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Irene Bridget Feretti
University of New Hampshire - Main Campus, ireneferetti@gmail.com

Honors Thesis

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Irene Bridget Feretti

University of New Hampshire – Department of Geography

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Abstract

Studies suggest households closest to parks and protected areas (PAs) are more likely to sustain park-related losses, but the relationship between human sickness and PAs has not been fully explored. Existing literature primarily focuses on human-wildlife conflicts (i.e. crop raiding) and the potential for zoonotic disease spillover and emergence at the human-livestock-wildlife interface at PA boundaries. Understanding local perceptions of disease risk and vulnerability is essential for assessing human health relative to conservation areas. This understanding will promote better-informed consideration of human health impacts in decision making for conservation. Data from surveys taken at 301 households around Kibale National Park (KNP), an important conservation area, were used to identify risk perception and factors influencing perceived disease risk and vulnerability. Human sickness was the most frequently cited worry by respondents (88%) and malaria was the most frequently cited illness (80.1 %). Those living closer to PAs may be at greater risk for park-related harm and cited more frequent cases of malaria and non-malarial fever. The perception of high risk for human sickness is pervasive across the region independent of household distance to the park and actual disease risk.

Introduction

Densely settled landscapes surrounding parks and protected areas (PAs) in eastern Africa are increasingly stressed by population growth and anthropogenic activities, including land-use change, expansion of intensive small-scale subsistence agriculture, and growing demands for land and resources (Fisher and Christopher, 2005; Hansen and Defries, 2007; Hartter and Southworth, 2009). The surrounding landscapes strongly influence PAs that depend on them since resources like water, nutrients and energy are shared between these regions by organisms protected within and the people transforming the landscape outside (Defries, Foley and Asner, 2004; DeFries, Karanth, and Pareeth, 2010). Population growth rates in these regions surrounding biodiversity hotspots in developing countries, especially around PAs in East Africa, have much higher population growth rates compared to the global rate of population growth (Cincotta, Wisnewski, and Engelman, 2000).

This growth strongly influences anthropogenic environmental change that can influence detrimental edge effects and disrupt the normal function of natural environmental processes, harm ecosystem health and threaten or negatively impact biodiversity within a PA (Cincotta, Wisnewski, and Engelman, 2000; Hansen and Defries, 2007; Hartter et al., 2012; McKee et al., 2004; Wittemyer et al., 2008). Most importantly, land–use change affects the dynamics of infectious disease transmission, has been linked to changes in disease ecology and increases the incidence of human sickness (Myers, 2012). Human-driven environmental and ecological disturbances or changes most strongly affect the vectors in this dynamic host-parasite-vector relationship (Patz and Norris, 2004). These changes (affecting the ecology of the pathogen, vector, and/or host) have occurred concurrently with the rise in incidence of emerging infectious diseases (EIDs), is considered a strong influence on disease emergence and vector-borne disease in particular, which affect about half the world's population, are especially sensitive to environmental changes (Daszak, Cunningham, and Hyatt, 2000; Myers, 2012). Few studies have explored the effects of PAs on human health in surrounding regions (Valle and Clark, 2013).

Households surrounding PA landscapes, especially those located nearest PA boundaries, often bear the greatest "costs of conservation" and are more likely to be disproportionately burdened by park-associated losses (Hartter & Goldman, 2011; Nyhus et al., 2005). The most impoverished households are often clustered nearest park boundaries, are often financially unable to move away, lack access to social services like healthcare and are less likely to feel benefitted by the park than those that live farther away (Bremner and Zuehlke, 2009; Mackenzie, 2012; Naughton-Treves et al., 2011; Naughton-Treves, 1997). These poorer, natural resource-reliant households cannot be ignored in conservation discussion because they often live in the most threatened conservation regions in the world and are drastically changing the landscapes while burdened by a complex dilemma concerning land-use and natural ecosystem service conservation (Cordeir et al., 2007; DeFries, et al., 2007). Even still, individuals often choose to live near the boundaries because of the availability of resources there (Hartter, 2009).

Anthropogenic environmental change is expected to have major effects on infectious diseases and disease vector ecology. Any type of human ecological change may present a chance for a pathogen to exploit a new niche or opportunity for transmission and can result in disease emergence (Daszak, Cunningham, and Hyatt, 2000; Smith and Guegan, 2010). Human encroachment on PA boundaries may affect incidence of human sickness through a variety of pathways. Land-use change affects the natural landscape and reduces the buffer separating people and their livestock from natural disease reservoirs and vectors. It also may affect climate, which may affect the range of vector habitats. This greatly increases risk for disease incidence and possible emergence by increasing the potential for contact between infected and susceptible individuals, increasing the risk of cross-species disease spill-over and increasing the risk of interactions with disease vectors (Anthony, Scott and Antypas, 2010).

In Uganda, most people are rural farmers that rely on agriculture. Land-use change, particularly those due to agricultural practices, is a driving factor for disease emergence and has the most pathogens associated with it (Smith and Guegan, 2010). Intensification of agriculture has been linked to increased malaria prevalence and is most common amongst the rural poor (Morrow and Moss, 2007). Higher incidence of malaria is particularly detrimental to rural farmers, often causing declines in output, income and quality of labor and ability for farmers to work (Ajani and Ashagidigbi, 2008; Asante, 2009).

