0001; χ^2 = 24.13, df = 1, p = 0.0001 for elephants and bush pigs, respectively).

Discussion

Rural people in Mozambique rely on subsistence agricultural and the extraction of a variety of natural resources from woodlands and forests. Under these conditions, wildlife conservation needs to address both sustainability of peoples' livelihoods systems and persistence of wildlife populations.

My study started by assessing the demographic profile of households inside and beyond protected areas. I postulated that people inside protected areas would have bigger families than those living beyond and that the survival probability of children inside protected areas would be

greater than outside these. My analyses did not support these expectations. This may suggest some lifestyle similarities under which both rural households living inside and beyond protected areas persist. The frontier rural areas of Mozambique may have more land available for people and they thus may not find it difficult for their children to settle in nearby areas. This thus may provide a marginal benefit in labour available to produce crops and collect resources. As a result, people may either have a higher fecundity as suggested by the frontier hypothesis (Easterlin, 1976) and the scarcity of common wild resources hypothesis (Dasgupta, 2000).

The subsistence economy based on the extraction of natural resources contrasts with typical protected area objectives, which itself reduces the net benefits of living inside protected areas and the survival probability of children. But this was not the case in my studied protected areas. For instances, I observed high rates of survival probability of children inside these. The high rates of survival probability of children together with the differences in the annual survival rates in favour of households living inside protected areas may agree with the notion that living inside protected areas in Mozambique may confer some benefits to reproduction and survival, as also predicted by numerical responses (e.g. Sibly & Hone, 2002).

My assessment of household economic profiles illustrated that rural households in Mozambique satisfied basic needs by various resources and activities available to households. For instance, economic profiles showed high level of unemployment while people did buy basic food items (e.g. sugar and salt) and others (e.g. soap and matches). Some luxury items were also acquired by a significant number of households, such as fridges, vehicles and bicycles. This consumer profile is similar to that observed by others (see Sitoe, 2005; Brück & van den Broeck, 2006; Walker *et al*., 2006; Ribeiro, 2008; Landry, 2009) in different parts of Mozambique.

Although a significant number of households have reported self-employment, this was a natural resource-based (e.g thatching grass, baskets, and wood-carvings). Government jobs were those in schools and clinics and private sector opportunities and were very limited. The incomes earned by those in employment vary enormously, but were generally low (Boughton *et al*., 2006; Brück *et al.*, 2006). Thus, the high level of unemployment, which is associated with a high level of basic requirements within consumer profiles, but low in some luxury items, may suggest some level of dependence on extraction of wild products and/or agricultural production.

Wild products (e.g. wild plants and wild resources) did satisfy subsistence needs of life for rural households. For example, wild plants were harvested for building, firewood, food, medicine, utensils and alcohol. Forests did also provide non-wood products such as, fruits, fish, mammals, mushrooms, honey and birds. While some of these provided basic subsistence needs (e.g. fuel wood, charcoal, raw materials, fruit, fish, etc) others, however, did give opportunities to households for barter and sales.

This profile of wild products use is similar to that observed by Ribeiro (2008) and Landry (2009) in their case studies of Maputo National Reserve and Sanga District, respectively, but with some specific differences across the country (Sitoe, 2005; Salomão & Matose, 2007). For instance, 46 and 30% of households in rural areas of Mozambique are thought to use wild plants for firewood and building, respectively (Sitoe, 2005). However, 90.9% of the households in the Sanga District did use wild plants as firewood (Landry, 2009). Differences on the use of wild products may be much more due to geographical effect of the location of villages on the variability in the use of the natural resources (e.g. Parker, Hessl & Davis, 2008).

As in most African rural areas (e.g. Brigham *et al*., 1996), the main source of income for households is agriculture. In Mozambique, agriculture offers low productivity and is mostly

dependent on rainfall regimes (Sitoe, 2005). Given this, households are increasingly dependent on non-agricultural livelihoods such as charcoal production, firewood collection, fishing and raw material extraction (Kityo, 2004; Ribeiro, 2008) particularly due to the fact that non-agricultural livelihoods have a variety of uses, and are generally more drought tolerant than cropping and livestock options (Ashley & LaFranchi, 1997).

I predicted that people inside protected areas would extract a greater variety of natural resources than those living beyond. However, the niche width (a proxy of the resource variety) of wild plants, livestock and agriculture was similar between inside and beyond protected areas, which suggests some similarities in the environment inside and beyond protected areas (Hardesty, 1975). The wide niche of the wild products beyond protected areas may, however, reflect an uncertainty of household lifestyle (see Hardesty, 1975), due to the resource scarcity dictated by the large number of users. This contrasts to the resources availability inside protected areas, generally exploited by relatively few people living here as illustrated by the relatively narrow niche from all other resources, but wild plants. With high uncertainty in resource exploitation, users tends to expand the number of the resources used (Hardesty, 1975).

The majority of households owned livestock and crops for subsistence living. In the rural areas of Mozambique, chickens, maize, cassava and beans are basic products which make a significant contribution in poverty alleviation of households (Walker *et al*., 2006; Ribeiro, 2008). This may explain the greater similarity between agricultural production noted from this study and others across the country (Sitoe, 2005; Walker *et al*., 2006; Ribeiro, 2008; Landry, 2009) as well as the importance given by the households to livestock and crops. During drought, floods and famine events, livestock and crops can be sold to buy staple foods and eventually luxury products (Landry, 2009). The aggregate structure of household's expenditure in Mozambique

accounts for higher consumption rates (e.g. 66.8%) rather than bought items and savings, respectively of 22.5% and 10.7% (Benfica, 2006; Tschirley & Benfica, 2001), which is typical of a rural developing economy.

These economic profiles, extracted for the rural population across Mozambique suggest that most households rely on subsistence farming to extract or produce products from the land, primarily for their own purposes. Bartering and cash sales of crops, and to a lesser extent livestock and wild products, provide for consumer items such as sugar and salt.

Agriculture and keeping livestock for subsistence living was more commonly practiced inside protected areas, a contradicting pattern with my expectation. This observation may reflect a small source of income for households living inside protected areas, a situation that necessitate them to crop or/and to keep livestock. Beyond protected areas, people may engage in a cash economy given a wide diversified source of incomes, a situation that reduces cropping and keeping livestock.

The vulnerability to stresses induced by unemployment, declining yields due to droughts or floods, declining water availability, declines in natural resources differed between households and study areas. For example, most injuries and deaths were due to diseases and wind; floods did damage homes. Family dwellings and damage to homes due to animals were less. Some pattern was observed for critical resources such as water, food stores, livestock and crops. For instance, diseases were the major reason for livestock losses; while drought did cause water scarcity and imposed losses on crops. Animals were identified as the main threat to food store and crops.

These results agree with findings from others (e.g. Sitoe, 2005; Walker *et al.*, 2006; Landry, 2009). For example, Walker *et al.* (2006) stated that drought followed by floods, theft,

birds and insects is the main threat that represents a risk for agriculture in Mozambique. In the Sanga District (Niassa province), Landry (2009) captured from households responses that family dwellings are mostly exposed to hunger, disease, animals and theft. Cycles of droughts, floods and cyclones and theft outbreaks are frequent events in Mozambique (INGC, 2009). Some of these (e.g. droughts and floods) are being linked to some endemic diseases such as malaria (INGC, 2009). It is thus no surprise that rural households of Mozambique are exposed to a great variety of environmental and social hazard events such drought, floods and diseases.

