The Vulnerability of Indigenous Health to Climate Change: A Case Study of Uganda's Batwa Pygmies

by

Kathryn Dingle

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Department of Geography
McGill University
Montréal, Québec, Canada

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ABSTRACT

The potential impacts of climate change on human health in sub-Saharan Africa are wide-ranging, complex, and largely adverse. Indigenous peoples are considered to be at heightened risk given their relatively poor health outcomes, marginal social status, and resource-based livelihoods; however, little attention has been given to these most vulnerable of the vulnerable. This paper contributes to this gap by taking a bottom-up approach to assessing the vulnerability of health to climate change in two Batwa Pygmy communities in rural Uganda. Rapid Rural Appraisal and PhotoVoice field methods complemented by qualitative data analysis were used to identify key climate-sensitive, community-identified health outcomes, describe determinants of sensitivity at multiples scales, and assess adaptive capacity of Batwa health systems. The findings stress the importance of human drivers of vulnerability and the need to address social determinants of health in order to reduce the potential disease burden of climate change.

INTRODUCTION

The potential impacts of climate change on human health are wide-ranging, complex, and largely adverse (Confalonieri et al., 2007; Costello et al., 2009; McMichael et al., 2003; Patz et al., 2005). These impacts may be immediate, such as through an extreme weather event, or may manifest through more distal pathways such as a change in food security or the distribution of disease vectors (Haines, 2004; McMichael et al., 2006). Those regions of the world where poor health status is met with a limited capacity to adapt will be the most severely affected (Apuuli et al., 2000; Fuessel, 2010; Confalonieri et al., 2007). For this reason, sub-Saharan Africa has been identified as one of the world's most vulnerable regions (Davidson et al., 2003; Tschakert, 2007; Ramin and McMichael, 2009; Sokona and Denton, 2001). The IPCC predicts with high confidence that climate change, among other impacts, will reduce agricultural yields, aggravate water stress and alter the ecology of infectious disease vectors in the region through alterations in temperature and precipitation patterns (Boko et al., 2007). The health effects arising from these changes will raise the region's burden of disease and exacerbate the existing burden in already fragile health systems.

Uganda, a landlocked country straddling the equator, is highly susceptible to these impacts due to its climate sensitive ecosystems, economic underdevelopment, and limited health care resources. While a lack of scientific monitoring and information at the national and local levels makes it difficult to accurately predict how climate change will manifest in Uganda, the consensus of climate models, relevant literature and community-based research is that the foremost impacts will be more variable and intense rainfall, warming temperatures, and increased frequency of extreme weather events (Christensen et al., 2007; Hepworth, 2010; Magrath, 2008; NAPA, 2007; NWDR, 2005). Given that more than eighty per cent of Uganda's

population is dependent upon rain-fed agriculture for their livelihood, these environmental changes will have implications for economic well-being which in turn will aggravate potential health impacts (World Bank, 2010). Malaria, diarrhoeal and waterborne diseases, poor hygiene and sanitation and decreased food security have emerged as the greatest public health concerns related to climate change in Uganda (Magrath, 2008; Namanya, 2009; NAPA, 2007). Strained under insufficient resources and a heavy burden of disease, Uganda's healthcare system has a weak ability to cope with increased disease outbreaks or adapt to changes in the composition of health determinants. In this context, Uganda is highly vulnerable to the negative health impacts of climate change.

This vulnerability, however, is not evenly distributed. Marked differences exist between groups when it comes to how severely their health systems may be affected by climate change. One group widely considered to be at heightened risk is Indigenous peoples. In general, Indigenous populations in sub-Saharan Africa experience poorer than average health outcomes, a marginal social status, and are especially sensitive to environmental change due to their resource-based livelihoods and traditional health systems (Ohenjo et al., 2006). However, little attention has been given to these most vulnerable of the vulnerable. Ford et al. (2010) refer to this as an Indigenous peoples 'vulnerability deficit' and identify it as a major gap in climate change research.

Within this context, I contribute to this gap by taking a bottom-up approach to assessing the vulnerability of health to climate change in highly marginalized Indigenous communities in Uganda. I do so by presenting a case study of the Batwa Pygmies, an Indigenous peoples inhabiting the southwest highlands of Uganda. Also known as the Abayanda or Twa, the Batwa are traditional nomadic hunter-gatherers who formerly lived in the equatorial rainforests of

Central Africa, across what is today Uganda, the Democratic Republic of the Congo ("DRC"), Rwanda, and Burundi. Over the course of the past century, the Batwa have gradually lost the basis of their livelihoods as they have been forced from the forest due to agricultural land clearing and industrial logging activities (Lewis, 2000). In the early 1990s, conservation projects caused the Batwa in Uganda to be evicted from the forest completely, thereby removing their access to the resources they used for food, shelter, and medicine (Zaninka, 2001). This dislocation and subsequent adjustment to life outside of the forest has led to a significant and relatively unsuccessful cultural and socio-economic transition for the Batwa; many remain landless, impoverished, subject to human rights abuses and in a struggle to maintain their cultural identity (Namara, 2007; Jackson, 2003). The Batwa have achieved significant improvements in wellbeing over the past decade, in large part through the aid of development organizations, and many have transitioned to an agricultural livelihood in sedentary communities (Balenger et al., 2005). However, the Batwa remain with a very low socioeconomic and health status relative to the majority population in their own region and Uganda as a whole (Table 1).

Climate change may pose a significant threat to the health of the Batwa in their current state. I seek to characterize this vulnerability through participatory qualitative research in two Batwa communities in Uganda. My objectives are as follows:

1. Identify key climate-sensitive, community-identified health outcomes
2. Describe determinants of sensitivity at the individual, community and regional levels
3. Assess the adaptive capacity of Batwa health systems

Table 1.1: Selected development indicators

	Batwa	Southwest Uganda[1]	Uganda
Health			
Life expectancy at birth (years)	28[2]	n/a	53[3]
Child mortality (% under 5)	41.0%[4]	18.1%[5]	13.7%[6]
Prevalence of malnourishment (% underweight children under 5)[7]	n/a	19.3%[8]	15.9%[9]
Education			
Adult literacy rate	<10%[10]	Women: 67.6%	Women: 56.3%
(% literate aged 15-49 years)		Men: 84.1%[11]	Men: 82.8%[12]
Income			
GDP per capita (constant 2000 $US)	$97[13]	n/a	$366[14]

[1] Consists of ten districts: Kiruhura, Isingiro, Mbarara, Ibanda, Bushenyi, Ntungamo, Rukungiri, Kabale, Kisoro and Kanungu.
[2] As of 2003 (BDP, 2011).
[3] As of 2008 (World Bank, 2010).
[4] As of 2000 (EMMF, 2000).
[5, 6] Average between 2000-2005 (UBOS/Macro Intl., 2007).
[7] As measured by the proportion of children age 0-59 months who are below -2 standard deviations from the median of the WHO Child Growth Standards in weight-for-age.
[8, 9] As of 2006 (UBOS/Macro Intl., 2007).
[10] Based on author's research during case study.
[11, 12] As of 2006 (UBOS/Macro Intl., 2007).
[13] (Hodosi, 2010).
[14] As of 2009 (World Bank, 2010).

METHODS

The vulnerability framework

I structure the case study using the concept of human vulnerability to climate change. Vulnerability is a measure of the susceptibility to harm in a *system* in response to a *stimulus* or *stimuli*, and can essentially be thought of as the 'capacity to be wounded.' In this paper I am interested in *Batwa health* and *health systems*, the latter defined collectively as organizations, institutions (formal and informal) and resources whose primary purpose is Batwa health. This includes traditional medicine practitioners, government health authorities, external development organizations (including domestic and international non-governmental organizations and church- and missionary-run groups) as well as individuals and households who comprise the fundamental component of health care provision and advice in Batwa communities. The *stimulus* or *stimuli* are health risks linked directly or indirectly to climate change.

A general model of vulnerability has emerged in climate change scholarship that conceptualizes vulnerability as a function of exposure and sensitivity to climate change and adaptive capacity (Ebi et al., 2006; IPCC, 2007; Smit and Wandel, 2006). In a health context, *exposure* refers to the nature of climatic risks which affect (directly or indirectly) health outcomes. *Sensitivity* concerns the organization and structure of health systems relative to the climate-related health outcomes and determines the degree of severity at which exposures manifest. *Adaptive capacity* reflects the ability of health systems to address, plan for, or adapt to adverse climate-related health outcomes and take advantage of new opportunities. Exposure, sensitivity, and adaptive capacity are not mutually exclusive, with interaction between these components potentially moderating or exacerbating vulnerability. Recognition of the roles of

adaptive capacity and sensitivity is important as it directs attention to health systems themselves and the non-climactic factors operating at multiple spatial–temporal scales that determine how climate change will be experienced and responded to. It is in this realm of analysis that vulnerability differentials at the local and household level become apparent. For example, while the Batwa may to a large extent experience the same exposures to climate-sensitive health outcomes as their neighbouring communities, it is factors that contribute to their sensitivity and adaptive capacity, such as a low socio-economic status and political marginalization, which are likely to result in their relatively higher vulnerability.