Agriculture has been deemed essential for human well-being and good health as a source of employment and provider of nutritious food, but agriculture may have unintended and unbalanced consequences for the farmers that rely on it to survive. Intensive substance farming practices have caused drastic alterations in PA landscapes which were only exacerbated by unyielding population growth so that malaria, a preventable disease, still remains endemic and further harms agriculture by preventing farmers from working and ultimately perpetuates the cycle of illness, hunger and abject poverty (Hawkes and Ruel, 2006). Exploring and understanding the links between malaria and agricultural, especially in rural regions near PAs, is fundamental for development of appropriate malaria prevention measures and control approaches (Mboera et al., 2010).

Local response to parks and perception of benefits and harm has been related to park proximity, which strongly influences the types and severity of risks cited (Baird, Leslie and McCabe, 2009; Hartter and Goldman, 2011). Understanding perceptions of human sickness and disease risk is key for implementing proper preventative measures. The perceived degree of benefit from, or harm due to, a park is a key determinant of local attitudes, which are further influenced by, and vary between, socioeconomic groups (Hartter and Goldman, 2011).

The goal of this study is to explore the relationship between household proximity to Kibale National Park (KNP) and local perceptions of risk and vulnerability concerning human sickness. For the purpose of this study, the concept of "risk" is considered to be "the probability of harm occurring due to some hazard" and is synonymous with anything a respondent cites as something that cuases them to worry (Trumbo, 2012). Human disease and livestock disease have been perceived as high-incidence risks independent of park proximity, but the perceived incidence and severity of these risks were significantly higher for those that lived nearer to a park (Baird, Leslie and McCabe, 2009). Health risk has been cited as the most prevalent concern amongst people living near PAs with malaria being a primary concern (Smith, Barrett and Box, 2000). Numerous factors influence local perceptions of and attitudes towards parks. Given that previous studies cite crop raiding and other problems closer to the park, we would have similar expectations.

We hypothesize that there is a relationship between distance to a park or protected area boundary and local perceptions of human health risk and susceptibility to illness.

It is expected that (1) Households located closer to the park are more vulnerable to sickness than those that live father away (2) those closer to the park are more likely to worry about human sickness (3) those located closer to the park are more likely to rank sickness higher than other worries.

These expectations were compared to results from surveys taken in Western and Eastern Uganda around Kibale National Park.

Importance of Disease Risk Perception

Incorrect perceptions of disease risk and lack of related knowledge affects household participation in high-risk behaviors (Geoghegan, 2009). The perception of disease risk affects how people prevent and respond to such risks. Lack of perceived risk or worry leads to lack of adequate prevention and protection behaviors. Susceptible human populations may use various preventative measures in order to decrease risk for disease emergence or infection, but their adoption is strongly dependent on the perceived risk of transmission or infection (Lambin et al., 2010). Local perceptions of risk influence risk-mitigation and coping responses by those affected while these perceptions serve as mediators that determine behavioral responses by people to different environmental and socioeconomic factors (Baird, Leslie and McCabe, 2009). Human sickness is perceived as a severe risk because illness would make it more difficult for individuals to manage other problems (Baird, Leslie and McCabe, 2009).

Local perceptions concerning Kibale National Park have been linked to feelings towards loss and household proximity to the park; people living within a half km of the park had the greatest amount of park-related losses (Mackenzie, 2012). Perceived human health risk was linked to park proximity and respondents felt that close proximity to the park was causing them to become ill more often (Mackenzie, 2012).

Study Area

Kibale National Park (795 km^2) is an isolated island of mid-altitude, tropical forest land-cover in western Uganda within the Eastern Afromontane Biodiversity Hotspot on the Albertine Rift (Hartter and Southworth, 2009; Plumptre et al., 2007). The region's fertile soils, favorable climate and rainfall patterns support widespread, intensive agriculture, which fosters rapid population growth (Hartter and Goldman, 2011; Hartter et al., 2012). The annual population growth rate for Uganda is one of the world's highest (3.2%) and has been blamed for hindering nation-wide economic growth (Bremner and Zuehlke, 2009; Lepp and Holland, 2006; WHO Uganda Country Cooperation Strategy, 2009). Within 5 km of the Kibale National Park boundary, estimates of population density range from 260 individuals/km^2 to more than 600 individuals/km^2 (C. MacKenzie in Hartter et al., 2012). The population had increased 300% between 1959 and 1990 and is now one of the most densely settled areas in Sub-Saharan Africa (Naughton-Treves, 1998; Lepp and Holland, 2006).

The two major ethnic groups in the region are the Batooro and Bakiga. The population to the west and north of the park is predominantly Batooro while the east and south is predominantly Bakiga. The majority of households around Kibale National Park are dependent on agriculture, which is unsurprising since nearly 85% of the population live in rural areas participating in intensive subsistence agriculture (Ryan and Hartter, 2012; UBOS Statistical Abstract, 2010). The land around the park has changed significantly and people farm right up to the park boundary (Ryan and Hartter, 2012). The landscape surrounding Kibale National Park is ideal for studying the effects of land-use change on malarial incidence amongst poor, rural farmers in tropical forested regions.

Methods

Household Health Perceptions and Risks

Research was done around Kibale National Park from August 2012 to February 2013 in regions of varying geographic and demographic patterns.