Animals are threatening events to critical resources in general, but specifically to food security. From my results, I did learn that animals did not have significant impact on critical resources, but caused crop damage. Elephants, followed by monkeys, bush pigs, baboons and rats/mice were responsible for crop losses. Contrary to my expectation, elephants and monkeys were more problematic for food store and livestock inside protected areas, while crop damage, injuries and deaths, damage to homes and to water by elephants, lions, rats/mice and insects were mostly beyond protected areas. These observations may agree with the notion that conflict profiles may be due to complex interplays of risks and households coping strategies, which are dependent on the socio-economic context (Hill, 2004; Naughton-Treves and Treves, 2005; Dickman, 2010). People tend to be intolerant to animals that injury and kill human lives and livestock as well as to those animals imposing losses on ´famine´ crops such as cassava, maize and beans (Naughton-Treves and Treves, 2005). This is strongly true for households inside protected areas where income sources are small.

Beyond protected areas, human population density is relatively high and cultivated areas are large. As stated by Newmark, Manyanza, Gamassa & Sariko (1994), people tend to be less effective in controlling small-bodied species at high human population density. De Boer &

Ntumi (2001) and Sitati *et al*. (2003) reported a positive relationship between cultivation and the intensity of crop raiding by elephants at the Maputo National Reserve (Mozambique) and at the Masai Mara National Reserve (Kenya), respectively. These observations may support my results on the sharply increase of crop damage by large bodied wildlife species (e.g. elephants) and food store damage by rats/mice and insects beyond protected areas.

My study sites did cover villages and households which differed in the exposure to risk and capacity to cope with risk. Tolerance to conflicting animals tend to increase with the existence of various alternate incomes, labour availability, wider coping strategies and communities absorbing losses to wildlife (Naughton-Treves & Treves, 2005). As illustrated by my results, rural households in Mozambique had little alternative incomes, high rates of unemployment, few coping strategies and absorb losses to wildlife. These restrictions are more severe inside protected areas.

As elsewhere (see Kangwana, 1993; Lahm, 1996; Naughton-Treves, 1998; Nyhus, Tilson & Sumianto, 2000; De Boer & Ntumi, 2001; Parker & Osborn, 2001; Dunham *et al*., 2010), I did learn from my study that elephants were key to crop losses. But, in general critical resources threats were mostly linked to other animals (e.g. insects, mostly beetles and rats/mices). For example, in the nationwide assessment on human and wildlife conflict, elephant, hippopotamus, buffalo, bush pigs and monkeys were referred as the most problematic animals that imposed losses of crops (Dunham *et al*., 2010). Apart from these, insects and rats/mice did not have any mention.

The perception of people on the risk posed by wildlife tend to focus on rare, extreme damage events such as those by elephants, rather than ´persistent, small losses, which cumulatively may be greater´ (Naughton-Treves & Treves, 2005). More specifically, elephants

are large and dangerous; and they raid a greater range of crops at the mature stage mostly at night. Elephant raids seem to be chronic and impose unlimited amounts of losses (Naughton-Treves & Treves, 2005). The description above may explain why elephants are being topped in human and wildlife conflicts elsewhere and in Mozambique, particularly. But, while elephants did represent challenges for households, insects and rats may have represented a similar threat.

In the tropics (e.g. Mozambique), farmer's are exposed to a greater variety of pests, which impose elevated and chronic levels of losses (Porter & Sheppard, 1998 cited in Naughton-Treves & Treves, 2005). The productivity of the rain fed agriculture in Mozambique is low (Kityo, 2004). For example, grain productivity of maize may vary from 56 to 64 kg/ha, depending on the agro ecological zone of Mozambique (Cugala, 2007). Losses in the field due to the larger grain borer, *Prostephanus truncatus*, may vary from 30 to 35% (Cugala, 2007). In rural areas of Mozambique, 1, 500kg of maize are stored in a small scale farmer's storage (Dick, 1988) per year. The mean losses of maize due to insects (e.g. *Prostephanus truncatus*) range from 26 to 62% of these (Cugala *et al*., 2007). Thus, insects represent key factors that would limit the storage of maize in small scale farmers store conditions as well as potential risk and threat for food security (Cugala *et al*., 2007).

Forty-seven and 77% of households in the rural areas of Limpopo province (South Africa), which borders Mozambique, considered rodents as a pest for crops in fields and in storages, respectively (Kirsten & von Maltiz, 2005). Rodents were problematic in the two crucial phases of crop growing; at planting, they dig up maize seeds and, the heading stage, rodents damage cobs. Losses due to rodents were estimated at 37% (Kirsten & von Maltiz, 2005).

From my assessment, human-wildlife conflict is a reality in the rural areas of Mozambique. Elephants are often responsible for crop damage, rodents and insects are the

primary agents responsible for food loss during storage. Conflict with elephants appears not to affect food security, but it is more about life styles being affected by the presence of elephants. The rural nature of the landscape, with relatively small and widely dispersed agricultural fields in the proximity of villages and embedded in relatively intact landscapes, provide habitat for elephants and other wildlife. Some of this wildlife contribute to the local economy and are taken through hunting, trapping and snaring. Elephants, however, were not killed or poached by local inhabitants and appear to serve as an important icon of the hardships associated with a subsistence lifestyle typical of rural Mozambique. Elephants focus political attention on the destitution of these people and calls from local leaders to find solutions for conflict may detract from the primary drivers of lifestyle insecurities associated with a near settler lifestyle typical of the rural areas of Mozambique.

These results highlight the importance of socio-economic approaches in our effort to understand and find solutions to human and wildlife conflicts in general and HEC in particular. Human and wildlife conflicts may impose a significant impact on rural people's livelihoods and lives. The degree to which people consider these to be an important issue may depend on the alternatives they have to cope with. In my study sites, people may perceived losses on human lives, livestock and crops as threats to household assets, which in turn are key features part of coping strategies to environmental stress and shocks (Chamuene *et al*., 2007; Landry, 2009). Under this context, human and wildlife conflict mitigation strategies will certainly need to expand the traditional species-based approaches (e.g. Hoare, 2001) and consider socio-economic approaches under which conflicts occur. The decision support system (DSS) (Hoare, 2001), a toolkit for HEC mitigation will need to be combined with such alternatives that generate income

and benefits for local people. Ultimately, this will improve people perceptions on support elephant conservation and increase tolerance to HEC (Nelson *et al*., 2003).

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Table 1 Study sites details. Districts from where study sites were selected, with respective population density and percent of cultivated area as well as sampling sites from each study sites and respective number of households and total living population.