Given the community-based nature of this research, we use the vulnerability framework in the context of a 'starting point' analysis. In contrast to 'end point' analyses in which health outcomes are projected from an identified climate change exposure, starting point analyses begin with the health outcome, examine all aspects of its exposure and sensitivity (i.e. what caused it) and then identify which of those aspects could be related to climate change. This 'starting point' approach thus does not seek to describe vulnerability as independently attributable to climate change, but rather as a function of the conditions and processes which predispose a system to be negatively affected by it. In conceiving vulnerability as a state or condition rather than an outcome, this approach recognizes that climate change does not occur in isolation, but instead interacts with a dynamic and evolving system on the ground. Such an approach is especially pertinent for this case study where vulnerability could not be fully understood separate from a context of extreme poverty, political marginalization, and ongoing social change.

Along with allowing for a more complete representation of Batwa health systems and the broad determinants of how climate change will interact with it, the 'starting point' analysis also allows for communities to identify their greatest concerns and participate directly in the design

and conduct of the research agenda (UNFCCC/LEG, 2002; Lim and Spanger-Siegfried, 2005). The importance of engagement of Indigenous communities in social sciences research is supported by a strong literature and was a key requisite of this case study for reasons of both ethics and research quality (McTaggert, 1991; Kuhnlein and Sims, 2011; Kwiatkowski, 2010; UNDP, 2000).

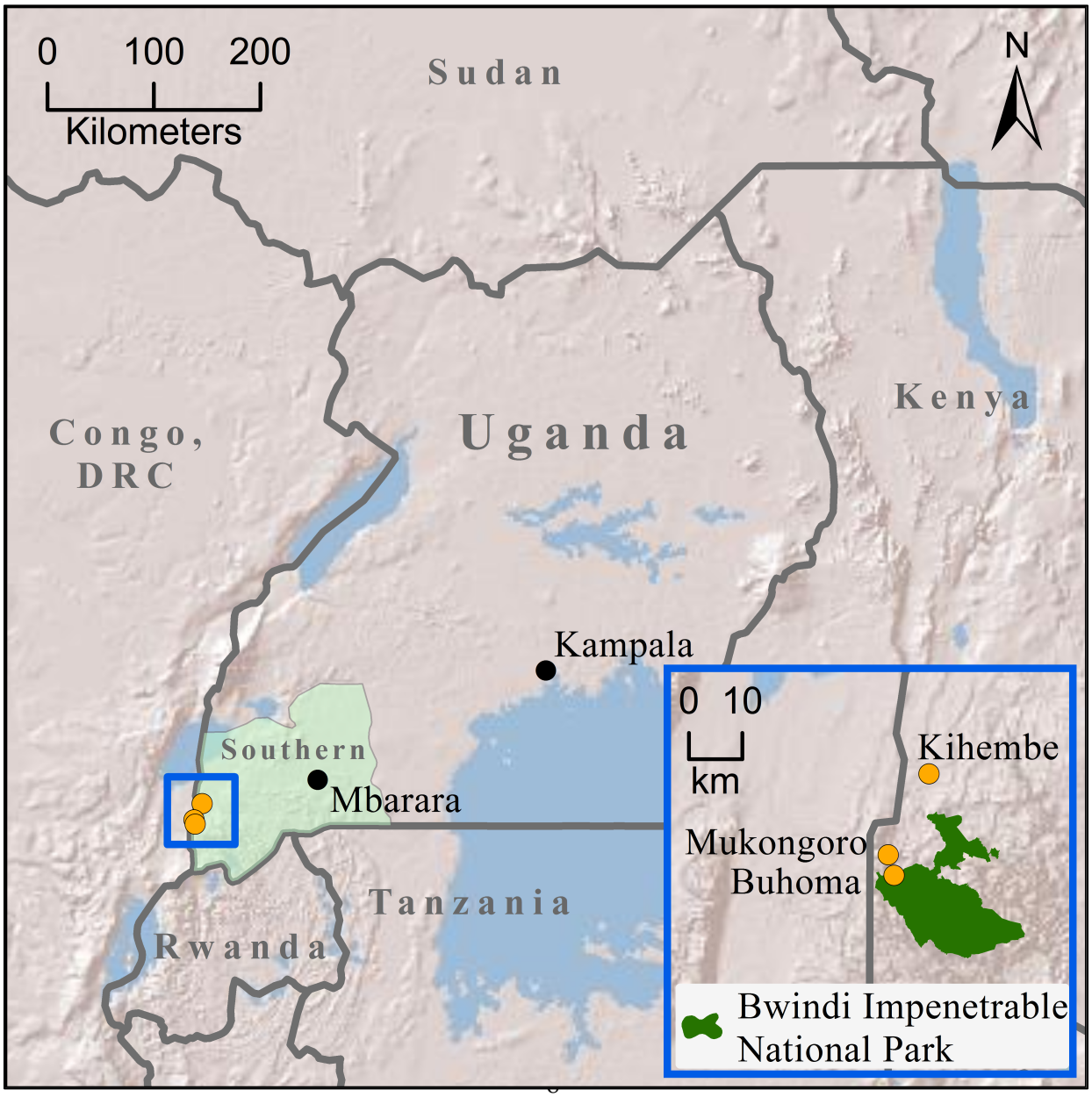
Study area

The Batwa represent the easternmost group of Central Africa's Pygmy population. Of the estimated 300,000 to 500,000-strong Pygmy population living between Cameroon and Gabon in the west and Uganda and Rwanda in the east, approximately 80,000 comprise the Batwa group concentrated in the four countries of the DRC, Rwanda, Burundi, and Uganda (Jackson, 2005). For millennia, the Batwa lived in relative isolation in the Albertine Rift Valley's equatorial rainforests as hunter-gatherers but have faced a turbulent recent history marred by land dispossession, conflict, and threats to their socio-cultural integrity (Kabananukye and Wily, 1996; Klieman, 2003).

Uganda's 6,700-strong Batwa population, representing 0.02% of the national population, is concentrated in three rural districts in the southwest of the country (Uganda Population Secretariat, 2008). The research was conducted with two Batwa communities – Kihembe and Mukongoro – in Kanungu, one of these three districts, which is located adjacent to the north of Bwindi Impenetrable Forest National Park ("Bwindi"). Approximately 900 Batwa live in Kanungu, representing less than 0.1% of the district's population (Bwindi Community Hospital, 2010). The Batwa of Kanungu were selected in consultation with the Ugandan Ministry of Health based upon the unique historical experience of the Batwa in the district and documented

disparities in health outcomes among the Batwa and the majority population in the area. The communities of Mukongoro and Kihembe were selected after preliminary visits to several communities in the district. The communities share a similar history of forest eviction and agricultural resettlement, but reflect differing livelihood transition dynamics and current proximity to the forest and its associated services, two factors with significant implications for health outcomes.

Map 2.1: Location of case study communities



Source: Adam Bonnycastle, 2010

The environment of Kanungu is typical of Uganda's southwest highlands, characterized by hilly terrain, rich biodiversity, and a temperate climate (UNEP, 2010). The district has a bimodal rainy season with rainfall from March to May and September to December that governs the planting and harvesting schedules (ITFC, 2010). Mean temperatures range from minimums of 12-16°C to maximums of 19-29°C (Ibid., 2010). As the last vestige of forest in the area, Bwindi creates its own microclimate that moderates its immediate surroundings with higher precipitation and cooler temperatures (Oluput, 2009). The majority ethnic group in the district is the Bakiga, whose principal livelihoods include agriculture, industrial tea and coffee production, and tourism services.

Figure 2.1: Mukongoro

Figure 2.2: Kihembe

The current state of the Batwa in Kanungu is inextricably tied to their eviction from their ancestral forest, Bwindi, two decades ago. Bwindi was gazetted as a park in 1991 in order to protect the endangered mountain gorilla. Approximately half of the species' remaining population lives in the park and serves as a major tourist attraction, drawing more than 10,000 visitors annually (Uganda Migration and Tourism Statistics, 2007). The Batwa received negligible compensation for this appropriation, as their traditional, informal system of land tenure was not recognized under Uganda's national statutory system (Kenrick and Lewis, 2001). For the next decade, the Batwa struggled to adjust to livelihoods outside of the forest. Many entered into bonded labour contracts with Bakiga farmers or moved between temporary settlements in search of work (Lewis, 2000). Their compromised socioeconomic situation was exacerbated by widely held prejudices. As forest peoples, the Batwa were discriminated against

by agriculturalists and marginalized from fully participating in the latter's local society; however, this has been steadily changing, particularly over the past decade as external development organizations have assisted the Batwa through the provision of Western healthcare and land. Wellbeing is generally improving amongst the Batwa, yet they remain the poorest segment of the local population with limited opportunities for upward mobility (Balenger et al., 2005).

Data collection

After the two communities of Kihembe and Mukongoro were selected, preliminary community-wide meetings facilitated by local development organizations were held with each. During these meetings, researchers presented their aims to conduct a participatory qualitative research agenda and consulted with community members as to the most appropriate and effective methods. A schedule involving Rapid Rural Appraisal ("RRA") and Photovoice methods structured around the vulnerability framework was designed.