Randomly produced GPS coordinates within 5 km of the Kibale National Park boundary were selected and used as center points of 9-ha units for sampling (superpixels). The study included 10 superpixels located within 8 ranger stations near the Kibale National Park boundary located within the study area spanning 5-ha from the park boundary. This distance has been used elsewhere in other studies and long-term longitudinal research and was deemed sufficient to capture impacts of park and park-people relationships (Goldman et al., 2008; Hartter, 2010; Hartter and Goldman, 2011).

At each superpixel, a minimum of one household and maximum of 5 households were interviewed by an enumerator in local vernacular (Rutoro, Rukiga or Rukonjo). Respondents were asked general questions to describe their households and were asked to free-list perceived risks. In the study, risk is defined as events or circumstances that may have occurred or that may occur and affect the individual's life in some way. Since there is no local word for risk, "worry," or "concern" were used interchangeably. Risks were ranked with one (1) being the most important, two (2), the next most important and so on for all cited risks.

Questions about worry and risk were asked using an open-ended approach so that which worry, the amount cited and the ranking of each risk cited would not be influenced. Similar risks that are descried or termed differently by respondents were post-hoc grouped into similar conceptual categories by the author (Smith, Barrett and Box, 2000).

There were 301 households interviewed, but at the time of this study data on questions concerning malaria from the surveys was only available for 200 of these surveys. An overall study of risk perception was done using the sample of 301, then a subset of this sample that had data related to questions concerning malaria was analyzed separately.

Analysis

Incidence and severity of risk were calculated for each individual risk (Baird, Leslie and McCabe, 2009; Smith, Barrett and Box, 2000). Incidence of risk was the measure of how often a particular risk was cited amongst all respondents in total. More frequently cited risks had a higher incidence. Severity of perceived risk was calculated by designating the highest ranked (most severe) risk as 1 and the lowest ranked (least severe) risk as 2. Overall severities for each risk between all respondents were calculated. The most severely perceived risk was most often ranked as "1" for severity, so the lowest calculated value of overall severity was actually the perceived risk with greatest severity.

The relationship of perceived risks and their importance to distance to the park boundary was tested using a T-test (independent samples). Tukey-Kramer post hoc analysis was used to examine distance to park and the human sickness ranking of risk identified by respondents. Lastly, chi-square was used to examine perceived risks within 1 km of the park boundary, a range purported to have the highest impacts from the park (Naughton-Treves, 1997; Mackenzie and Hartter, 2013). Relationships between reported frequency of malaria and individual household independent variables (ethnicity, respondent gender, head of household gender, wealth, proximity to park and geographic location) were analyzed using chi-square tests for independence. A significance of .1 was used for all statistical tests.

Results

General Perceptions of Park-Related Risk

Table 1 summarizes the overall distribution of socioeconomic characteristics amongst the rural, predominantly agriculturalist (97%) households within the study area.

Table **1** Summary of socio-economic variables (minimum, maximum, and mean; % (n)) for survey respondents around Kibale National Park.

Variables	**Min**	**Max**	**Mean**
Age (years)	18	98	41
Total Land* (Units of land)	0	100	6.2

Variables	**%**	**(n)**
Distance from Park		
≤ 1 km	56.5%	17
> 1 km	43.5%	131
Location		
North	45.8%	138
South	54.2%	163
East	35.2%	106
West	64.8%	195
Gender		
Male	41.9%	126
Female	58.1%	175
Head of Household Gender		
Male	77.1%	232
Female	19.9%	60
Ethnic Group		
Bakiga	45.2%	136
Batooro	39.2%	118
Other		
Education Level		
None	26.9%	81
Primary	58.8%	177
Secondary	9.0%	27
Higher	1.7%	5
Total sample= 301		

Some frequently cited risks were wildlife, climate, drought, human sickness, poor soils, lack of resources (clean water, firewood, and land) and lack of infrastructure (schools, roads, and hospitals or clinics). There was a fairly even distribution of respondents that lived within 1 km of the park boundary (56.5%) and those that lived farther than 1 km (43.5%) and the distributions for ranking of human sickness and wildlife were similar although there were differences in severity of perceived risk between the two (**Tables 5 and 6;Figs. 1 and 2**). Wildlife was cited as the most severe risk (1.25). Human Sickness had a higher incidence but a lower perceived severity (1.65). Drought and climate also were ranked as severe (1.38).

Human Sickness as Risk

Human sickness was the principle worry amongst households. Human sickness was cited by the majority of respondents (88%) with many respondents ranking human sickness as a top-3 worry (76.4%). Human sickness was cited more frequently than wildlife (83%) (**Tables 2 and 3**). The mean distances to the park for those that cited human sickness as a worry (1241.39 m) and those that did not (1178.24 m) were similar. Citing human sickness as a worry or not was independent of household distance to the park boundary (p.= .729, 2-sided T-Test). The mean distance for households ranking human sickness as a top-3 worry (1213.23 m) or higher (1178.24) were similar and not independent of distance to park (p= .530, 2-sided T-test).

Table **2** T-Test for (a) Human sickness as worry (yes/no) and mean distance to park. (b) Human sickness as worry ranking (Top-3) and distance to park.

