Scaling Up: Expanding Community Health Worker Programs for Former Refugees and Internally Displaced Persons in Southwest Burundi

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To the staff of Village Health Works

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Burundi is a small and often-forgotten country in East Africa, directly south of Rwanda and north of Tanzania. Although poorly reported in Western media, Burundi underwent two significant genocides, one in 1972 and one from 1993-2006. These ethnic conflicts killed upwards of 600,000 people and displaced an additional 2 million, either internally or internationally, mostly to Tanzania. When the conflict officially ended in 2006, Burundi was ranked as the poorest country in the world. Its health outcomes are equally low. According to the World Health Organization, nearly one in five children die before their fifth birthday. Millions lack access to reliable healthcare. Additionally, returning refugees and internally displaced persons (collectively referred to as *returnees*) may be especially vulnerable to poor health. In these settings, the use of community members trained in basic health delivery has become popular. These Community Health Workers (CHWs) are able to provide basic health education, prevention, and infectious disease treatment. Village Health Works, a community-run clinic in southwest Burundi, has implemented a small CHW program. Currently, they employ 60 CHWs, but are planning to expand to 500 over the next few years. In this paper, I analyze how the program could be expanded to serve the needs of the surrounding community, especially those returning from displacement. Data were collected on 10,401 patients undergoing 11,525 clinical consultations from September 2010 to March 2011. I found that the epidemiological profile of the patients was characterized by infectious disease and malnutrition. To determine ideal geographic placement of new CHWs, I built a model for CHW need that included disease abundance and severity. Additionally, it included CHWs' efficacy to prevent or treat various diseases. I found that when combined with ArcGIS software, our model served as a powerful tool for health human resources. I additionally found that 49% of patients visiting VHW were returnees, mostly from Tanzania, and that many areas VHW serves are comprised of over 60% returnees. These populations were found to show equal or better health and demographic metrics than non-returnee patients.