Study sites	District	Density	Cultivation (%)	Sampling sites	Households	Population
Matutuine	Matutuine	1.8	1,25	Maputo NR	388	1,940
				Futi Corridor	642	3,210
Magude-Moamba	Magude	7.7	2,48	Mapulanguene	451	1,834
				Motaze	1,606	7,824
				Mahele	511	2,294
				Panjane	768	4,124
	Moamba	12.3	2,84	Pessene	4,354	14,846
				Sabie	3,824	16,041
Limpopo NP	Massingir	2.7	2,34	Mavodze	1,114	8,366
				Zulo	1,568	9,180
	Mabalane	2.0	2,30	Combumune	1,687	9,641
				Ntlavene	1,421	9,160
	Chicualacuala	1.2	1,18	Mapai	2,893	17,616
				Pafuri	798	5,112
Banhine NP	Chigubo	0.8	0,71	Ndindiza	2,102	11,511
	Massangena	1.2	0,90	Mavue	1,067	6,376
Chimanimani NR	Sussungenga	18.3	4,22	Dombe	9,882	49,404
				Muhoa	3,445	17,936
				Rotanda	2,060	10,833
Mágoè	Mágoè	8.3	1,05	Maphende	3,063	13,522
				Chinthopo	5,385	24,860
				Mukumbura	6,755	30,470
Marrupa-Nipepe	Marrupa	3.7	0,63	Marangira	5,287	1,288
				Nungo	5,747	1,390
	Maua	6.1	1,12	Maiaca	3,300	13,355
	Nipepe	6.1	1,20	Muipite	2,336	9,438
Quiterajo	Macomia	19.3	4,19	Quiterajo	2,290	8,571

Table 2 An assessment of demographic parameters of four study sites that were situated inside protected areas (n = 310) and others five study sites that were situated beyond protected areas (n = 502). In the table, MNR = Maputo National Reserve; LNP = Limpopo National Park; BNP = Banhine National Park and CNR = Chimanimani National Park.

Demographic parameters	Study sites																								Total/Mean		
	Inside												Beyond														
	MNR			LNP			BNP			CNR			FUTI			MOAMBA			MÁGOÈ			NIPEPE			QUITERAJO			Overall	Inside	Beyond
Sample																														
Males	229			288			230			359			155			212			268			262			431			2,434	1,106	1,328
Females	190			272			226			378			152			217			296			288			573			2,592	1,066	1,526
Unknown	0			0			0			0			3			3			0			9			0			15	0	15
Families	54			94			66			96			39			52			94			78			239			812	310	502
Family size	5,6			3,7			4,0			3,9			4,4			4,1			4,0			3,9			2,8			4,1	4,3	3,9
Reproduction	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n			
Age at first birth	20,6	0,9	50	20	0,6	83	21,0	1,0	57	19,9	0,7	98	22,3	1,1	34	19,9	0,8	52	21,9	0,95	84	18,2	0,6	55	20,1	0,9	94	21	20	21,9
Age at last birth	34,5	1,4	38	35,3	1,1	36	35,5	1,5	44	39,0	1,3	45	36,4	1,7	19	36,5	1,2	28	33,5	1,7	70	38	3,5	8	33,2	1,3	38	36	36,1	35,8
Interval between births	3,1	0,2	193	3,7	0,2	236	4,5	0,3	173	3,5	0,1	323	3,6	0,2	133	3,2	0,2	183	3,2	0,15	263	3,1	0,2	190	3,4	0,2	257	3,5	3,7	3,2
Population growth																														
Closed	0,03			0,02			0,00			0,01			0,02			0,03			0,01			0,01			0,00			0,02	0,02	0,01
Open	-0,03			-0,03			-0,03			-0,01			-0,07			-0,05			-0,02			-0,02			-0,01			-0,03	-0,02	-0,03
Emigration	0,06			0,24			0,14			0,10			0,41			0,36			0,24			0,19			0,04			0,22	0,19	0,25
Child survival	0,94			0,97			0,99			0,99			0,95			0,97			0,98			0,95			0,99			0,97	0,97	0,97

Table 3 An assessment of socio-economic and conflict profiles of eight study sites and frequency of positive responses with respective 95%CI and range. The table illustrates a breakdown of Matutuine study site into the Futi and Maputo NR sampling sites.

			Study sites									Frequency			
			Futi	MNR	Magude-Moamba	LNP	BNP	CNR	Magoe	Marrupa-Nipepe	Quiterajo	TOTAl				
Total number of interviewees per study site			39	54	52	94	66	96	94	78	239	812	n	%	95% CI	Range
1.0	Employment	Not employed	30	18	41	68	47	70	47	61	171	812	553	68.10	3.21	64.89 – 71.31
		Self-employed	5	36	9	16	13	10	46	9	59	812	203	25.00	2.98	22.02 – 27.98
		Government	3	0	1	1	6	10	1	3	5	812	30	3.69	1.30	2.39 – 4.99
		Private	1	0	0	9	0	6	0	4	4	812	24	2.96	1.17	1.79 – 4.13
2.0	Bought items	Sugar	38	51	48	90	62	85	90	57	192	812	713	87.81	2.25	85.56 – 90.06
		Salt	38	52	5	88	63	86	90	72	201	812	695	85.59	2.42	83.17 – 88.01
		Soap	37	52	49	87	63	81	90	68	192	812	719	88.55	2.19	86.36 – 90.74
		Matches	38	47	45	75	62	57	21	52	172	812	569	70.07	3.15	66.92 – 73.22
		Stationary	16	25	23	32	34	20	85	46	80	812	361	44.46	3.42	41.04 – 47.88
		Mirror	27	14	26	22	50	4	70	32	115	812	360	44.33	3.42	40.91 – 47.75
		Radio	18	13	29	16	43	11	62	45	89	812	326	40.15	3.37	36.78 – 43.52
		Wheelbarrow	0	4	17	4	2	1	3	1	10	812	42	5.17	1.52	3.65 – 6.69
		Bike	4	3	23	11	19	8	4	52	34	812	158	19.46	2.72	16.74 – 22.18
		Fridge	0	0	1	3	0	0	0	0	4	812	8	0.99	0.68	0.31 – 1.67
		Vehicle	3	5	3	1	0	1	1	0	1	812	15	1.85	0.93	0.92 – 2.78
3.0	Wild plants	Building	37	50	49	88	62	92	94	75	202	812	749	92.24	1.84	90.40 – 94.08
		Firewood	23	52	50	92	64	96	94	75	231	812	777	95.69	1.40	94.29 – 97.09
		Food	36	20	28	88	36	80	94	54	202	812	638	78.57	2.82	75.75 – 81.39
		Medicine	18	19	14	62	17	24	94	5	93	812	346	42.61	3.40	39.21 – 46.01
		Utensils	1	28	23	24	29	10	87	47	35	812	284	34.98	3.28	31.70 – 38.26
		Alcohol	2	8	14	44	17	0	6	6	0	812	97	11.95	2.23	9.72 – 14.18
4.0	Wild products	Mushrooms	15	2	3	0	28	27	2	60	40	812	177	21.80	2.84	18.96 – 24.64
		Fruit	37	50	28	88	58	80	80	54	200	812	675	83.13	2.58	80.55 – 85.71
		Honey	36	15	13	19	30	19	20	41	50	812	243	29.93	3.15	26.78 – 33.08
		Fish	24	39	15	20	20	12	12	43	159	812	344	42.36	3.40	38.36 – 45.76
		Birds	4	2	2	19	10	10	10	22	59	812	138	17.00	2.58	14.42 – 19.58
		Animals	24	13	16	15	9	41	30	24	79	812	251	30.91	3.18	27.73 – 34.09
4.1	Use	Household	36	54	35	90	64	91	77	65	139	812	651	80.17	2.74	77.43 – 82.91
		Barter	2	0	0	4	2	1	5	0	15	812	29	3.57	1.28	2.29 – 4.85
		Cash	9	30	2	0	0	4	12	14	85	812	156	19.21	2.17	16.50 – 21.92
5.0	Livestock	Dogs	8	9	24	44	22	21	26	3	7	812	164	20.20	2.76	17.44 – 22.96
		Chickens	27	39	39	70	52	85	74	55	129	812	570	70.20	3.15	67.05 – 73.35
		Guineafowl	1	2	2	1	0	1	0	1	2	812	10	1.23	0.76	0.47 – 1.99
		Cattle	6	4	35	63	32	34	42	1	1	812	218	26.85	3.05	23.80 – 29.90
		Goats	20	32	35	56	31	47	35	15	111	812	382	47.04	3.43	43.61 – 50.47
		Sheep	0	2	3	6	13	2	0	0	4	812	30	3.69	1.30	2.39 – 4.99
		Bush pigs	0	0	0	7	6	2	7	1	0	812	23	2.83	1.14	1.69 – 3.97
		Duck	0	0	10	0	4	0	12	0	6	812	32	3.94	1.34	2.60 – 5.28
5.1	Use	Household	30	43	44	56	56	52	16	57	129	812	483	59.48	3.38	18.37 –23.99
		Barter	4	1	0	1	0	1	12	11	21	812	51	6.28	1.67	56.10 – 62.86
		Cash	19	11	19	37	10	43	66	32	89	812	326	40.15	3.37	4.61 – 7.95
6.0	Crops	Cassava	23	38	19	18	25	21	0	45	101	812	290	35.71	3.30	36.78 – 43.52
		Maize	27	34	45	83	63	88	63	54	68	812	525	64.66	3.29	32.41 – 39.01