Risk variable	**% (n)**	**Mean Distance to Park (meters)**
Total sample	301	
(a)		
Human sickness as worry	88% (265)	1241.39 Std. Deviation: 1007.53
Human sickness not as worry	12% (36)	1178.24 Std. Deviation: 1148.93
p= .729 (2-tailed)		
(b)		
Human sickness as Top-3 worry	76.4% (230)	1213.23 Std. Deviation: 968.08
Human sickness > Top-3 worry	23.6% (71)	1300.62 Std. Deviation: 1190.97
p= .530 (2-tailed)		

The mean distance to the park for those that cited wildlife as a worry (1148.89 m) was much smaller than the mean distance for those that did not (1650.27 m) (**Table 3**). Citing wildlife as a worry was not independent of household distance to the park boundary (p= .001, 2-sided T-Test).

Table **3** T-test for variance of means. Mean distance of households that cite wildlife as worry to Kibale National Park boundary.

Risk variable	**% (n)**	**Mean Distance to Park (meters)**
Total sample	301	
Wildlife as worry	83% (250)	1148.89
Wildlife not as worry	17% (51)	1650.27

***p= .001**

Table 4 summarizes the relationships between geographic variables of households and citing human sickness as worry. Responses were independent of whether the household was located within 1 km of the park boundary or farther than 1 km (p=.578, X^2-Test). Those living within 1 km from the park cited human sickness as a worry (87.1%) nearly as often as those who live farther than 1 km from the boundary (89.3%). This suggests that perception of human sickness as risk is independent of a household proximity to the park being less than or greater than 1 km from the PA boundary.

A greater proportion of respondents in the east (98.1%) cite human sickness than those in the western region (82.6%). Perception of human sickness as a risk or not is not independent of household location in the east or west (p=.000, X^2-Test). More respondents from the northern region of the study area (95.7%) perceived human sickness as a risk than those from the southern region (81.6%). Perception of human sickness as a risk or not as risk is not independent of household location in the north verses the South (p=.000, X^2-Test).

Table **4** Chi-square test for independence of human sickness as worry and geographic location.

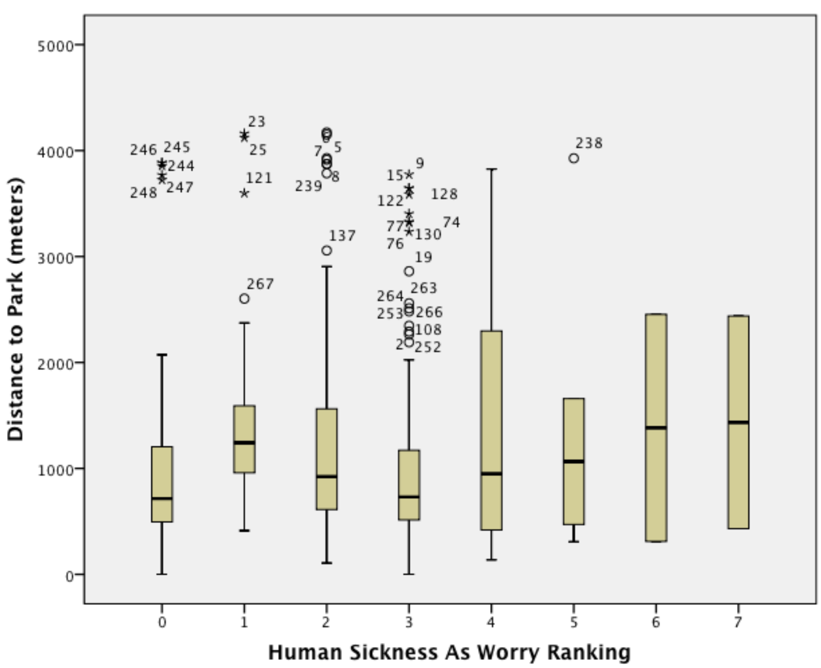
Geographic Variable	Sickness Not as Worry % (n)	Sickness as Worry % (n)
Total sample	301	
Distance to Park		
>1km	10.7% (14)	89.3% (117)
≤1 km	12.9% (22)	87.1% (148)
p=.595		
Location		
North	4.3% (6)	95.7% (132)
South	18.4% (30)	81.6% (133)
p=.000		
East	1.9% (2)	98.1% (104)
West	17.4% (34)	82.6% (161)
p=.000		

The mean distance to the park was similar for every ranking of human sickness as risk (Table 5). There was no variance of mean distance to park between rankings of human sickness and the relationship was not significant (p= .401, Tukey's Post-Hoc).

Table 5 Tukey's post-hoc analysis of human sickness as worry ranking and mean distance to park.

Ranking Human Sickness as Risk	**n (%)**	**Mean Distance to Park (meters)**
Total sample	301	1233.84
1	34	1494.73
2	84	1288.42
3	113	1064.98
4	24	1477.04
5	6	1415.82
6	2	1382.96
7	2	1434.60
Sickness Not Identified as Risk	36	1178.24
ANOVA p = .401 **F=** 1.043		

Figure 1 Human sickness as worry ranking as a function of distance to park.