TABLE OF CONTENTS

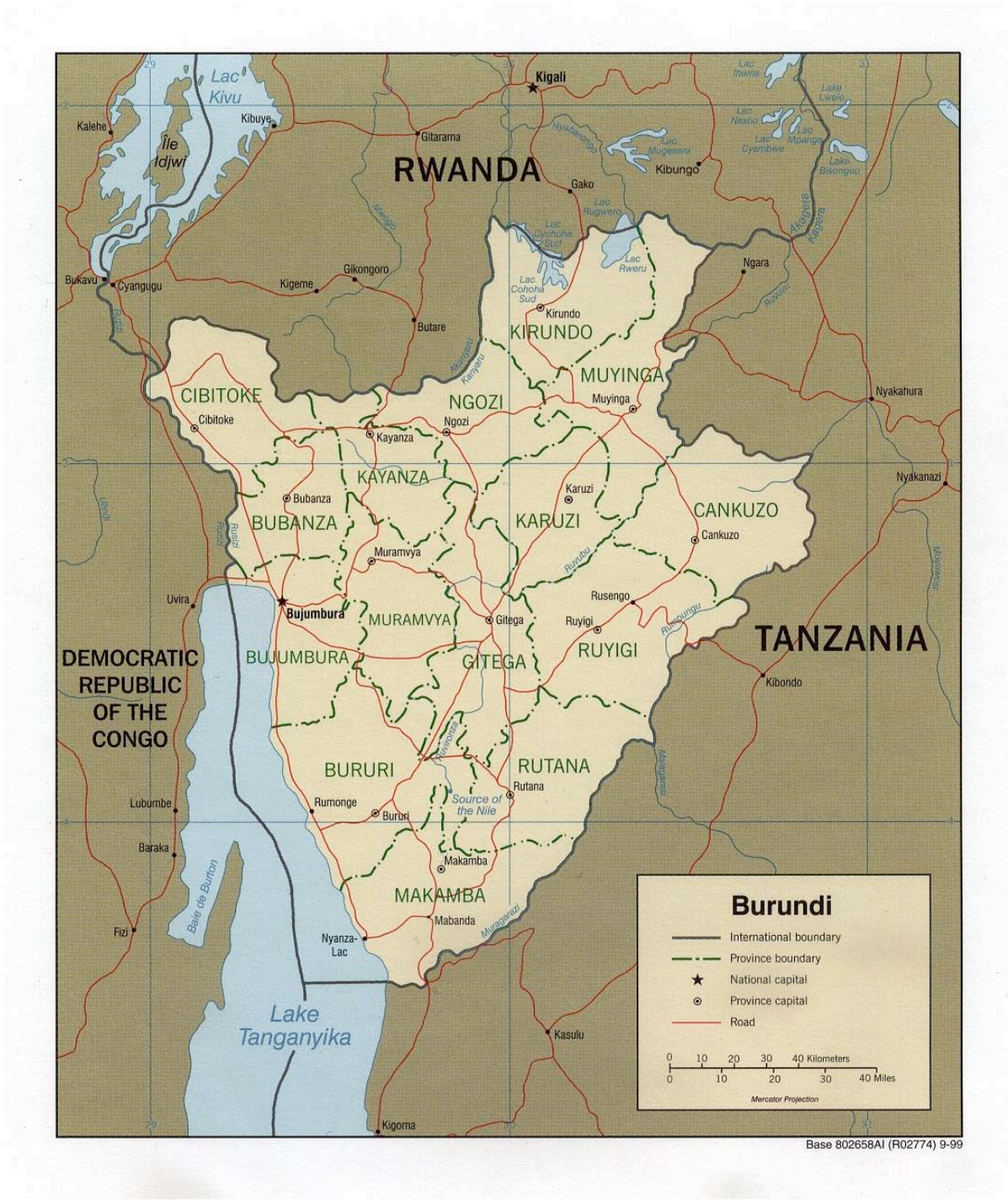

Figure 1. Map of Burundi

1. INTRODUCTION

Burundi is a nation characterized by a series of unfortunate and violent years that have toppled the county's ability to serve its population. Although poorly reported in Western media, Burundi underwent two significant genocides, one in 1972 and one from 1993-2006. These ethnic conflicts killed upwards of 600,000 people (Watt 2008). When the conflict officially ended in 2006, Burundi was ranked the poorest country in the world (World Bank 2006). Its health outcomes are equally low. According to WHO (2010), nearly one in five children die before their fifth birthday. Millions lack access to reliable healthcare. Infectious diseases such as HIV/AIDS, malaria, and tuberculosis are active and destructive even when treatment is available. Many of these poor health metrics are the result of warfare.

Often, some of the people most affected in civil conflict are those who are forced to leave their homes. These people, referred to as *refugees* if they leave their home nation and *internally displaced persons* (IDPs) if they do not, often face significant challenges associated with violence and migration. Often they report poorer health outcomes than people who were not forced to leave their homes (Miller and Rasco 2004). In Burundi, over two million people were forced to leave their homes during the violence (Watt 2008). Hundreds of thousands are returning to their past home regions, many with the assistance of the UN High Commission for Refugees (UNHCR). These *returnees* (comprised of past refugees and IDPs) are often assumed to be at a higher risk for developing health problems since they do not have the economic, health, and welfare resources to which they previously had access.

Village Health Works (VHW), a small community-run clinic in the Bururi province of Burundi, addresses some of the returnees' needs through its Community Health Worker (CHW) program. CHWs are lay citizens trained in basic medical techniques. At VHW, they focus on treatment of HIV and TB patients. Additionally, they are often able to reach out emotionally and support the returnee patients with health and economic assistance through the clinic. Many of the CHWs are returnees themselves.

Because of this perceived difference in health outcomes, a focus on returnee health has become prominent in the global public health arena. The US Bureau of Population, Refugees and Migration (PRM) at the US State Department has been providing funding for Burundian returnee health projects since 2009 (PRM 2011). In 2011, they expanded their grant funding to include VHW's catchment area. One request for proposals (RFP), entitled *Funding for NGO programs benefiting refugees and refugee returnees in Burundi, the DRC, Tanzania and Uganda*, offers $500,000 - $1,000,000 to expand community programs for health and development. The RFP stipulates:

- Proposed activities for Burundi should support the repatriation and reintegration of Burundi refugees… Primarily in Bururi, Rutana, and Makamba Provinces…
- Proposals should focus on health/mental health, water, sanitation, shelter, sustainable livelihood promotion, primary education …
- Proposals should target priority sectors specific to the geographic area and target population as identified in collaboration with UNHCR, local authorities, and returnees themselves (PRM 2011).

VHW applied for this grant in the winter of 2011 to expand their CHW program to 500 CHWs, focusing on the needs of returnees. However, during the application process, VHW realized that I knew little about the health or distribution of returnees. Did they actually have poorer health outcomes? Additionally, VHW had no method for quantitatively planning the geographical expansion of the CHW program upon an influx of funds. These issues serve as the basis of this paper.