Table 3 (Continued)

			Study sites									Frequency			
			Futi	MNR	Magude-Moamba	LNP	BNP	CNR	Magoe	Nipepe-Marrupa	Quiterajo	TOTAl				
Total number of interviewees per study site			39	54	52	94	66	96	94	78	239	812	n	%	95% CI	Range
		Rice	4	0	0	3	1	6	0	15	110	812	139	17.12	2.59	61.37 – 67.95
		Groundnuts	12	21	15	35	41	11	25	9	18	812	187	23.03	2.90	14.53 – 19.71
		Mangoes	2	0	0	0	1	0	0	14	0	812	17	2.09	0.98	20.13 – 25.93
		Beans	22	14	20	62	56	32	4	29	54	812	293	36.08	3.30	1.11 – 3.07
		Sorghum	0	0	3	5	8	22	19	28	11	812	96	11.82	2.22	32.78 – 39.38
		Water-melon	0	0	1	32	28	0	0	0	11	812	72	8.87	1.96	9.60 – 14.04
		Wheat	0	0	0	0	0	14	0	0	0	812	14	1.72	0.89	6.91 – 10.83
6.1	Use	Household	36	47	46	89	45	71	53	70	128	812	585	72.04	3.09	0.83 – 2.61
		Barter	3	0	3	0	2	0	16	15	22	812	61	7.51	1.81	68.95 – 75.13
		Cash	15	5	10	5	19	25	25	46	89	812	239	29.43	3.13	5.70 – 9.32
		Floods	0	0	0	6	0	0	0	0	0	812	6	0.74	0.59	26.30 – 32.56
7.0	Injury and deaths	Animals	1	1	1	4	0	0	0	1	50	812	58	7.14	1.77	0.15 – 1.33
		Fire	0	0	1	0	0	0	0	1	2	812	4	0.49	0.48	5.37 – 8.91
		Disease	9	20	6	27	17	13	0	4	100	812	196	24.14	2.94	0.01 – 0.97
8.0	Damage to homes	Wind	7	24	9	14	22	3	0	8	43	812	130	16.01	2.52	21.20 – 27.08
		Floods	0	3	2	5	3	2	0	12	29	812	56	6.90	1.74	13.49 – 18.53
		Animals	1	1	0	4	0	0	0	2	7	812	15	1.85	0.93	5.16 – 8.64
		Fire	0	2	0	2	3	0	0	1	5	812	13	1.60	0.86	0.92 – 2.78
9.0	Damage to water supply	Drought	20	17	21	24	36	17	0	25	80	812	240	29.56	3.14	0.78 – 2.46
		Animals	1	0	11	30	0	0	0	3	64	812	109	13.42	2.34	26.42 – 32.70
		Pollution	1	17	2	4	1	7	0	7	13	812	52	6.40	1.68	11.08 – 15.76
		Fire	0	0	0	0	0	0	0	0	1	812	1	0.12	0.24	4.72 – 8.08
		Mechanical	1	0	3	0	4	0	2	0	0	812	10	1.23	0.76	-0.12 – 0.36
		Distance	0	3	10	0	0	0	0	8	0	812	21	2.59	1.09	0.47 – 1.99
10.0	Damage to food store	Disease	0	1	0	0	0	0	0	7	0	812	8	0.99	0.68	1.50 – 3.68
		Fire	0	0	0	0	1	0	0	0	0	812	1	0.12	0.24	0.31 – 1.67
		Floods	0	0	2	2	0	0	0	0	0	812	4	0.49	0.48	-0.12 – 0.36
		Animals	22	24	41	15	9	46	2	45	17	812	221	27.22	3.04	0.01 – 0.97
		Pollution	0	0	0	0	0	0	0	0	0	812	0	0.00	0	0.00 –0.00
		Drought	0	0	0	0	0	0	0	0	0	812	0	0.00	0	0.00 –0.00
		Wind	0	0	1	2	5	2	0	0	0	812	10	1.23	0.76	60.47 – 1.99
		Thefts	0	0	0	1	1	0	0	0	1	812	3	0.37	0.42	-0.05 – 0.79
11.0	Damage to livestock	Disease	11	22	20	8	24	52	2	39	37	812	215	26.48	3.03	23.45 – 29.51
		Fire	0	0	0	0	0	0	0	0	0	812	0	0.00	0	0.00 –0.00
		Floods	0	3	0	0	0	0	0	0	0	812	3	0.37	0.42	-0.05 – 0.79
		Animals	9	15	14	18	2	6	2	10	29	812	105	12.93	2.31	10.62 – 15.24
		Pollution	0	0	0	0	0	0	4	0	0	812	4	0.49	0.48	0.01 – 0.97
		Drought	0	0	2	3	4	0	0	0	0	812	9	1.11	0.72	0.39 –1.83
		Wind	0	0	0	0	0	0	0	0	0	812	0	0.00	0	0.00 –0.00
		Thefts	1	0	0	0	0	1	0	0	14	812	16	1.97	0.96	1.01 – 2.93
12.0	Damage to crops	Animals	37	43	33	75	12	82	85	57	153	812	577	71.06	3.12	67.93 – 74.18
		Drought	1	0	13	77	34	9	29	5	22	812	190	23.40	2.91	20.49 – 26.31
		Theft	0	0	0	0	0	4	0	0	0	812	4	0.49	0.48	0.01 – 0.97
		Soils	0	1	1	1	0	4	0	0	4	812	11	1.35	0.79	0.56 – 2.14
		Floods	2	1	1	1	0	2	0	4	4	812	15	1.85	0.93	0.92 – 2.78
13.0	Conflict & homes	Elephants	1	1	0	2	0	0	0	2	8	812	14	1.72	0.89	0.83 – 2.61
		Monkeys	0	0	0	0	0	1	0	0	3	812	4	0.49	0.48	0.01 – 0.97
		Baboons	0	0	0	0	0	1	1	0	2	812	4	0.49	0.48	0.01 – 0.97