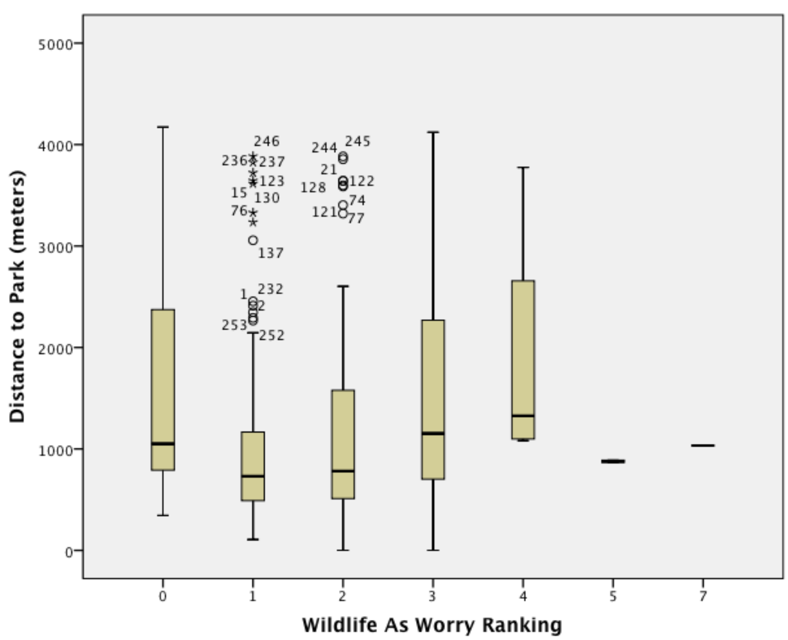


The mean distance to the park varied between each ranking of wildlife as risk (Table 6). The relationship between mean distance to park and ranking of wildlife as worry was significant (p= .002, Tukey's Post-Hoc). The mean distance to the PA boundary was significant between ranking as 1 or not ranked at all (p=.003, Tukey's Post-Hoc) and 1 and 3 (p=.042, Tukey's post Hoc).

Table 6 Tukey, post-hoc analysis of wildlife as worry ranking and mean distance to park.

Ranking Wilflide as Risk	**n (%)**	**Mean Distance to Park (meters)**
Total sample	301	1233.84
1	142	994.54
2	71	1276.62
3	31	1575.26
4	4	1877.01
5	2	878.65
6	0	N/A
7	1	1034.02
Not Ranked as Risk	50	1607.78
ANOVA p = .001 **F=** 4.162		

Figure 2 Wildlife as worry ranking as a function of distance to park.



Malaria

Many respondents felt troubled by living next to the park (70.5%). Many respondants felt that because of the park their household was troubled by human sickness "a lot" (71%), "somewhat" (17%) and "not at all" (9%). Contrastingly, very few respondents felt troubled by animal sickness due to the park (66.5%). Malaria is one of the most frequently cited park-related troubles and those closer to the park report a higher frequency of non-malarial fevers.

Most respondents (of the 200 valid cases)[1] listed malaria specifically as their main illness of concern (87.5%). Typhoid (23.5 %) was cited the next most frequently. Four respondents mentioned syphilis and only 8% mentioned animal or wildlife-related sickness as a worry. Interestingly, of these respondents, some mentioned a fear of sickness from livestock or wildlife and one worried about wildlife making humans sick.

Table 7 Frequencies of malaria, non-malarial fever and methods to confirm malarial infection. Tukey's Post-Hoc analysis of malarial frequency and distance to park.

Reported variable	**% (n)**	**Mean Distance to Park (meters)**
Total Sample	200	
Frequency of Malaria		
Once	2.5% (5)	2470.78
Twice	11% (22)	1399.53
Three Times	25.5% (51)	1212.53
More than Three Times	61% (122)	1111.19
p=.022 F= 3.270		
Frequency of Non-Malarial Fever		
Never	30.5% (61)	1623.35
Once	25.5% (51)	1105.74
Twice	25% (50)	1105.13
Three Times	8% (16)	894.04
More than Three Times	11% (22)	707.69
p= .001 F= 4.983		

[1] Only 200 cases were used for the "Malaria" section because the data from the surveys concerning the malaria-related questions was not yet available at the time of this study.

The mean distance to the park boundary is smallest for those reporting contracting malaria more than three times in the last year (1111.19 m). Reported frequency of malaria is not independent of the distance to the park (p=.022, Tukey's Post-Hoc). The mean distance to the boundary is significant between those reporting malaria once or three times (p=.040, Tukey's Post-Hoc) and once or four times (p=.018, Tukey's Post-Hoc).

The relationship between distance to park and frequency of non-malarial fever is not independent either (p= .001, Tukey's Post-Hoc). Mean distance of households for those reporting non-malarial fever three times in a year (894.04 m) and more than three times (707.69) are smaller than those who report it twice (1105.13 m), once (1105.74 m) or never (1623.35). There is no significance between those citing non-malarial fever three or four times (p=.969 Tukey's Post-Hoc) but those that report non-malarial frequency once and those that report three or more times have significantly different mean distances (p=.001, Tukey's Post-Hoc).

Only 52.5% of respondents report getting a blood test to confirm they had malaria (Table 8).

Table 8 Methods for confirming malarial infection.