Upon asking the question, "How can VHW expand the CHW program to meet the needs of returnees?" I determined four important sub-questions:

- What is the epidemiological profile of VHW's patient load?
- How do health metrics differ in returnee and non-return populations?
- What is the geographical distribution of disease in VHW's catchment area?
- Where should new CHWs be placed?

To answers these questions, I analyzed patient records from September 2010 to March 2011. I found that the epidemiological profile was dominated by infectious disease and malnutrition (Table 3). Based on these findings, I analyzed the difference in infectious disease and malnutrition statistics (among other metrics) between returnees and non-returnees. I found, surprisingly, that returnees and non-returnees varied little in health outcomes, and that returnees reported better health and demographic metrics in some instances.

Since I found little difference in health metrics for returnees, I made no distinction between returnees and non-returnees in planning the CHW program expansion. Instead, I focused on the various diseases affecting each geographic region.

By analyzing each disease in a statistical and geographic manner, I encountered a variety of findings. The data suggest that HIV/AIDS prevalence may be linked to highly traveled roads, and that using river or lake water as a primary water source is a risk factor for diarrheal disease.

Using this health and geographic data, I developed a model to determine which regions had the highest need for CHWs. The model incorporated the abundance and severity of disease as well as the efficacy of CHWs to prevent and treat the disease. I found that VHW's current CHW distribution is unbalanced and recommend an expansion into the west of the catchment area. This analysis suggests that in combination with mapping software, my model can serve as a powerful tool for health human resources planning.

2. BACKGROUND

Burundi's miserable health outcomes are inseparable from the historical processes which made them so prevalent. After a brief introduction to the VHW clinic, this section explores the effects of war on the citizens of southwest Burundi.

2.1. War in southwest Burundi

Burundi is a small, landlocked nation in East Africa with a long history of ethnic tension (Appendix 1). Throughout its pre-colonial history, there was a division between the majority Hutu ethnicity and the minority Tutsis. During the Belgian colonial era, this tension was heightened as the Belgians gave almost all administrative power to Tutsi elite. After independence, the situation was not mended and only turned more hostile after the assassination of Burundi's first Hutu president in 1962. Since independence until 2006, there has been a constant tension, with a genocide occurring in 1972 and a full-scale civil war occurring from 1993 to 2006.

These conflicts had very significant impacts on the area surrounding the clinic. Rumonge (about 10 miles to the northwest of the clinic) was the origin of the 1972 conflict, and coworkers told me that violence was particularly bad in the city of Mugara, a few miles southwest of the clinic. Hoyt (1974) notes that, "In area after area no educated Hutu is believed to be alive. This is particularly true in the South where I have word from growing number of villages that no Hutu males remain at all." This is

confirmed by 2008 returnee figures from UNHCR (Figure 2).

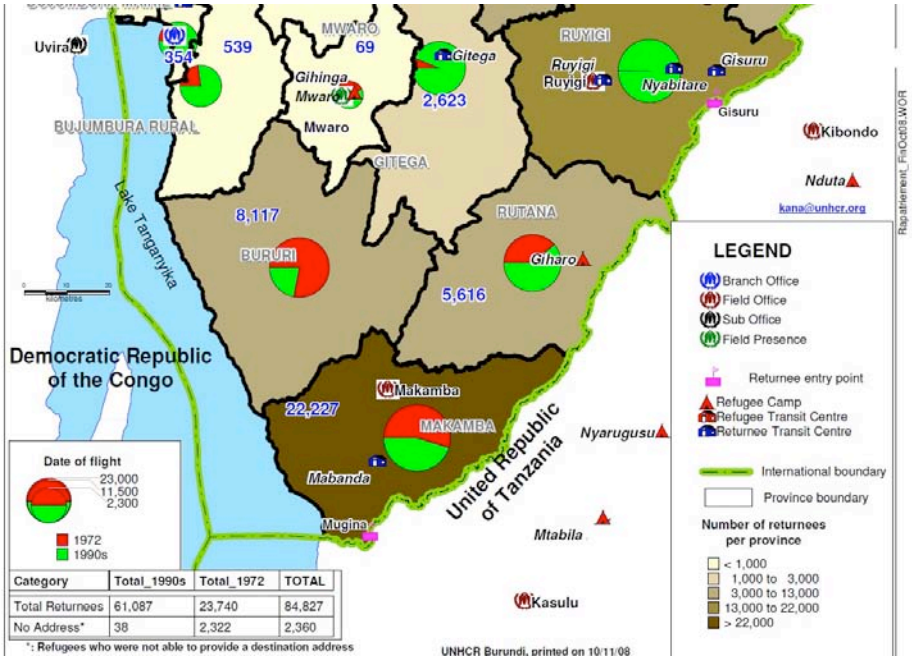

Figure 2. 2008 returnees from Tranzania to southern Burundi (UNHCR 2008)