Table 3 (Continued)

			Study sites									Frequency			
			Futi	MNR	Magude-Moamba	LNP	BNP	CNR	Magoe	Nipepe-Marrupa	Quiterajo	TOTAl				
Total number of interviewees per study site			39	54	52	94	66	96	94	78	239	812	n	%	95% CI	Range
14.0	Conflict & water	Elephants	0	11	3	20	0	0	0	2	43	812	79	9.73	2.04	7.69 – 11.77
		Cattle	2	0	3	0	0	0	0	0	0	812	5	0.37	0.42	-0.05 – 0.79
		Crocodiles	0	0	6	3	0	0	0	0	0	812	9	1.11	0.72	0.39 – 1.83
		Hippopotamuses	0	0	2	0	0	0	0	1	0	812	3	0.37	0.42	-0.05 – 0.79
15.0	Conflict people	Elephants	0	1	0	9	0	0	0	0	19	812	29	3.57	1.28	2.29 – 4.85
		Crocodiles	0	0	0	1	0	0	0	0	1	812	2	0.25	0.34	-0.09 – 0.59
		Lions	0	0	0	2	0	0	0	0	1	812	3	0.37	0.42	-0.05 – 0.79
		Snakes	1	0	0	0	0	0	0	0	0	812	1	0.12	0.24	-0.12 – 0.36
16.0	Conflict & crops	Elephants	26	41	9	2	5	19	82	27	120	812	331	40.76	3.38	37.38 – 44.14
		Monkeys	11	0	3	0	0	37	0	23	20	812	94	11.58	2.20	9.38 – 13.78
		Bush pigs	28	0	24	3	0	26	20	34	9	812	144	17.73	2.63	15.10 – 20.36
		Rats/mice	0	0	13	0	0	39	0	4	0	812	56	6.90	1.74	5.16 – 8.64
		Insects/beetles	3	0	0	0	1	4	0	2	0	812	10	1.23	0.76	0.47 – 1.99
		Cattle	1	0	2	0	0	0	0	0	0	812	3	0.37	0.42	-0.05 – 0.79
		Baboons	0	0	0	43	2	0	0	20	0	812	65	8.00	1.87	6.13 – 9.87
		Hippopotamuses	7	2	3	1	0	0	0	0	0	812	13	1.60	0.86	0.74 – 2.96
		Birds	7	0	0	0	0	0	0	0	0	812	7	0.86	0.64	0.22 – 1.50
17.0	Conflict & livestock	Elephants	0	0	0	14	0	0	0	0	0	812	14	1.72	0.89	0.83 – 2.61
		Monkeys	0	0	0	0	0	5	0	1	4	812	10	1.23	0.76	0.47 – 1.99
		Birds	3	0	2	2	0	0	0	1	0	812	8	0.99	0.68	0.31 – 1.67
		Lions	0	0	3	3	0	0	0	0	23	812	29	3.57	1.28	2.29 – 4.85
		Baboons	0	0	2	1	0	0	0	0	2	812	5	0.62	0.54	0.08 – 1.16
		Crocodiles	2	1	1	1	0	0	0	0	0	812	5	0.62	0.54	0.08 – 1.16
		Snakes	3	0	0	0	0	0	0	0	0	812	3	0.37	0.42	-0.05 – 0.79
18.0	Conflict and food store	Insects	18	0	25	0	7	16	0	1	2	812	69	8.50	1.92	6.58 – 10.42
		Rats/mice	9	12	40	0	0	34	0	23	23	812	141	17.36	2.61	14.75 – 19.97
		Bush pigs	6	0	0	0	0	0	0	0	0	812	6	0.74	0.59	0.15 – 1.33
		Monkeys	1	0	0	1	0	13	0	1	7	812	23	2.83	1.23	1.69 – 3.97
		Elephants	0	0	0	7	0	2	0	3	8	812	20	2.46	1.07	1.39 – 5.53