Reported variable	**% (n)**
Total sample	200
Confirmation of Malaria	
Blood Test	52.5% (105)
Recognize Symptoms	39.5% (79)
Took Medication	7.5% (15)

Table 9 summarizes the relationships between household variables and reported frequency of malaria within a year and calculated chi-square test results for independence. The reported frequency of malaria was independent of ethnicity (p=.404, X^2-Test), gender (p .481, X^2-Test), and head of household gender (p=.670, X^2-Test). Proximity to park within 1 km or farther (p= .141, X^2-Test) was somewhat significant since a greater proportion (63%) of the selected respondents living within 1 km of the park boundary cited a frequency of malaria of three times or more. Household location in the north or south (p= .014, X^2-Test) or in the east or west (p= .037, X^2-Test) had a significant influencer on malaria frequency.

Table **9** Chi-square test for independence frequency of malaria and geographic and socio-economic factors.

Reported variables	Frequency of Malaria Once or Twice % (n)	Frequency of Malaria Three Time or More % (n)
Total Sample	200	
Ethnic Group (s)		
Batooro	55.6% (15)	43.9% (76)
Bakiga	37% (10)	50.9% (88)
Other[a]	7.4% (2)	5.2% (9)
p= .404 (2-sided)		
Gender		
Male	33.3% (9)	40.5% (70)
Female	66.7% (18)	59.5% (103)
p= .481 (2-sided)		
Male-headed households	77.8% (21)	75.7% (131)
Female-headed households	22.2% (6)	21.4% (37)
p= .670		
Distance to Park		
≤ 1km	48.1% (13)	63.0% (109)
≥ 1 km	51.9% (14)	37.0% (64)
p= .141 (2-sided)		
Location		
North	77.8% (21)	52.6% (91)
South	22.2% (6)	47.4% (82)
p= .014		
East	18.5% (5)	39.3% (68)
We**st**	81.5% (22)	60.7% (105)
p= .037		

[a] "Other" includes Bafumbira, Bakonjo, Banyankole, Banyarwanda, Basongora and Batuku.

The factors that influenced these perceptions of health risk, such as household proximity to park, are important to understand in order to further explore the spatial distribution of risk perception. Those that did cite sickness as a worry tend to live farther from the park boundary than those who did not list human sickness as a worry. Malaria is a prominent concern amongst households surrounding parks associated with every economic and social group. The results show that perceptions of malaria risk and number of reported malarial infections were dependent on different factors.

Discussion

Literature assessing PA impacts on human health in surrounding areas is scarce and most studies focus wildlife-related impacts such as crop losses from animals (Hartter and Goldman, 2011). Zoonotic emerging infectious diseases (EIDs) have been a major focal point of research concerning human health in regions surrounding PAs. While this has been widely explored, only four respondents cited animal sickness as a concern. The principle perceived risk is malaria. Malaria is catastrophic for development, perpetuates abject poverty and is simultaneously an acute and chronic problem that puts a huge burden on every member of a household while contributing to the expansion of disparities in wealth between the wealthy and poor and between genders. The largest disparity being amongst the poorest women and men living in developing countries.

Africa has had the least success in the global efforts to eradicate malaria and of the Sub-Saharan countries plagued by malaria, Uganda is one of the most heavily burdened as it struggles with achieving their Millennium Development Goals (MDGs) concerning health indicators (Morrow and Moss, 2007). The MDGs in Uganda have not been realized evenly across geographic regions since rural area, especially those in the North and East. Poverty levels in rural regions are twice as high as urban areas and have had significantly less improvement in numerous health indicators- particularly those concerning alleviating the burden of malaria (Millennium Development Goals Report for Uganda, 2010).

Changes in incidence of preventable, communicable and neglected tropical diseases have been directly linked to anthropogenic activities and environment change. These diseases pose a major threat to Uganda's ability to develop, cause the greatest burden of disease and under-five mortality and are most prevalent in rural regions (Bremner & Zuehlke, 2009; WHO Uganda Country Cooperation Strategy, 2009). Malaria is endemic in Uganda and is the number one cause of morbidity and mortality there. Every household in Uganda is at risk for infection and the climate has ideal temperatures and rainfall that make transmission possible year round (Millennium Development Goals Report for Uganda 2010). Malaria accounts for 36.2% of illness in Uganda (UBOS Statistical Abstract, 2012).

Land clearing, proximity to forest edges and amount of forest cover has been linked to higher risk and incidence of malaria (Valle and Clark, 2013). Distance to vector breeding sites has also been linked to malarial risk (Clarke et al., 2002). Famer efficacy too has been linked to health so it is unsurprising that agriculture is greatly affected by malaria. Poor health inhibits creativity and innovation in the agricultural sector, removes children from school and drastically affects income, and only a 1% improvement in farmer health has been linked to a 31% increase in productivity (Ajani and Ugwu, 2008; Badiane and Ulimwengu, 2013).

Issues concerning malaria and fevers of unknown origin (FUO) should be addressed and incorporated into discussion of PA management. Focus must shift towards implementing effective malarial education, prevention and treatment programs. In order to develop effective malaria intervention programs, there must be an integrative assessment of the relationship between malaria, agriculture, and local perceptions of risk aimed at highlighting any geographic variations that may exist within the results

Conclusions

This study demonstrates that household proximity to PA boundaries may not necessarily influence local perceptions of disease risk even though disease risk may actually be influenced by proximity to boundaries. While a small handful of respondents voiced a concern about disease risk linked to livestock and wildlife, none linked changing climate to disease risk. Many of the water and vector-borne disease the respondents were concerned about are likely to be affected by climate changes, especially rainfall changes since weather patterns have been linked to disease emergence of malaria (Daszak, Cunningham, and Hyatt, 2000).