All community members were invited to participate in every research method except for the RRA biographies in which participants were specifically selected by the researchers in order to meet set criteria. Participants were generally recruited at the end of the introductory community-wide meeting and then invited to choose an appropriate time during the research schedule for their participation. Officials from the local development organization who were facilitating these initial meetings took active responsibility for participant recruitment given their familiarity with the community members as well as their language skills. Researchers specified to the officials that they would like all twenty-seven households between the two communities to participate as much as possible. Most households did take part, though a minority opted not to

because they were either unavailable during the scheduled times or were uninterested in participating. All participants were compensated with lunch, photographs and a t-shirt, in accordance with local customs for compensation. The fieldwork was conducted in the local language of Rukiga with simultaneous English translation.

Rapid Rural Appraisal

Pioneered in the 1970s to address a need for systematic qualitative and comprehensive field surveying in rural development research, RRA is methodologically characterized by small, multi-disciplinary research teams who employ a range of tools targeted at gathering information in an intensive, iterative, and expeditious manner (Chambers, 1981; FAO, 1997). Its participatory nature is premised on the importance of locally situated knowledge and having rural people examine their own problems (Chambers, 1994). The five RRA methods used during this case study are described below.

1. *Semi-structured household interviews*

   Semi-structured households interviews were aimed at providing a breadth of qualitative information to cover all research objectives. They were conducted with an interview guide to ensure thoroughness (Appendix A); however, their flexible structure allowed questioning to maneuver towards the interviewee's area/s of expertise. Interviews were conducted on a household rather than individual basis at the request of the communities. While this presented a concern related to gender, specifically that female interviewees may not feel comfortable expressing their personal opinions in the presence of males, researchers found these concerns to be unwarranted. As a general observation,

women tended to answer questions to do with children, housing, and food while men responded to questions related to agriculture and land.

The interviews were conducted according to a predetermined schedule arranged by each community. At the designated time, researchers would arrive at a household and conduct the interview with its adult members present. The Batwa are traditionally monogamous, and in Mukongoro, households generally consisted of a nuclear family made up of a husband and wife and their children. In Kihembe, there tended to be greater diversity in household composition (e.g., numerous single female head of households) as well as a number of extended family households (e.g., husband and wife and their parents, brothers and sisters). There were few children present in Kihembe because almost all attend a boarding school twenty kilometers away thanks to the assistance of a local development organization who funds their education.

A total of twenty-one household interviews were conducted in the two communities: ten in Mukongoro and eleven in Kihembe. Between those households, of whom all recruited from the introductory community-wide meetings, approximately fifty adults participated in the interviews. The number is approximate given that some interviewees would leave during the interview if they had an alternative engagement or others might arrive unsolicited and begin to participate. To as great an extent as possible, researchers conducted interviews in a structured and organized manner and recorded who was speaking. Interviews ranged from thirty minutes to one hour, with the average length being forty minutes.

2. *Key informant interviews*

Key informants are defined as those individuals with a highly specialized knowledge related to Batwa health. Interviews were conducted within the communities with the chairman or highest-standing political representative of each community, as well as externally with nine individuals from various non-profit, government, church, and academic institutions. These interviews were guided by an outline of contextual topics related to health such as demographics, livelihoods, and development priorities (Appendix B). On average, they lasted one-and-a-half hours.

3. *Future storylines*

Conducting a future storylines exercise involves proposing a hypothetical future situation to interviewees in order to gauge their responses in a particular context. The primary aim of the method was to collect information for the third research objective of assessing adaptive capacity, in this case at the community level. Three questions related to future environmental scenarios identified through local climate change projections were posed:

> How will your health be affected if:
> a) the rains change and your crops fail more often?
> b) the water source dries up more often?
> c) there are more mosquitoes?

Each individual question was followed up with the query of "How will you adapt?" In both communities, future storylines were conducted on a community-wide basis during final group meetings that were held at the end of the research schedule in each community.

4. *Biographies*

Biographies sought to scale-down assessments of vulnerability to the individual level, and thereby evoke the unique sensitivities of every individual relative to their historical experiences and contextualize climate change and the environment, in general, within the array of health challenges faced by the Batwa. Life narratives were constructed through biographical interviews following a standard guide (Appendix C). They lasted approximately half an hour and were conducted with two members of each community who were selected by the researchers in consultation with key informants near the end of the research period as individuals who best represented the historical experiences of the Batwa.

PhotoVoice

PhotoVoice, defined by Wang and Burris (1997) as "a process by which people can identify, represent, and enhance their community through a specific photographic technique," is an emerging methodology in the social sciences field. As the method with the highest degree of participation for community members, PhotoVoice was intended to be the primary mechanism through which community members could identify their concerns and influence the research agenda in this case study. By passing over agency to the subject of study and allowing them to dictate what is important, PhotoVoice helps to facilitate a contextual understanding of vulnerability that is vital to climate change research (Wang et al., 1996; Wang, 1999).

In practice, PhotoVoice in the two communities was conducted in three stages. The first involved recruiting volunteers for participation. After each semi-structured household interview, all adult members of the household were invited to participate in PhotoVoice. Those who consented then attended a half hour training session conducted by the researchers in which

participants were taught how to use the cameras and conveyed the objectives of the activity. Participants were presented with the guiding question, “How does the environment affect your health?” and asked to respond to it using photography. In total, twenty-three adults participated in PhotoVoice, consisiting of six females and nine males in Mukongoro and six females and two males in Kihembe.

Following training, community members had two to five hours with their assigned cameras to complete the activity. After the cameras and photographs were returned to the researchers, participants were invited to take part in either an individual or group PhotoVoice discussion group depending upon logistical matters. During the discussion, participants were invited to speak about the photographs they took and the motivations behind them. Such expressions led to relevant dialogue that both communities reported as finding effective and educational. Researchers extracted qualitative data from these discussions, which were used for the purposes of all research objectives.

Data analysis

All of the findings gathered from the research were in the form of qualitative data. Field notes and photographs from the interviews and other research methods were transcribed and organized digitally according to participant and date. Content analysis framed by the vulnerability framework was performed on the data to identify themes relating to health outcomes, exposures, sensitivity, and adaptive capacity. The resulting typology of themes was used in a matrix analysis to examine causation and association pathways, with health outcomes as the starting point for analysis. For example, the common theme of ‘malaria’ under health outcomes was associated, in one illustration of a causation linkage, with ‘mosquito’ under exposure, ‘lack of household goods’ under sensitivity, and ‘mosquito net’ under adaptive

capacity. Pictorial representations of these thematic relationships were used to assess the interconnectedness of variables and illustrate the web of vulnerability at multiple scales. For descriptive purposes, basic quantitative analysis involving counting the number of participants who mentioned a certain theme was conducted; however, results were only used to gather information on trends in an approximate sense. Data analysis was complemented with a review of relevant literature on climate change, health, Uganda, and the Batwa. Peer-reviewed literature that touched upon more than two of the topics, nevertheless all four, is notably scarce; thus, grey literature including government reports, development organization policy papers, newspaper articles, and media were included in the review.

RESULTS

Mukongoro and Kihembe share many similarities in health vulnerability to climate change; however, they do have notable differences in some of their social, economic and biophysical characteristics, which manifest as distinct vulnerabilities (Table 2). Key differences include the relatively higher security of land and housing in Mukongoro, the contentious social relationships of Kihembe, and their respective climates: hot and dry in Kihembe and cool and wet in Mukongoro.

Exposure-sensitivity

Climate-sensitive health outcomes

Community members identified a consistently poor health status as one of their greatest challenges. Healthcare professionals concurred that despite recent improvements, the Batwa face a significantly higher burden of disease than that of the rest of the district. There is limited literature available on historical trends; however, it is generally asserted by key informants and community members alike that Batwa health declined dramatically following their eviction from the forest as a result of livelihood dislocation, the introduction of new communicable diseases and the loss of their traditional diet of forest products (Ohenjo et al., 2006).

The earliest statistics of Batwa health in Kanungu available are those taken as part of a comprehensive anthropological study of the population in 1996 undertaken by Kabananukye and Wiley. The study found that 87% of Batwa women had lost at least one child, 60% of those before the age of two. Approximately one-fifth of these deaths were attributed to “unknown” causes. Of those that were known, measles, kwashiorkor, diarrhea and malaria were the most noted causes of death. Around ten years ago, separate studies by two local development

Table 3.1: Characteristics of case study communities

Characteristic	Mukongoro	Kihembe
Social		
Population	12 households (approx. 24 adults) Average number children per household: 5 Total (est.): 84	15 households (approx. 45 adults) Average number children per household: 3 Total (est.): 90
Settlement history	Established in 2000, land purchased for Batwa by development organizations	Established in 2001, land purchased for Batwa by development organization
Immigration	Households arrived from the DRC (fleeing conflict), and nearby Ugandan Batwa and Bakiga communities (many as squatters in the latter)	Generally, similar to Mukongoro; however, less immigration from the DRC and more from other Batwa and Bakiga communities
Social relations	Congenial, individuals exhibit a great willingness to work together	Contentious, history of conflict over land and social relationships
Political organization	Village chairman elected by community, serves as representative to development organizations	Village council elected by community; representatives (often on council but not necessarily) nominated to development organizations
Relationship w/development organizations	Low dependence; relationship appears mutually beneficial and is long-standing with frequent contact between parties	Greater dependency; relationship has a history of tension, though appears to be improving now with house-building project
Economic		
Principal livelihoods	Agriculture; small amounts of hired labour, handicraft making, and tourist performances	Split evenly between agriculture and hired labour; small amounts of handicraft making, and brick making
Crops grown	Bananas, maize, beans, cassava, sorghum, millet, jackfruit	Maize, beans, sorghum, cassava, millet, jackfruit
Housing	Development organization in process of building mud houses for all community members, most are complete	Development organization in process of building mud huts for all, approximately half are complete; remaining households live in grass huts, one relatively wealthy household lives in self-built brick huts
Land	Small, steeply sloping plots of similar size are evenly divided between households	Gently sloping plots in range of sizes are unevenly divided between households
Biophysical		
Relative climate	In Bwindi microclimate, wet and cool	Far from forest, hot and dry
Environment	Narrow valley of steep, terraced hills	Broad expanse of low, cultivated hills
Distance from Bwindi; access	3km; 45 minute walk on trails	40km; one hour drive on dirt road

organizations in Kanungu found child mortality rates (under five years of age) for the Batwa of close to 40%, more than double both the regional and Ugandan averages (EMMF, 2000; BDP, 2003).