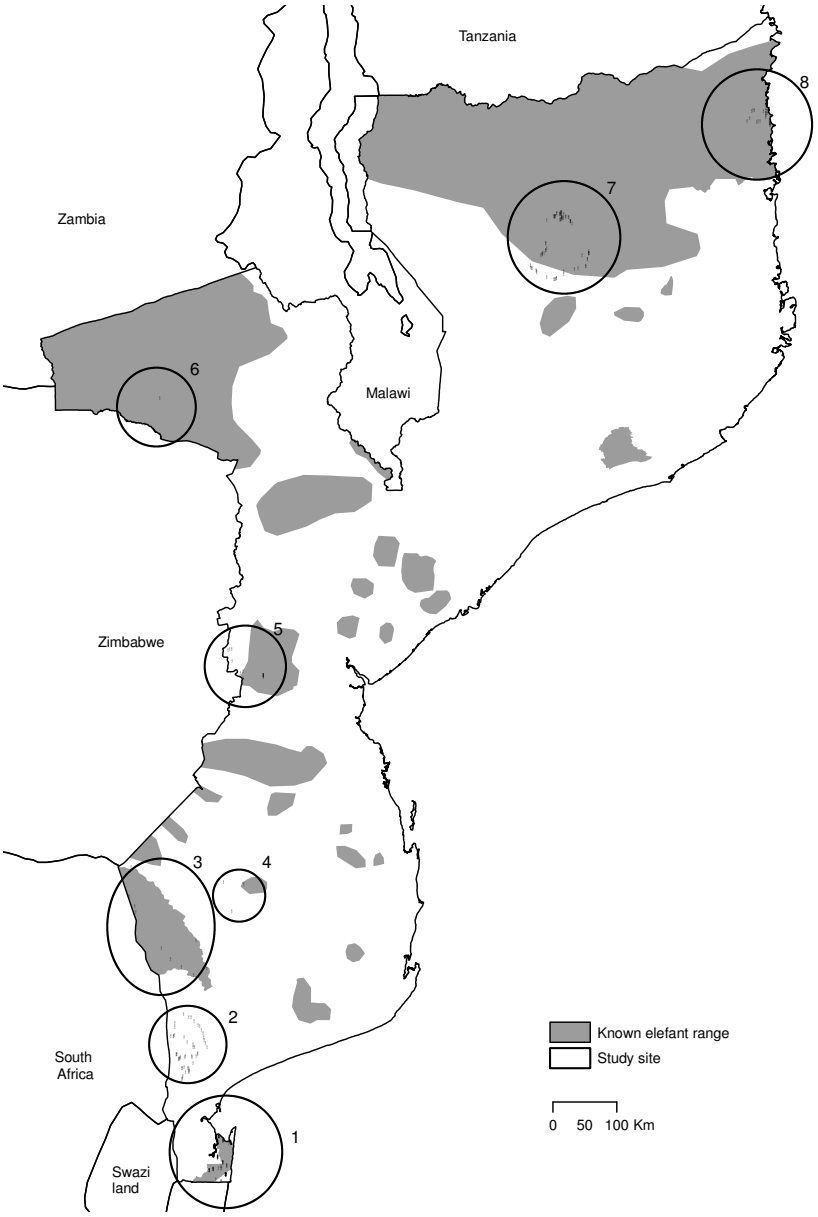

Fig. 1 Line diagrams of Mozambique, showing the location of the eight study sites where the structured questionnaire-based survey were carried out as well as the reduced and fragmented present elephant range with links to Tanzania, Zambia, Zimbabwe and South Africa. Inset shows location of each of study site. 1, Matutuine; 2, Magude-Moamba; 3, Limpopo NP; 4, Banhine NP; 5, Chimanimani NR; 6, Mágoè; 7, Marrupa-Nipepe and 8, Quiterajo. Elephant range was modified from Ntumi *et al.* (2009).

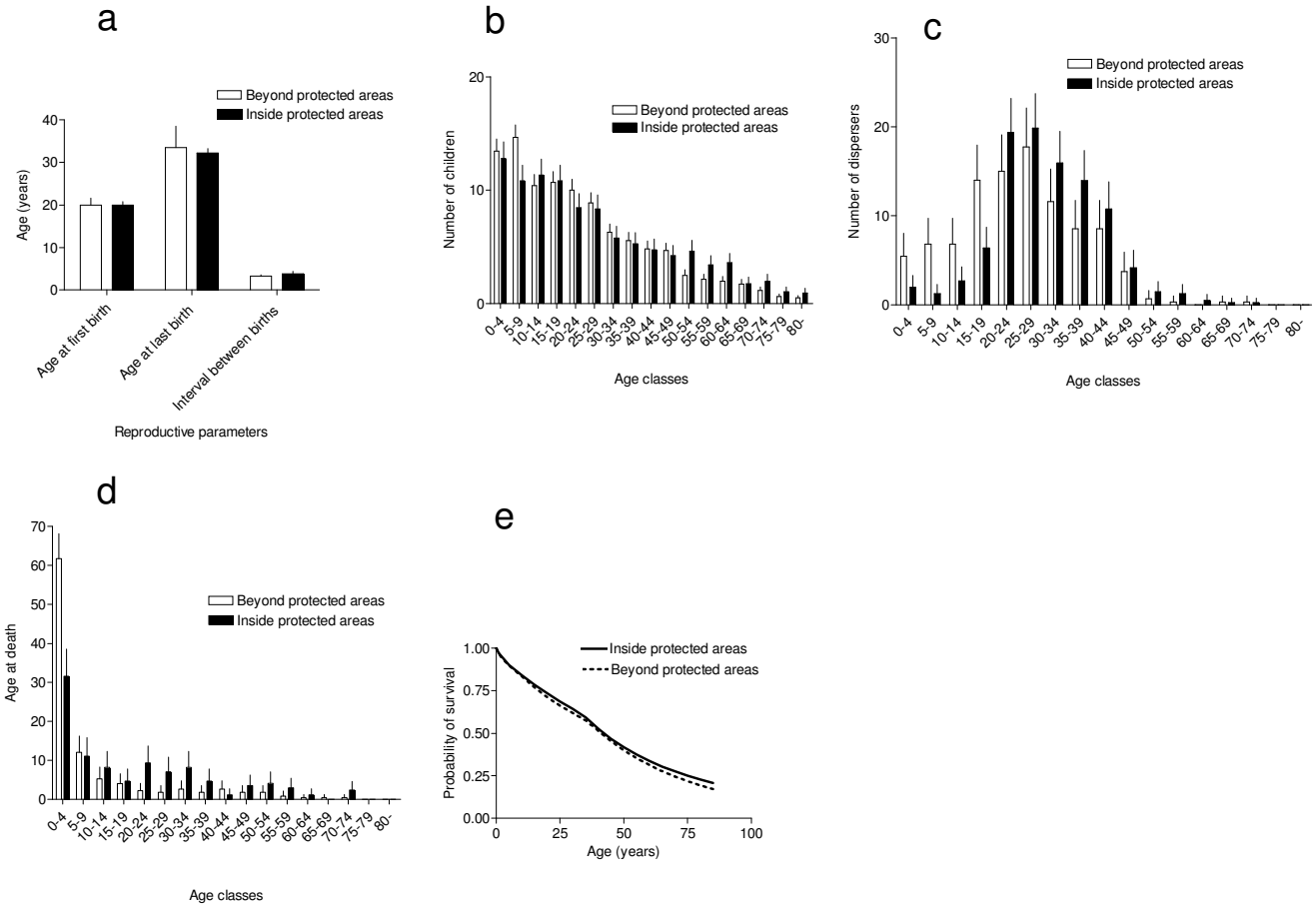

Fig. 2 The demographic profile of rural people living beyond (clear bars, n = 502) and inside (dark bars, n = 310) protected areas of Mozambique. The figure, illustrates the reproductive parameters (a), number of children by age classes (b), number of dispersers by age classes (c), age at death by age classes and (d), the probability of survival (e).