Malaria is the primary disease of concern, but understanding of the environmental mechanisms that drive malaria incidence is not clear. This study leads to the conclusion that ranking of human sickness as a worry and perceived disease risk does not generally vary with distance from Kibale National Park.

The geographic variation in perceived malarial risk amongst households was that it was more frequently cited as worry in the North and West. Previous study discussing rainfall patterns surrounding Kibale National Park have identified certain changes and trends in weather that may have influenced these results. The region West of the park, where people generally worry more about malaria than those in the East, has had rainfall trends that have been declining significantly both during the short rains and during the long rains that follow the dry season. Contrastingly, the region North of the park has seen a significant increase in rainfall during the short rains (Stampone et al., 2011). Households from the regions to the North and West generally perceive human sickness as a greater risk than those from the South and East, but these regions are experiencing opposite changes in rainfall patterns, suggesting that many other factors along numerous possibly pathways are affecting perceptions of risk around Kibale National Park.

Most households are concerned about human sickness and have varying socioeconomic backgrounds. People worry about sickness and rank human sickness high on their list of worries no matter how far they live from the park since ranking of human sickness as a worry was independent of distance to the park boundary.

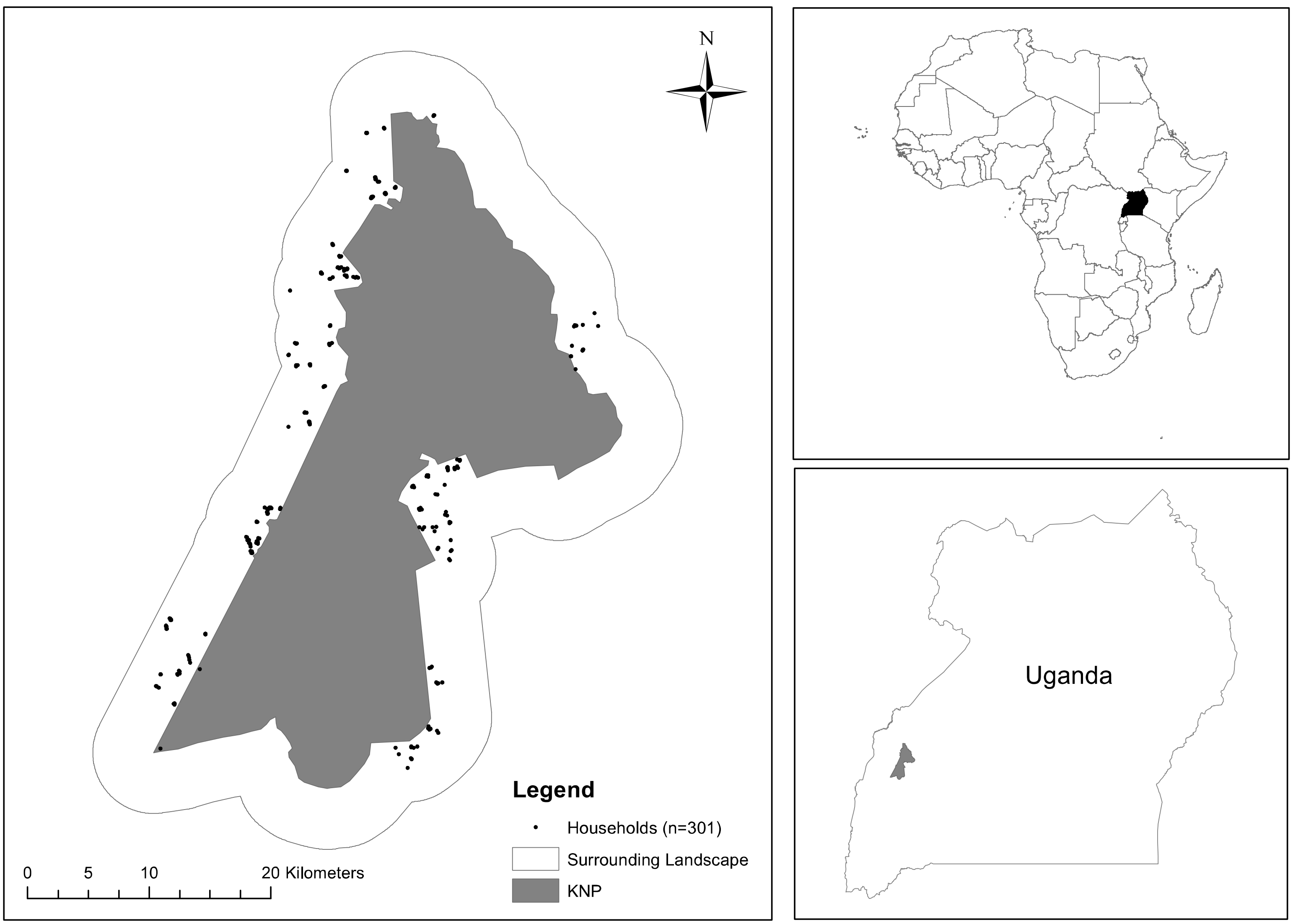
Studies have shown that the difference between risk of malarial infection and actual incidence of clinical attacks can be stark even across short distances (Clarke et al., 2002).   The cited frequency of incidence of malaria and non-malarial fever was not independent of distance to park. There were significantly higher frequencies of reported malaria and non-malarial fever amongst those living closest to PAs. This is consistent with studies linking a higher perceived risk of illness because of PA proximity by those living close to a boundary (Mackenzie, 2012).