An influx of development aid, the majority of which came from foreign NGOs and missionaries, has targeted Batwa health in the past decade (Balenger et al., 2005). Key informants concurred that increased education, access to Western medicine and overall economic development has led to significant improvements in Batwa health. Healthcare officials expressed optimism that within the next decade there could potentially be no disparity between Batwa and Bakiga health outcomes in Kanungu. However, current statistics still illustrate a marked difference. A 2009 household survey in two sub-counties of Kanungu conducted by the local hospital concluded that the Batwa suffer poorer health outcomes and access fewer health services relative to Bakiga communities (Bwindi Community Hospital, 2010). Specifically, the Batwa are less likely to use malaria nets, access safe delivery during birth or use family planning, and are more likely to have tuberculosis or be malnourished (Ibid., 2010).

During interviews and PhotoVoice discussions, community members were asked to specify their major health problems, a measure meant to encompass both frequency and severity of disease. Four of the five major problems identified were climate-sensitive: malaria, malnutrition, stomach disorders, and respiratory disease. The fifth, HIV/AIDS, does not yet have a significant burden in the community according to key informants, but it was likely frequently noted by community members due to its status as a major future health concern. The diseases identified are consistent with the morbidity profile of the region's majority population, suggesting that the Batwa suffer from the same diseases as the general population, but at a more severe degree (Jackson, 2003).

Table 3.2: Key community-identified, climate-sensitive health outcomes

Health outcome	Community description	Representative quotes	PhotoVoice results
Malaria	Feverish symptoms including any combination of headache, high temperature, common flu, physical weakness, loss of appetite, dizziness	"Malaria is rampant here and all the time we are going to Kihembe clinic [for treatment]" "Malaria is the most common disease. It has always been a problem." "With malaria, you feel weak, [your] temperature increases, and you have a headache"	
Malnutrition	Insufficient nutrition to meet basic needs; characterized by length of time without food, types of food consumed, and visible physical symptoms (e.g. circumference of upper arm, bloated stomach)	"It is a common problem that the children will not have enough food" "When we don't get all of our harvest, having enough food is a problem." "We continuously dig on the same land, so it gets exhausted…We have small portions of land and the crops don't grow very well."	
Stomach disorders	Diarrhea, parasitic worms, ulcers, hernias, holistically referred to locally as "stomach itching'"	"Worms are caused by eating badly" "We have no clean water. We use the stagnant water that kids play and bathe in. Every dry season it dries up and we must go somewhere else to fetch water…When that dries up, we go even further."	
Respiratory disease	Common cough, tuberculosis, pneumonia	"Digging in hot temperatures makes dust come into the nose, and then flu comes" "Old women who sleep without something to cover them at night get coldness and fevers."	

Without exception, all households identified malaria as a top health concern. No clear spatial or temporal trend could be discerned from the responses of community members, though there was a general consensus that the disease had always been present in their communities. Healthcare and NGO officials report that the prevalence of malaria is increasing as a function of warming temperatures and higher frequency of the disease in local mosquitoes. Key informants attributed the higher concentration of malaria in the local mosquito population to the increasing mobility of the local population to and from endemic malarial areas as well as the large numbers of visitors arriving from these areas. As for the warming temperatures, the *Anopheles gambiae* S.L mosquito is the dominant malarial vector in southwest Uganda and observed increases in its density during the El Niño year of 1998 where abnormally high temperature and precipitation caused a malaria epidemic in the region are consistent with local reports that gradually warming temperatures are causing increased prevalence of clinical malaria (Lindblade et al., 1999; Kilian et al., 1999).

Between the communities, Kihembe was reported to suffer from a higher burden of malaria relative to Mukongoro because of its hot and humid climate. In both communities, households reported that cases of malaria are most common at the beginning of each dry and rainy season because of the presence of stagnant water at these times of transition. Community members explained that at the beginning of the rainy season, rainfall is not heavy enough to wash away stagnant pools of water, while at the beginning of the dry season, rainfall is still enough that the pools are yet to completely dry up.

Consistently unclear is what exact illness community members are referring to by declaring a case of ‘malaria’. Locally, the word for malaria is associated with a broad complex of feverish symptoms rather than with the narrow clinical definition of the disease, thus self-

reported prevalence of malaria may differ from clinical observations (Kengeya-Kayondo et al., 1994). Common symptoms of malaria listed by the households include headache, fever, shivering, vomiting, muscle weakness and loss of appetite. Healthcare resources in the region are insufficient to conduct clinical testing on all reported cases of malaria and thus cannot confirm incidence. However, local hospital officials noted that the high rate of malaria reported by the Batwa is not disproportionate relative to district and national levels.

Malnutrition was only explicitly mentioned by a few households as a health concern, yet sixty-five per cent (thirteen of twenty households in semi-structured household interviews where the issue was raised) of families reported that they did not have enough food to satisfy their needs on a daily basis. Of the food they did have, no household said it was of sufficient nutritional quality. The diet of the Batwa consists principally of locally-grown foods such as banana, cassava, maize, millet, beans, and greens sourced from their own farms or bought at the local market. In general, the greater amount of food a household could acquire from their own farm, the less malnutrition they endured. Some households lamented the loss of traditional foods from inside the forest and linked the loss to present malnutrition. For example, one mother described how *Kimbo*™, an artificial saturated fat spread, had replaced the cheese from cow's milk they used to use for frying, making her family less healthy.

Equally problematic as malnutrition in both communities is dehydration, which leads to general weakness and a range of stomach disorders. Diarrhea was noted by most households as a common, yet not perilous, problem. Healthcare officials reported a high rate of parasitic worms in both communities; however, only in Mukongoro did community members offer worms as an ailment, referring to them as "stomach itching". Kihembe community members did not report "stomach itching" until they were specifically asked about it by the researchers. The fact that

"stomach itching" is not perceived as a health abnormality in Kihembe could be a reflection of how commonplace worms and other stomach disorders are in the community or the limited amount of Western health sensitization and education received by Kihembe relative to other communities like Mukongoro which are located closer to the local hospital.

The opposite reporting trend occurred for respiratory diseases as Kihembe noted a higher prevalence than Mukongoro. Healthcare officials suggested that this is likely due to the dry climate in Kihembe, which causes there to be high levels of dust in the air. Community members voiced numerous complaints about the dust, specifically that it makes them cough while working on the fields. Pneumonia was reported in both communities, with respondents living in grass huts in Kihembe reporting the highest incidence.

The three main biophysical exposures through which the Batwa come to experience negative climate-sensitive health outcomes are summarized in Table 4. Both communities are affected by similar exposures through the pathways of water, food, and disease vectors but also experience unique exposures based upon their different physical environments.

Table 3.3: Health exposures

Exposure pathway	Exposures			Key climate-sensitive health outcomes
	Both communities	Mukongoro	Kihembe	
Water	▪ Insufficient amounts ▪ Polluted water sources	▪ Alternative sources 2 and 7km away, respectively	▪ Alternative source is 2km away (Ikankoko river)	▪ Stomach disorders
Food security	▪ Quantity ▪ Quality	▪ Small agricultural plot size ▪ Over-cultivation	▪ Poor quality of soils ▪ Pests attacking crops	▪ Malnutrition
Infectious disease vectors	▪ Large vector population ▪ Breeding opportunities in stagnant water ▪ Low levels of antibodies in population	▪ Attractive climate for vectors due to high precipitation	▪ Attractive climate for vectors due to high temperatures	▪ Malaria
Weather events	▪ Extreme weather events ▪ Extreme temperatures	▪ n/a	▪ High temperatures ▪ Relative lack of precipitation	▪ Respiratory disease

Healthcare officials reported that poor water is responsible for a high degree of morbidity in both communities, causing numerous stomach disorders and other types of waterborne disease. In both interviews and PhotoVoice, water emerged as the primary response to the question of how environment affects health. The principal water sources in both communities are small ponds, which appear visibly polluted in colour as well as content. Access to the sources is relatively easy in both communities as the sources are within fifteen minutes walking distance from the respective centres of each. Community members consistently referred to their respective water sources as “dirty”, “infected”, or “full of disease”. Despite being aware of these dangers, community members continue to use their current water sources due to a lack of accessible alternatives. However, the principal sources in both communities run out of water during the dry season for upwards of two months, forcing community members to seek out alternative sources. For Mukongoro, the next closest sources are two ponds of similar poor quality two and seven kilometres away, respectively. In Kihembe, the alternative source is the Ikankoko River, located two kilometres away in the adjacent valley. The water in the River is reported to be of higher quality due to its fast flow, though the arduous walk to and from the River is cited as a significant barrier to more frequent use of it.