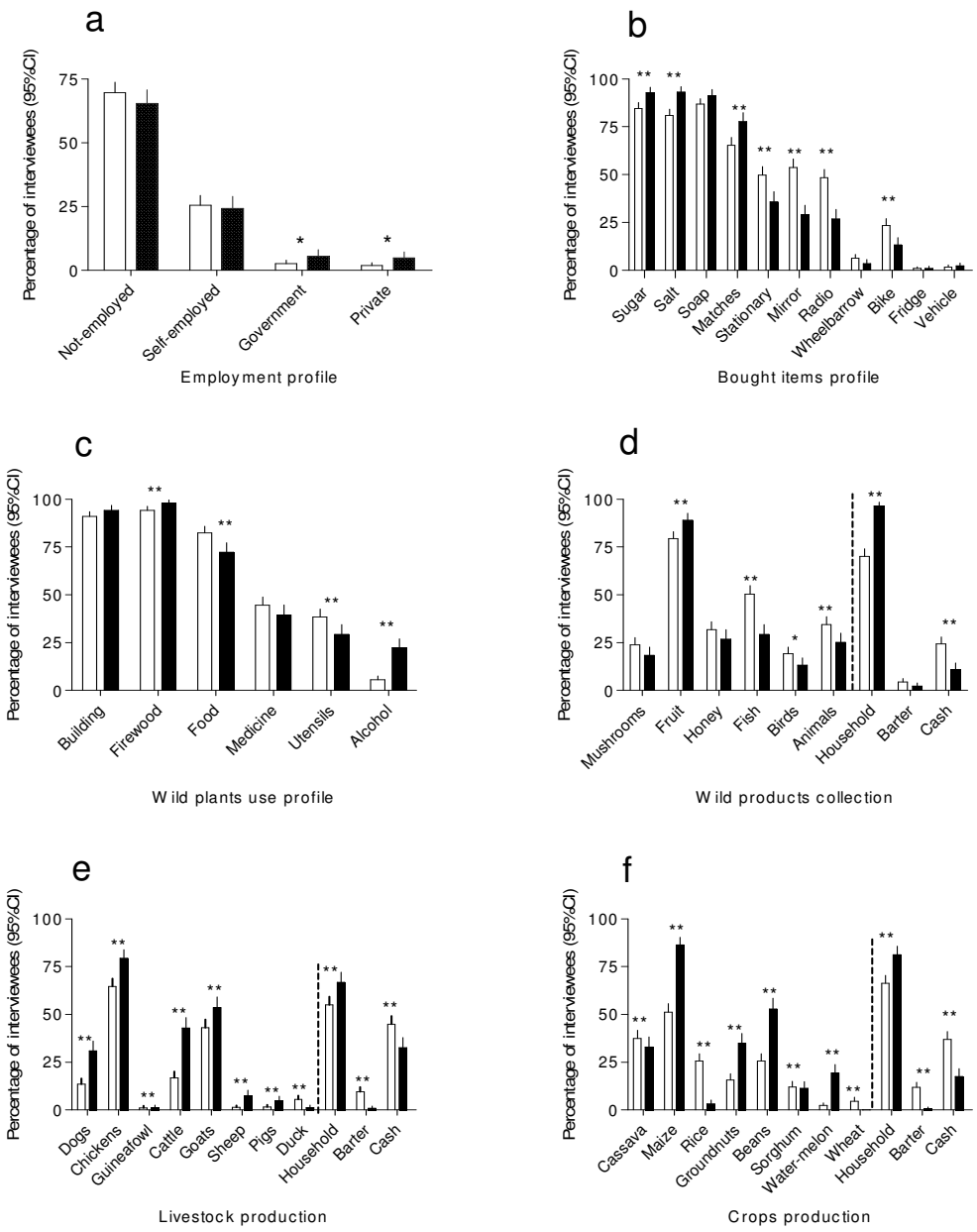

Fig. 3 The economic profile of rural people living beyond (clear bars; n = 502) and inside (dark bars; n = 310) protected areas of Mozambique. The figure, illustrates the consumer profile with (a), employment and (b), bought items; wild product use with (c), wild plants and (d), collection of wild products and agricultural production with (e), livestock and (f), crops (*$p < 0.05$, **$p < 0.001$).

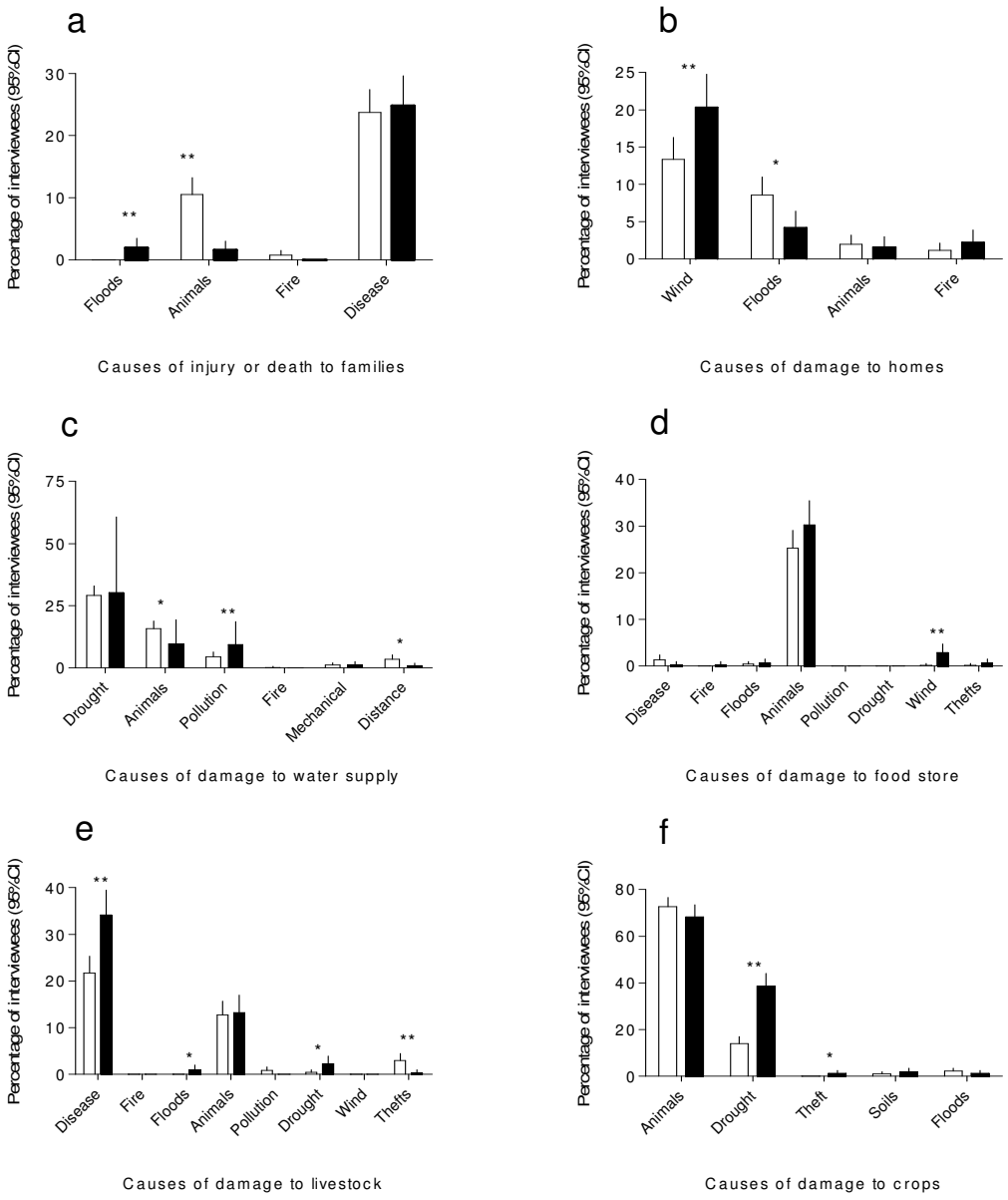

Fig. 4 The conflict profile compiled for 820 rural households living beyond (clear bars; n = 502) and inside (dark bars; n = 310) protected areas of Mozambique. The figure highlights family and dwellings with (a), injury or death and (b), damage to homes; critical resources with (c), damage to water supply and (d), damage to food store; agricultural production with (e), damage to livestock and (f) damage to crops (*$p < 0.05$, **$p < 0.001$).