Further studies are needed to explore the pathways that may influence higher reported malarial incidence amongst households closest to PAs. Understanding the relationship between PA habitats, human populations, and other organisms sharing the space (i.e. pathogens, primates, ect) is necessary in order to implement strategies that may continue to promote conservation and improve human health conditions.

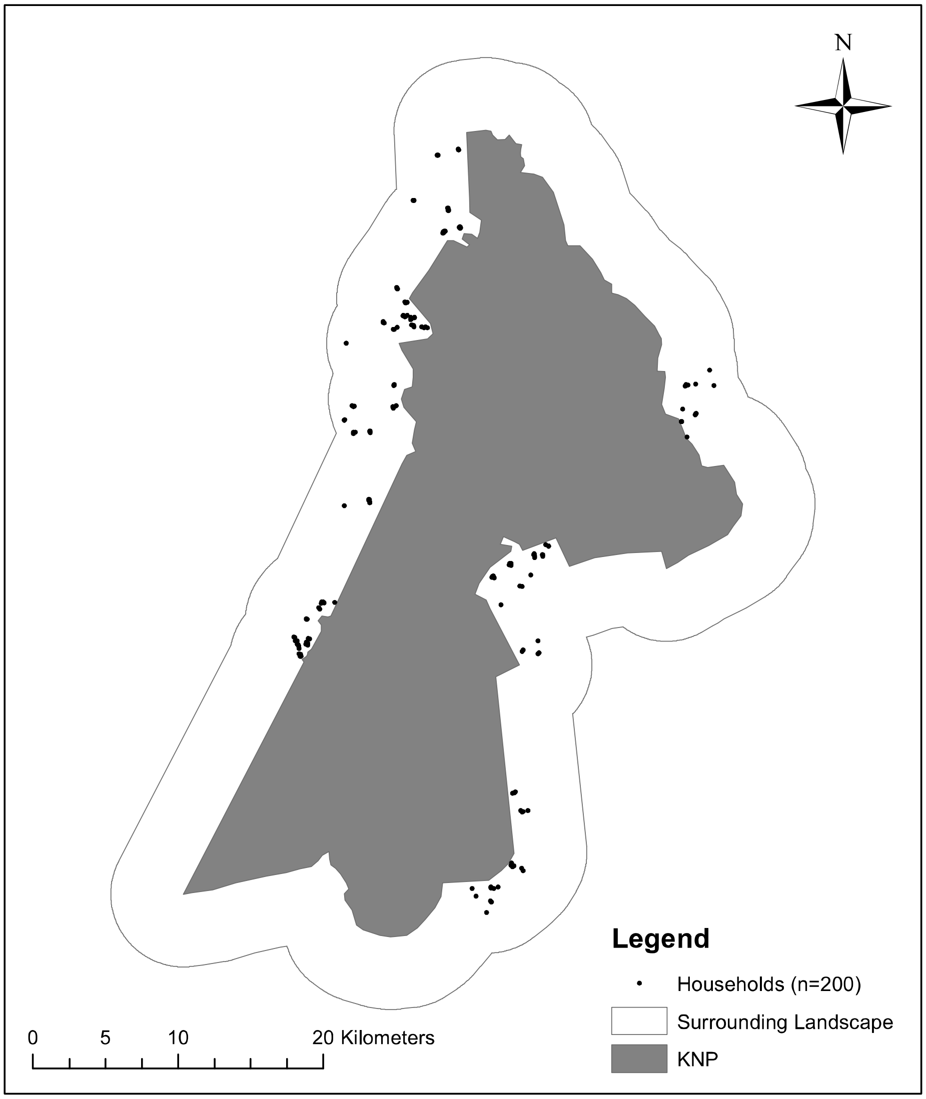
Appendix A: Figures & Tables

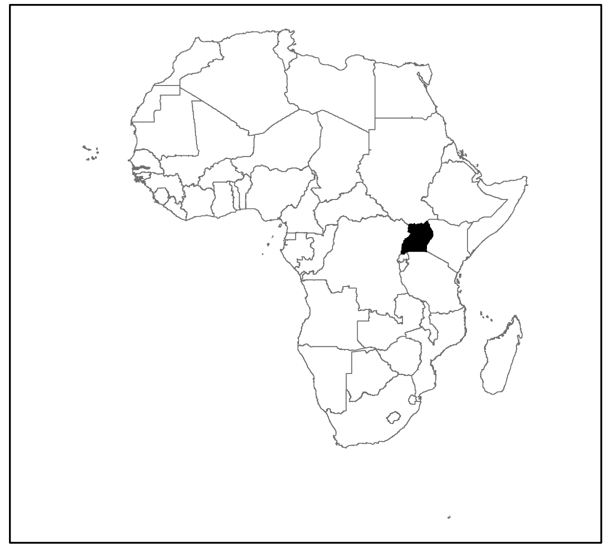
a. **Study Area Map**

   a. **N=301**



b. N=200


N
Legend
Households (n=200)
Surrounding Landscape
KNP
0 5 10 20 Kilometers

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