Treatment of the water, principally through boiling, was a common but not unanimous activity in both communities. Mukongoro appeared to participate more actively in water treatment relative to Kihembe, where community members expressed a desire to treat their water, but an inability to do so because they lacked the necessary resources (e.g. saucepans). During a PhotoVoice discussion when feedback to the researchers was solicited, community members asked about alternative methods for treating polluted water when boiling was not possible, an outright indicator of their interest in doing so.

Food security is another pathway through which negative health exposures are manifest. Most Batwa source food from their own farm, from Bakiga farms as payment for their work, or from purchases at the local market. Charity and begging also remain major sources of food for the Batwa, an indication of the inadequacy of conventional sources to meet their basic nutritional needs. According to community members, this paucity is due in large part to challenges associated with their own farming practices. Both communities experience frequent crop failure, though for different biophysical reasons. The steep valley environs of Mukongoro limit each household to small agricultural plots prone to erosion. Their size, in the face of population pressure, leads to over-cultivation and an exhaustion of the land. Over time, this negative feedback loop of continuous digging on progressively deficient soil reduces productivity and decreases food security. In Kihembe, an arid climate leads to dry and infertile soils. This condition, frequently observed by community members, is exacerbated by the presence of eucalyptus trees locally, which further drain out water from the soil. Crop failure due to pests is also a serious problem in Kihembe. In recent years, cassava crops have failed community-wide due to locust attacks. There is limited research globally on the relationship between climate change and locust outbreaks, though, notably, researchers in China have found that locust outbreaks are more likely to occur in warmer, drier weather as a consequence of climate change (Qiu, 2009).

Infectious disease vectors present a third pathway of climate-sensitive health exposures. The vector of primary concern is the *Anopheles gambiae*, which carries the malarial parasite *Plasmodium falciparum*, the leading cause of morbidity and mortality in both communities. The environment of each community provides a suitably attractive habitat for the vectors: Kihembe for its warmer temperatures and Mukongoro for its wetter conditions. Additionally, there are

sizeable pools of stagnant water in both communities that can serve as breeding grounds for the mosquitoes. Once exposed to a vector, the Batwa are particularly susceptible to contracting malaria due to the population's relatively weak clinical immunity to the disease. The *Anopheles gambiae* prefers an open habitat and has vastly reduced survival rates under forest canopy (Tuno et al., 2005). Given that vector density is thus much lower inside of the forest where the Batwa have spent most of their existence, the Batwa have historically had minimal pathogen exposure to *Plasmodium falciparum* and as a result, have a lower immunity currently to the parasite.

Finally, certain weather events, inherently climate-related, can have direct health outcomes. The problem appears insignificant in Mukongoro where community members had few complaints to do with the weather. In Kihembe, however, high temperatures were blamed for general feelings of discomfort and illness while the environment's dryness was reproached for creating dust storms and high levels of air particulate which make community members ill with cough and respiratory disease.

Human drivers

While exposures dictate the environmental mechanisms through which Batwa health may be affected by climate change, the severity of these impacts is determined by sensitivity. In this context, the Batwa face a double burden. Their severely disadvantaged living conditions intensify, and increase their likelihood to experience, negative health outcomes from biophysical exposures. These sensitivities are manifest at individual, community and regional levels and stem from multiple sources, summarized in Table 5. While Kihembe and Mukongoro differ slightly at the community level, the sensitivities they experience are sufficiently similar that we combine them here.

Table 3.4: Health sensitivities

Scale	Sensitivity pathway		Sensitivity
Individual	**Demographics**	Children and women	▪ Children under seven years of age ▪ Pregnant women
Community	**Low socioeconomic status**	Inability to afford basic quality and/or quantity of livelihood assets	▪ Lack of land ownership, tenure insecurity ▪ Poor housing ▪ Lack of household goods ▪ Poor nutrition ▪ Poor sanitation
	Social and political marginalization	Social prejudice and discrimination	▪ Inability to fully engage in local society
		Political	▪ Lack of political representation ▪ Limited government assistance ▪ Traditional rights unrecognized in statutory law
	Livelihood transition	Loss of traditional livelihood	▪ Loss of socio-cultural integrity ▪ Limited access to forest resources
		Adjustment to new livelihood	▪ Lack of compensation ▪ Need to acquire agricultural knowledge ▪ Introduction to local market competition ▪ Dependence upon external sources of income and aid
Regional	**Demographics**	Population	▪ High population growth
	Economy	Major revenue sources	▪ Potentially volatile tourist industry ▪ Climate-sensitive industrial agriculture, coffee and tea production
	Conflict	Instability	▪ History of extreme conflict ▪ Close proximity to conflict in DRC
		Population	▪ Forced migration ▪ Large refugee population

At the individual level, children and pregnant women are most sensitive to the adverse health effects of climate change given their already high morbidity and special health and nutrition requirements. Up to the age of seven when they begin schooling, children bear the brunt of disease in both communities. Parents report that children tend to be sick most severely as well as most frequently, some requiring hospital visits up to four times a month. The morbidity profile of children is similar to that of the broader community, with malaria the primary reason for ill health (Jackson, 2003). According to hospital officials, sensitivity is high from birth, as many Batwa children are born with low birth weights. Underfeeding and malnourishment during infant

years then further contribute to disease susceptibility. While hospital officials report that child mortality rates amongst the Batwa are currently falling towards the regional average, it was rare to find a family in either community who had not lost a child due to illness. Of particular note, two households in Mukongoro have lost six of ten and six of seven children, respectively.

After children, pregnant women were designated as the demographic with the highest burden of disease in the communities. Difficulties in meeting nutritional requirements during their pregnancy, especially for calcium and iron, were cited as the key reasons behind the sensitivity. Many women also reported suffering from general aches and pains and vomiting during their pregnancies. Anecdotally, two female interviewees reported that they experienced "more" malaria during their pregnancies, though neither widespread nor clinical evidence for this could be found.

Sensitivities that raise Batwa vulnerability relative to the rest of the population are most pronounced at the community scale. The low socioeconomic status of the Batwa has been well documented in grey literature, by key informants, and by community members themselves. While exact income figures are hard to discern because the Batwa are often paid in-kind for their labour on nearby farms, development organizations confirm that most Batwa live well below generally accepted measures of poverty, such as the World Bank's US$1.25 per day poverty line (BDP, 2011). This destitution manifests into health sensitivities as an inability to secure the assets necessary for a dependable, sound livelihood.

The most apparent of these assets is land, the fundamental asset for an agricultural livelihood, but one which few households in either community own. Development organizations purchased plots of land for the Batwa in both communities to use, but did not pass on the titles to them because of past occurrences in other communities where Batwa households sold or

squandered their donated deeds to Bakiga farmers, rendering themselves landless again. Numerous community members, while appreciative of the organizations, stress that without their own title and defined plot size, their living situation remains temporary and prone to encroachment. They are thus hesitant to fully invest in it. Further complicating issues of tenure is the size of land plots given to the Batwa a decade ago. With population growth and immigration in the communities in the period since, the plots of land are no longer sufficient to meet household production needs. Because of their low socioeconomic status, the Batwa are priced out of the local land market and lack access to the credit markets – traditional, informal, or microfinance – necessary to gain access.

In Kihembe, poor shelter is responsible for a similar degree of sensitivity as landlessness. Half of households in the community live in thatched grass shelters because they lack the financial resources to upgrade to a sturdier structure. The grass huts present a number of health hazards. Firstly, mosquito nets cannot be used in them, presenting a direct risk of contracting infectious disease through vectors; and, secondly, heavy rainfall often leaks through the hut, rendering useless any insulation the grass may provide and soaking the inside. Respondents directly attributed cases of pneumonia and common cold to their poor housing. Mukongoro does not have the same concerns because a local development organization is constructing mud huts for all households in the community. At the time of research, most had been completed.

Members of both communities struggle to afford basic household goods which are necessary for the maintenance of good health, such as pots, plates, utensils, mats, and bedding. These goods were noticeably absent from many households and appeared to be replaced, for example, by dried grass for bedding and oil canisters for cookware. In their absence, community members reported being unable to engage in simple practices fundamental to their health such as

sleeping under a blanket at night, boiling their drinking water, or cooking on a stove without filling their huts with excessive amounts of smoke.

The provision and maintenance of proper sanitation facilities is also largely beyond the financial purview of Batwa households. In Mukongoro, only a handful of households have constructed permanent latrines while in Kihembe, there are none. For waste disposal outside of these latrines, small holes are dug in the ground and covered in soil when full. This accumulation of waste presents a severe health hazard, especially given the high population density in both communities. When heavy rainfall occurs, the waste is washed into the drainage and waterway system from which community members draw their water for drinking and bathing.