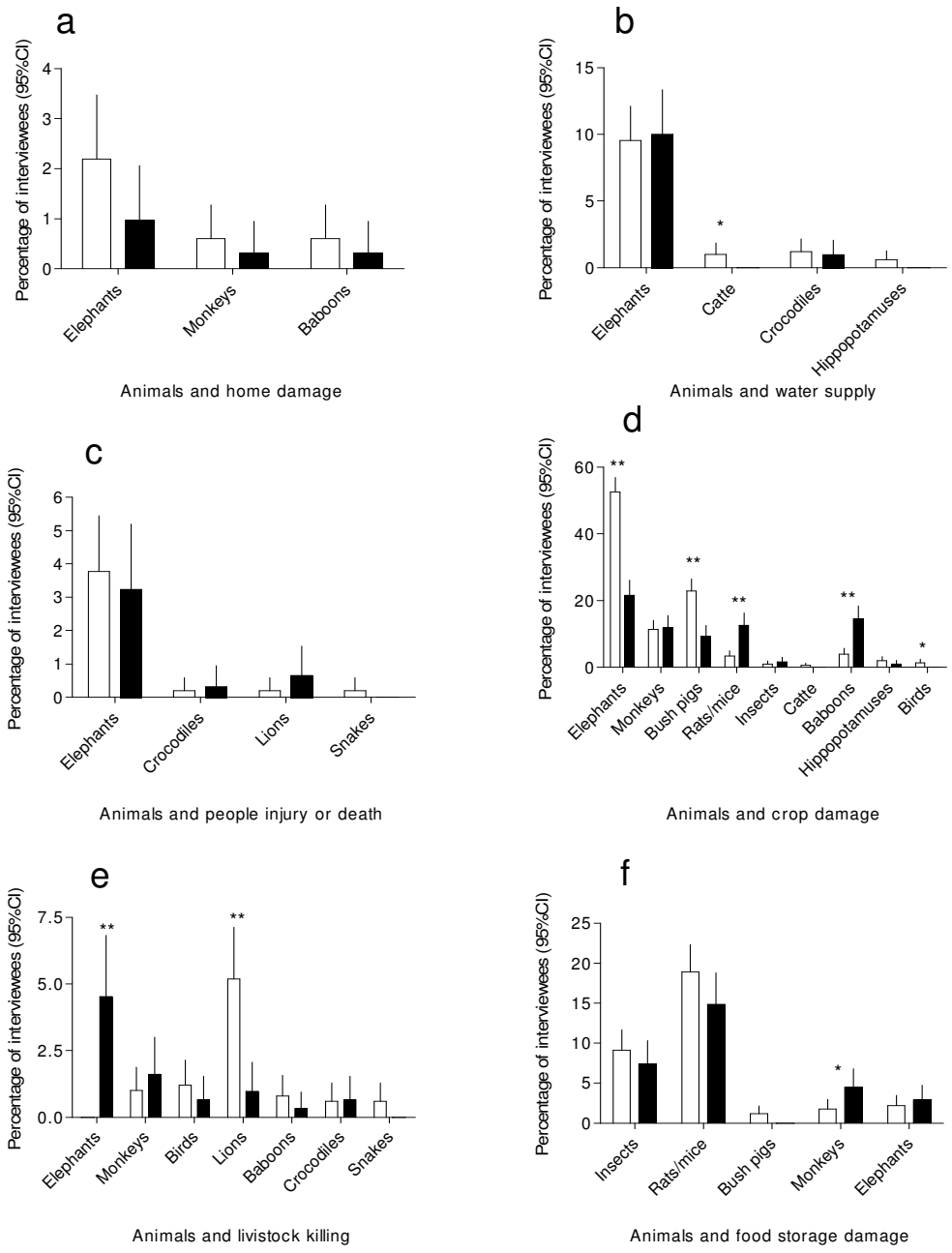

Fig. 5 The conflict profile compiled for 820 rural households living beyond (clear bars; n = 502) and inside (dark bars; n = 310) protected areas of Mozambique. Elephants, monkeys and rat/mices damage crops, while rat/mices and insects damage food stores (*p < 0.05, **p < 0.001).

Appendix 1 The confidential questionnaire for structured surveys used to access the demographic, economic and conflict profiles in the all nine study sites of rural areas of Mozambique between 2007 and 2010.

Reference:

Interviewer……

Date……

GPS coordinates ……Province & Country……

Demographic profile

1. Year of birth……..

2. Age……

3. Gender: male female

4. Ethnic group……

5. Details of spouse:

	Wife 1	Wife 2	Wife 3	Husband 1	Husband 2	Husband 3
Alive						
Age (at death)						

6. Details of children:

	Wife 1				Wife 2				Wife 3			
Child #	Boy / girl	Alive	Age Died	Age Today	Boy / girl	Alive	Age Died	Age Today	Boy / girl	Alive	Age Died	Age Today
1												
2												
3												
4												
5												
6												
7												
8												
9												

7. Place of residence Town Rural village Rural single

8. For how many years were you educated (or not educated)……..

9. Can you read? Yes No 10. Can you write? Yes No

11. Were you born in the province? Yes No

12. How many of your children: are still at home?..... have moved to a(nother) town or city?.....

Economic profile

13. Which of the following animals does your household keep?

Dogs Chickens Guinea fowl Cattle Goats Sheep Pigs None Other……..

14. Why do you keep livestock? Household use Non-cash trade (barter) Cash trade

15. Which of the following bought items does your household use?

Sugar Salt Soap Matches Pen / pencils Mirror Radio Wheelbarrow Bike Fridge Motor vehicle

16. Which of the following crops do you grow? Cassava Maize Rice Groundnuts Mangoes Beans Other…….…….. Other ……..……. Other…….

17. What do you grow your crops for? Household use Non-cash trade (barter) Cash trade

18. Do you use wild plants for the following purpose: Building Medicine Firewood Alcohol (beer / wine) Charcoal Household Utensils (mats, kitchen, pounding blocks) Tourist curios (carvings, mats)

19. Which of the following wild produce do you collect: Mushrooms Fruit Honey Fish Birds Animals

20. Why do you collect these products? Household use Non-cash trade (barter) Cash trade

21. How are you employed? Not employed Self-employed Government employed Private sector

22. In which sector are you employed? Agriculture Mining Tourism Conservation Other…….

23. What is the name of your employer?..... 24. What is your approximate monthly income……..

Conflict profile

25. Did anything stop access to your regular drinking water supply in the last year? yes no

If yes – water polluted fire drought floods wind mechanical failure animals

Details……...……

26. Did anything damage your home in the last year? yes no

If yes – fire floods / rain wind animals

Details……...……

27. Did anything injure or kill anyone in your household in the last year? yes no

If yes – disease fire floods animals other

Details……...……

28. Did anything kill or reduce your livestock numbers in the last year? yes no don't keep livestock

If yes – disease fire drought floods wind animals theft ran away

Details……...……

29. Did anything damage or reduce your crop harvest in the last year? yes no don't farm

If yes – disease fire drought floods wind hail animals poor soils theft

Details……...……

30. Did anything damage or take produce in your food stores in the last year? yes no don't have a food store

If yes – disease fire drought floods wind theft animals

Details……...……

SUMMARY TABLE TO BE FILLED IN FOR QUESTIONS 24-29

Animal	Water	Home	People	Livestock	Crops	Store
Cattle						
Goat / sheep						
Insects						
Birds						
Porcupine						
Rats and mice						
Bush pig						
Monkey						
Baboon						
Kudu						
Elephant						
Other……						
Other……						