Like most households in rural sub-Saharan Africa, the majority of Batwa household income necessarily goes towards food (ERS/USDA, 2010). According to health professionals, the diet of the Batwa since leaving the forest is lacking the vital nutrients and minerals they formerly sourced from forest fruits and vegetables (Kabananukye and Wily, 1996). A number of interviewees highlighted the importance of consuming a well-balanced, nutritious diet; however, they lamented not having the resources to provide this for their families. Purchases of food from the market, which the Batwa turn to in order to meet their nutritional needs given insufficient production from their own farms, can be prohibitively expensive, especially in their remote area. While prices are lower at larger markets in more central trading centres, the Batwa cannot physically access these markets because of high transportation costs. The provision of sufficient calories, a challenge in itself, takes precedence over the provision of nutritious calories. The result is a largely unbalanced and starch-based diet for the Batwa with nutritious foods such as meat, tomatoes, and onions considered “special” items that are only consumed once every two to three weeks because of their cost.

Posing a further sensitivity is the social and political marginalization faced by the Batwa. Historically, the Batwa have been discriminated against as "unhuman" or an "uncivilized race" because of their traditional hunter-gatherer lifestyle in the forest (Woodburn, 1997). They were perceived as dirty, lazy, backward, and undeserving of assistance by the majority of the population (Warrilow, 2008). Such perceptions manifest into minimal or no Batwa political representation, exclusion from local permits to access forest resources, refusal of service from government healthcare facilities, and in general, a wholly subservient relationship with the wider Kanungu community (Tumushabe and Musiime, 2006). The Batwa were commonly exploited in forced labour contracts and placed at the mercy of landowners, to whom ownership of a Mutwa was a sign of wealth and security (Namara, 2007). Known as a cheap source of labour and viewed with contempt by local governments, there was little incentive or desire locally to support their development (C. Kidd, personal communication, July 2011). In recent years, these perceptions have begun to change with sensitization by local human rights groups and an influx of international development activity associated with the Batwa. Instances of the more conspicuous, systemic forms of discrimination such as refusal of healthcare are now fairly rare (Balenger et al., 2005; Jackson, 2003). Additionally, Batwa communities have begun to organize politically by forming an NGO of their own, the United Organization for Batwa Development in Uganda ("UOBDU"), whose primary mission is to build representative capacity. Despite this progress, households report that there remain general prejudices against the Batwa, which manifest as an inability for them to fully and equally participate in Bakiga society. As an example of this, one community member cites his suspicion that some Bakiga shoppers do not buy his crops at market because they know he is Batwa, though none would explicitly admit to him that they do so.

Lastly, at the community scale, the historical transition from forest to agricultural livelihoods presents unique challenges for the Batwa that remain major drivers of their wellbeing today. The first is related to the Batwa's traditional knowledge, which after the forest eviction was rendered of little use since the Batwa no longer had access to the forest resources to which it largely applied. In addition to not receiving any monetary compensation for their eviction, the Batwa did not receive any training or capacity development in agriculture to help them develop a new form of traditional knowledge relevant to their new livelihoods. Over the past two decades, the Batwa's knowledge of agriculture has matured considerably through learning from fellow Bakiga farmers; however, as expected given their historical lag in the acquisition of this knowledge, it is still not at the same advanced degree as other local farmers who have been raised in communities and families with generations of experience in agriculture behind them. This information asymmetry contributes to the Batwa's struggle to compete in local agricultural markets and improve their incomes. Key informants affirmed that one of a number of reasons the Batwa face difficulties in selling their produce at market is price competition and their inability to produce at efficient scale economies relative to more experienced Bakiga farmers.

In terms of loss of socio-cultural integrity, some community members share sentiments such as "the forest is our life" and stress the forest's dominant role in their spirituality and cultural practices. Sites of worship and traditional ceremonies for the Batwa are all located inside of the forest (MRG, 2008). Along with the aforementioned poverty and marginalization which emanated from the transition, it is the loss of these more intangible assets such as a sense of belonging and spiritual connection with their surrounding environment that, while difficult to quantify, are vital to an understanding of the Batwa's current vulnerability.

Because agriculture cannot sufficiently meet the basic needs of the Batwa, many have looked for other work to supplement their incomes. Selling one's own labour on Bakiga farms remains by far the most accessible alternative. In Mukongoro, community members work on Bakiga farms on an ad hoc, irregular basis, while in Kihembe, community members spend up to three days a week working on Bakiga farms. Generally, one day's pay is enough to provide one household meal; however, community members in Kihembe stress that this is highly variable. For example, when millet is in harvest, a Bakiga farmer may offer a Batwa worker three kilograms of the crop for a day's labour, but that amount is reduced to one kilogram per day when millet is not in season. Beyond this seasonal pay sensitivity, there is concern about the long-term viability of this livelihood for the Batwa given that it is dependent upon the needs and generosity of the Bakiga. The average Bakiga farmer subsists at a socioeconomic level not much higher than the average Batwa farmer and faces livelihood challenges of their own. The ability of the Bakiga to hire outside labour is thus precarious, especially with the Batwa beginning to demand higher wages.

Sensitivities associated with the instability of current Batwa livelihoods exist concurrently with those associated with the absence of alternative options. While tourist services, handicraft making and other local service-based livelihoods may present potential opportunities for some community members, the demand for workers in these fields does not exist on a scale that would accommodate a majority of the Batwa population. Lacking alternative livelihood options, the Batwa have, to varying degrees, developed a dependency upon external aid. All households depend upon external development organizations for the provision of land, education, and healthcare, while approximately half of households report getting significant support in other areas such as housing, sanitation, and technical assistance in agriculture.

Aid dependence is inherently risky because it is a source of livelihood support contingent upon external donor resources and sentiment prone to fluctuation. This dynamic was illustrated in the 2008 global financial crisis, which caused a severe reduction in the flow of money from foreign donors to local development organizations for their work with the Batwa. A second example is a healthcare program funded by a European international development organization for the Batwa in a nearby district which has provided free treatments and community health outreach services for Batwa communities over the past three years to prominent success. However, the funding for the program is scheduled to run out within a year and there is no forthcoming replacement for the donor, a situation likely to have significant detrimental effects on the communities who have come to rely on the healthcare provided by the program. Development organizations may not portray their assistance as a sustainable, long-term source of income for the Batwa, but households tend to perceive it as one, making them extremely sensitive to its departure.

At the broadest level of analysis, the Batwa are exposed to region-wide health sensitivities to climate change. Demographically, Kanungu's high population growth of around three per cent per year puts a strain on public resources ranging from healthcare services to environmental goods, further weakening their ability to adapt to external pressures such as climate change and its potential health impacts (Bernard et al., 2010). The regional economy also comes under pressure due to the precariousness of some of its major revenue sources, especially the tourism and coffee and tea production sectors. In addition to the standard economic volatility of these sectors (due, for example, to fluctuations in consumer demand) it is curious to note that their robustness is also directly linked to climate change. By far the main tourist attraction in Kanungu is gorilla trekking in Bwindi, a major revenue earner not only regionally, but nationally as well.

It contributes up to seventy per cent of the national tourism authority's annual revenues (Tenywa, 2007). The presence of gorillas in Bwindi, however, is dependent upon availability of their desired habitat. There is anecdotal evidence that gorillas in Bwindi are moving closer to the Congolese border and out of the Park as the range of some of the vegetation in their diet changes. Such range variations are consistent with climate change predictions, thus the situation could become exacerbated in the future and potentially lead to the departure of the gorillas, the region's major revenue earners. As precedent, a key informant recalled how nearby Mgahinga Forest National Park experienced a dramatic reduction in visitor numbers and revenues when its habituated gorilla group left the Park in the 2000s. Coffee and tea production, which provide significant revenues and employment regionally, are also vulnerable to acute climactic changes as it is estimated that a further two to three degrees Celsius increase in temperature in the southwest will make the region unsuitable for production (Magrath, 2008). Lastly, the region is still recovering from a long and recent history of extreme and violent conflict, including spillover effects from the 1994 Rwandan genocide and decades of civil war in the eastern Kivu provinces of the DRC, which border Uganda. Instability is still rife in areas of Kivu bordering Kanungu, and potential armed militia attacks continue to pose a threat to regional livelihoods.

Adaptive capacity

Current adaptive capacity in Batwa health systems is a function of complementary formal and informal institutions that manage health outcomes. Formal healthcare institutions include both Western healthcare and traditional medicine. Generally, community members will use traditional medicine as a first course of treatment before seeking out Western healthcare. There

appears to be no apprehension or cultural opposition towards using the latter. While community members may prefer traditional herbal treatments, they concur that Western care is effective.

The Batwa are renowned for their traditional herbal medicines and studies have identified dozens of local medicinal plants used by the group, many of which contain active compounds against diseases such as malaria, diarrhoea and intestinal worms (Cunningham, 1996; C. Kidd, personal communication, July 2010). During interviews, approximately twenty different remedies were described, half of those recurrently. Accessibility of the herbs was a point of great discord, as some community members reported that they could no longer access certain herbs as they are forest-specific, while others interviewed said in reference to the same herb/s that they were available outside of the forest. One point of accord was that fewer community members are learning to use traditional medicine than in the past. Kihembe and Mukongoro each have one traditional herbalist, both of whom lamented that their knowledge was not being passed on to younger generations. Generally, the older an interviewee, the greater and more sophisticated their knowledge of traditional medicine.

As in much of rural central Africa, government provision of Western healthcare services is limited (Ohenjo et al., 2006). Of the services that are available, community members report problems in accessing them because of financial costs and discrimination. In light of this, both Kihembe and Mukongoro are dependent upon development organizations and their private facilities for the provision of Western healthcare, and are in a unique situation in regards to the availability of such resources to them. Recognizing the tremendous health challenges faced by the Batwa while visiting the area a decade ago, two American missionaries constructed a hospital in the nearest trading centre, Buhoma, specifically targeted at Batwa health. Bwindi Community Hospital ("BCH") opened in 2003. The 62-bed hospital provides health services to more than

25,000 patients annually as well as community outreach programs to remote Batwa communities. While it is locally referred to as "*Irwalilo rya abatwa*", or "The hospital of the Batwa", BCH serves the entire population of two sub-counties in Kanungu district. Its services receive positive feedback from all Batwa community members, most of whom report dramatic improvements in their health since its opening. These observations are confirmed by a number of local studies which have documented the positive health impacts of BCH and show how it has improved access to Western care for the Batwa both in financial and physical terms (C. Kidd, personal communication, July 2011). In partnership with local development organizations, the hospital pays for all of the Batwa's treatments. Before the hospital was built, Mukongoro community members would travel by foot to a clinic in the DRC approximately five kilometres away for Western care. BCH reduced access to care to a half hour's walk from the community. Distance is still a challenge for community members in Kihembe, who only attend the hospital with critical illnesses because it is forty kilometres away. Transportation to the hospital is provided for free by a motorcycle ambulance operated by the hospital's partner development organization.

Additionally, outreach programs provided by the hospital provide the communities with opportunities for health sensitization and education. Through programs such as these, formal institutions of adaptive capacity connect with informal ones. Informal institutions that contribute to adaptive capacity of Batwa health systems include knowledge and education and community support networks.

At a basic level, adapting to new and different health outcomes requires an understanding of the causation of these health outcomes. Such an understanding, in turn, necessitates a certain level of education and specialized knowledge. Adult Batwa community members have little formal education, with few having completed more than a year or two of primary school, if any

at all. While this statistic is changing with the current youth generation as their primary education is being sponsored by local development organizations, the current adult generation must rely on knowledge garnered through experience. Large differentials exist between households in this respect. Households with adults who had lived in the community for longer periods of time and had significant interactions with Bakiga and other outsiders tended to have a higher level of health-related knowledge relevant to adaptive capacity. For example, these individuals could describe how they changed their farming techniques corresponding to changing weather patterns, identify foods they eat for specific nutrients, and understand complex health pathways such as linking together rain patterns with crop failure and malnutrition. On the other hand, some individuals exhibited a weak understanding of the dynamics of negative health outcomes, attributing the bulk of their diseases to unknown causes or failing to make connections such as that between polluted water and illness. Overall, however, researchers found that the degree of knowledge relevant for adaptive capacity was quite strong, especially amongst community leaders, and according to key informants, was progressing at a steady rate as the communities developed.

Community support networks are defined here as a community's collective will to withstand disadvantageous circumstances and its facility to work together to do so. Given that many health adaptations to climate change will necessarily be community-wide, community support networks are a key component of adaptive capacity. A striking observation throughout the research was that the two communities exhibited significantly different degrees of internal community cohesion. In Mukongoro, community members were eager to collaborate with each other to overcome challenges and were optimistic about their collective future. While some "quarrelling and laziness" was reported by community members, this sentiment was far

outweighed by the focus community members put upon working hard and developing the community as a whole. In Kihembe, meanwhile, a history of serious social conflict still divides the community and there remains significant opposition to engaging in mutually supportive activity. Reactions during interviews to such activities ranged from relative apathy to complete rejection. Anecdotally, a number of households refused to eat or "take water" with each other, a serious indication of their mutual distrust.

The communities' perceptions of external support networks also differ. Community members in Mukongoro appear to take greater responsibility for their own development and while welcoming external aid, do not seek to rely upon it. Community members in Kihembe, on the other hand, exhibit far less desire for self-sufficiency and point outwards for the solutions to their problems. For example, in responding to a question about how to address a lack of malaria nets, the most common response in Mukongoro was that one should work hard to earn enough money to go out and purchase a mosquito net. In Kihembe, the most common response was that the government or development organizations should give all households with mosquito nets.

DISCUSSION

The research findings illustrate the importance of context – environmental, social, political, economic, and institutional – in characterizing the vulnerability of Batwa health to climate change. While climate change may expose all individuals and communities in the region to similar biophysical effects, it is the human-driven variables of high sensitivity and limited adaptive capacity that make the Batwa more vulnerable to the potential health impacts of climate change. It follows from this that as a starting point for successful adaptation of their health systems to climate change, the Batwa need to address the issues that make them more sensitive in the first place. Specifically, before adapting to future changes, the Batwa need to finish adapting to an older environmental change – the transition to life outside of the forest – which has plagued their communities with two decades of extreme poverty and marginalization lying at the root of their sensitivity. Overcoming these conditions to reach a minimum level of wellbeing such that more advanced adaptation measures specifically focused on climate change and health can be undertaken is the first step towards reducing sensitivity and building a stronger adaptive capacity.

Such a strategy is grounded in the consensus, bottom-up perspective espoused by the Batwa. This perspective became apparent in numerous ways, for example, through the telling skepticism voiced by key informants towards the research agenda, or the difficulty community members often exhibited in comprehending the relationship between subtle changes in their biophysical environment (of the variety brought about by climate change) and their health, or why it would be of concern. Holistically, their sentiments suggest that the Batwa view climate change as a minor threat relative to the other challenges they face. For example, a major impact of climate change on sub-Saharan Africa as a whole, and Uganda in particular, is predicted to be

a decrease in food security via lower agricultural productivity and higher food prices. Yet for the Batwa, who already suffer from severe malnutrition due to an inability to produce enough of their own food or afford current food prices, discussions of climate change and food security seem peripheral to their immediate problems. Their attitude towards this debate is if to point out that a potential change in their food security because of climate change is irrelevant when there is no food security to begin with.

While for external stakeholders interested in climate change, vulnerability is *magnified* in this context of extreme sensitivity, for community members, it is *overshadowed* by these sensitivities. For both, this research suggests that adaptation to the potential health impacts of climate change is best approached in the present through addressing the Batwa's social determinants of health, primarily through the provision of sustainable livelihoods in which their fundamental needs are met. With this principal aim of reducing vulnerability through sensitivity, three pathways figure prominently: land access and ownership, economic self-sufficiency, and new forms of traditional knowledge.

In general, Batwa households which have land tenure security through access and ownership experience better health outcomes and are more optimistic about their future than those lacking tenure security. This positive relationship between land and wellbeing was seen in both case study communities, has been confirmed by quantitative studies in Batwa communities over the past two decades, and is supported by a wealth of scientific and grey literature (Ohenjo et al., 2006). A 2005 study, for example, found that child mortality (under five years of age) of the Batwa was 59% for households without land while *only* 18% for households with land (Balenger et al., 2005). Given that the Batwa are now agriculturalists, land is inherently their foremost asset towards achieving a secure, sustainable livelihood. It serves as their principal

income generator, source of food, and greatest wealth holding, and its significance is not lost on a population of whom many have spent upwards of two decades squatting on others' land and immigrating between plots in search of tenure security. As an indication of the purport the issue of land holds for the Batwa, most interviewees raised the subject tangentially as soon as a discussion ventured towards issues of wellbeing or development. In the future storylines exercises, the acquisition of land was the most frequently cited strategy for health adaptation to climate change, a sign that community members appreciate its broader significance beyond economic benefits and into all aspects of their wellbeing, including health.

A recurring theme in the broader discourse related to the economic development of Batwa communities is that given the precariousness of external aid upon which livelihoods in both communities currently depend, self-sufficiency is a necessary prerequisite for sustainability. Within the communities, the households who were most successful in generating their own wealth, independent from external sources, were also the healthiest. For example, the wealthiest household in either community is one in Kihembe where the male head runs his own brick making business. He noted that while agricultural yields can vary and prices change, bricks "always sell". With this stable source of income, he has been able to build two brick houses of his own while most other households in the community await a development organization to build a mud hut for them. His household is generally in superior health relative to the rest of the community, with his wife reporting only minor illnesses and malaria amongst the children. None of his children have passed away. While this household is the exception rather than the norm in terms of degree of external dependence, it provides an exemplary case of the benefits of self-sufficiency.

However, self-sufficiency is a multi-scalar issue, and it needs to be approached at the community level in addition to the household level so as to avoid exacerbating inequalities within the communities. When drawn to speculate on future conditions, key informants were unanimously more optimistic about those of Mukongoro than Kihembe because of the community's relatively more active engagement towards this aim of self-sufficiency. The research suggests two possible reasons for this greater engagement. The first, related to settlement histories, indicates that because community members in Mukongoro for the most part have a shared history as refugees from the Congo and established themselves in Mukongoro with equal plots of land and opportunities, they have developed a more productive internal dynamic where support is offered between fellow community members. It follows that they are more likely to work towards inclusive, community-wide development in which Mukongoro as its own micro-economy is self-sufficient. The story is much different in Kihembe, where its four original households were given all of the land by development organizations and told to subsequently divide the land and distribute it to new families as they arrived. As Kihembe's population grew, the original landholders were unwilling to parcel off their land, fostering blatant inequality and an antagonism that remains a salient issue in the community today, preventing households from effectively working together. A second reason for the differing degrees of effort put towards self-sufficiency by the two communities may be the relationship between the respective communities and external development organizations. In Mukongoro, the relationship has been largely positive and many of the development projects have explicitly focused on capacity building and fostering self-sufficiency through an iterative process. In Kihembe, the relationship has been far more contentious and focused more on unilateral giving than on the type of mutual learning that fosters self-sufficiency. Amending these factors to help develop economic self-sufficiency and

reduce dependency upon external aid in the communities would allow the Batwa a more secure livelihood and enable them to adapt to future changes on their own without external assistance.

A third key pathway through which sensitivity may be reduced is the production of new forms of traditional knowledge relevant to the Batwa's present livelihoods. It was evident during the research that those households with individuals who have a high level of education and a sophisticated knowledge associated, in particular, with agriculture, have the most secure and prosperous livelihoods and are thus best prepared for adaptation. A number of these households are already active in adapting to environmental change using new "traditional knowledge" they have adopted from fellow Bakiga farmers. For example, one household reported altering their planting schedule based upon seasonal irregularities in precipitation patterns. While June is generally considered the dry season, if it is still raining when the month arrives the family will choose not to plant millet, which, despite being the regular crop for that month, is highly susceptible to unexpected rains. In its place, the household will plant a sturdier crop that can withstand more volatile weather. Another example of adaptation exhibited by multiple households is the planting of root vegetables as a safety crop to minimize risk since these vegetables are less prone to crop failure. It is livelihood adaptations such as these which will become increasingly important in the future as climate change induces increased variability and unpredictability in the biophysical parameters of agriculture. However, for every household who was advanced in these relatively new forms of agricultural knowledge, there was an equal number who exhibited the opposite, unaware of fundamental principles such as the timing of planting and harvesting seasons or the type of seeds to plant during each season. Raising the education and experience in all households to a basic level of knowledge will help households farm more efficiently and contribute broadly to their ability to build adequate livelihoods.

It is important to note, however, that education and knowledge are limited by the need for financial resources to effectuate them. Future storylines consistently showed that, at least at the community level, knowledge for adaptations did exist, but the resources to enact them did not. For example, when respondents related a desire to use advanced farming techniques such as multi-cropping or a higher-yielding seed, they quickly followed up their statements with an acknowledgement that they did not have large enough plots to use such techniques or enough money to purchase the different seeds.

This last point illustrates the interrelated nature of the sensitivities experienced by the Batwa. The provision of land without the education to utilize it, and vice versa, would be an inefficient response, just as economic self-sufficiency without land or education is an extremely challenging proposition for the Batwa. In highlighting key pathways to reduce sensitivity and build adaptive capacity, I do not mean to isolate them as separate levers of development, but rather, identify potential keystone issues that would have a positive cascading effect in the development of robust livelihoods for the Batwa that are capable of adapting to the potential health impacts of climate change.

CONCLUSION

When the Batwa were forced out of their ancestral forest two decades ago, they entered into Ugandan society at the lowest level, subject to extreme poverty, social and political marginalization, and socio-cultural challenges related to the livelihood transition. Although their numbers are small, their plight is immense. In this case study aimed at assessing the Batwa's vulnerability to the potential health impacts of climate change, they emerged as especially vulnerable because of these human-driven sensitivities. In their current state, the Batwa are predisposed to experiencing the brunt of the higher disease burden that is expected to arise from climate change in sub-Saharan Africa. Successful adaptation for the Batwa depends on the extent to which they can reduce their sensitivity to these negative health outcomes through the development of sustainable, self-sufficient livelihoods, which are a prerequisite for participation in more specific climate change and health-related adaptations. Land, economic self-sufficiency, and new forms of traditional knowledge are fundamental to this aim.

As one of the many variables in a complex, dynamic web of future health determinants for the Batwa, the impacts of climate change can only be understood in context. When done so, there appear many reasons to be optimistic about climate change adaptation and Batwa health. Indeed, the history of the Batwa is one of resilience in the midst of turbulent and abrupt change, and perseverance in the face of constant livelihood threats. For a population predicted to be on the verge of extinction twenty years ago when they were forced from their native environment, adaptation to adversity is the norm. Climate change should not change this.

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APPENDIX A: HOUSEHOLD SEMI-STRUCTURED INTERVIEW GUIDE

Introduction

1) Thank you for participating
2) Who we are
    - Student researchers from McGill and Makerere Universities with translator
3) Interviewee/s full name/s and relations
4) Description of research schedule:
    - Short morning discussion, PhotoVoice, discussion of PhotoVoice results
5) Consent

Current vulnerability

6) Exposures
    - What are your major health concerns/most common diseases? Causes?
    - Have these always been the major concerns/diseases? Any new diseases?
    - Generally, is your family getting healthier or less healthy?

7) Sensitivity
    - Who gets sick the most in your household?
    - Do men/women/children get different diseases?
    - Are there ways to improve the health of these identified groups?

8) Adaptive capacity
    - How do you treat yourself when you are sick?
    - Does treatment work? Are there any challenges in accessing it? In general, what do you do to stay healthy?

Future vulnerability

9) Exposures
    - Do you have concerns about the environment?
    - Noticed changes in environment (rainfall, crops, seasons, mosquitoes...)?
    - What is your livelihood?
    - Where do you get your water? Is it clean? Safe to drink?
    - Where does your food come from? Is it enough and is it good for you?

10) Sensitivity
    - How do you think health will change as the community develops?

11) Adaptive Capacity
    - How did you adapt to this new environment? Challenges? (for recent arrivals)
    - What hopes do you have for the future?
    - What can be done to help you deal with the challenges you face?

APPENDIX B: KEY INFORMANT SEMI-STRUCTURED INTERVIEW GUIDE

Introduction

1) Thank you for participating
2) Who we are
    - Student researchers from McGill and Makerere Universities with translator
3) Interviewee/s full name/s and role in community
4) Description of research schedule:
    - Discussion of community and issues, PhotoVoice, discussion of Photovoice results
5) Consent

Community info

6) Population
    - Total size? Number of households and families?
    - What is the Batwa/Bakiga split?
    - Age and gender distribution?
    - Average number of births and deaths in a year?

7) History
    - When was Batwa community established here?
    - What have been the major events in its history?
    - Biggest changes in the community during your time here?

8) Organizational structure
    - Who are the key leaders? How are they chosen?
    - How does governance work?

9) External influence
    - What outside organizations (e.g. NGOs, government, churches) work with you?

10) Education
    - How many people are educated? Number who can read and write?
    - Do children go to school now?

11) Livelihoods
    - What are the main livelihoods/sources of income for community members?
    - What crops are grown?

Current vulnerability

12) Exposures
    - What are the major health concerns/most common diseases in the community?
    - Has this always been the case? Any new diseases?

- In your opinion, is the community getting healthier or less healthy?

13) Sensitivity
    - Who gets sick the most in the community?
    - Do different groups of the community (men/women/children/more or less well off) get different diseases?

14) Adaptive Capacity
    - Where is the nearest health centre? Any challenges in accessing care?
    - Does anyone come to the community to offer healthcare?
    - How prevalent is the use of traditional medicine?

Future vulnerability

15) Exposures
    - Do you have any concerns about the environment?
    - Have you noticed any changes in the environment (rainfall, crops, land, seasons, mosquitoes...)?

16) Sensitivity
    - As the community develops how do you think its health will change?

17) Adaptive Capacity
    - How have the Batwa adapted to living in this new environment out of the forest?
    - What are your hopes for the community's future?
    - Do you have health concerns for the future?
    - As a community leader, what can you do to help deal with these problems? What help do you need?

APPENDIX C: BIOGRAPHY INTERVIEW GUIDE

Introduction

1) Thank you
2) Who we are (if they don't remember us)
3) Their full name/s (if don't have already)
4) Description of bio interview
5) Consent

Questions

6) Childhood
    - Where were you born? When is your birthday?
    - What memories do you have of your childhood?
    - Did you go to school? Can you read/write?

7) Family
    - Do you have brothers and sisters?
    - Tell me about your parents.
    - When did you get married? Have first child?
    - How many children do you have now?

8) Life in community
    - When did you move here? Why?
    - How do you spend of your time? What is a typical day like?
    - What job would you like to do?
    - What is your role in the community?
    - In your time here, what changes have you noticed in the community?

9) Health
    - Have you ever been very sick?
    - How do you keep yourself healthy?

10) Random personal
    - What have been the most significant events of your life?
    - What is the most important lesson you can pass on to your children?
    - What are the main challenges in your life?
    - Are things more or less difficult now than when you were a child?
    - What are you most proud of?
    - When are you happiest?