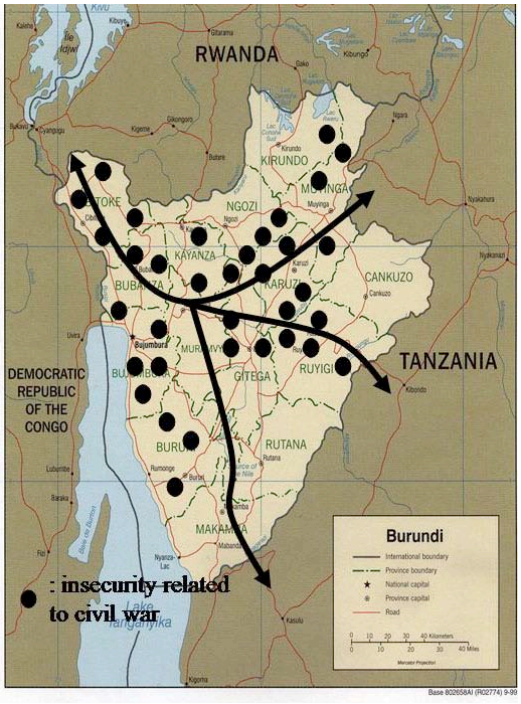

Figure 3. Insecurity related to civil war 95-97 (Budervoet and Verwimp 2005)

The 1993-2006 conflict was also quite destructive to the Bururi province. Budervoet and Verwimp (2005) report that significant violence occurred there from 1995-1997. Figure 3 shows insecurity around the clinic region. Throughout the 1993-2006 conflict, both the Burundian army and the rebel forces used civilians as proxy targets. Human Rights Watch (HRW) is one of the few organizations

that documented these accounts.

They report:

> "People throughout Burundi told Human Rights Watch that they feel trapped between two sides of the civil war. Both the armed forces of Burundi and the rebel troops have killed and stolen from civilians, and the people repeatedly said that they fear both sides. Many people said that they felt caught in a tragic dilemma: if they support the [rebels], they can be targeted by the government for retaliation, but if they refuse to support the [rebels], they can be targeted by the [rebels]" (HRW 1998).

Violence typically involved an attack against civilians by one side, followed by a retaliatory attack against civilians by the other side. Since the war had a uniquely genocidal character, killing Hutu civilians was seen as a retaliation by the Tutsi army, while killing Tutsi civilians was seen as an acceptable retaliation for the rebel groups. This destructive cycle produced what HRW calls "the war on civilians."

In 1996, the government began creating "regroupment" camps. These camps were areas of forced displacement where hundreds of thousands of Hutus were imprisoned. The camps were established in Bururi in 1996 (HRW 1998). Although the government claimed these camps were voluntarily set up in response to fear from the rebels, it has become clear that the displaced were forced into the camps through a campaign of "sheer terror," where the army would threaten, torture, rape, kill, pillage, and burn homes to force civilians into transports to the camps. After the camps had been formed, the army searched the surrounding area and "shot, stabbed, or bayoneted" anyone who had not regrouped (HRW 1998).

The primary purpose of the camps, beyond their genocidal madness, was to prevent organization of the rebel groups. Once the Hutu civilians were gathered, anyone suspected of having ties to the rebel groups was summarily executed (HRW 2000)

Within the camps, rape, gender-based violence, torture, beatings, murder, and forced labor were daily occurrences. In addition, sanitation conditions were poor and little food, water, or housing was provided (HRW 1998).

2.2. Health in Burundi

Health outcomes are extremely poor in Burundi due to the conflict discussed above. In fact, *Médecins Sans Frontières* / Doctors without Borders (MSF) found mortality rates in Burundi were significantly above one death per 10,000 persons per day, which qualified Burundi as an international "emergency situation" (2004).

The situation for children under five is particularly acute. MSF found mortality rates of over 3 deaths per 10,000 persons per day, past the threshold for a "severe emergency situation." An estimated 17% of children under 15 are single or double orphans (Guarcello 2004). Malnutrition shows the effect of war as well. In quantitative manner, Bundervoet *et al.* (2009) showed that children's weight-for-height z-score is 0.047 standard deviations less per month they were exposed to conflict. Burundi has the 9th highest infant mortality rate in the world, at 18%, and a full 1% of births result in a maternal mortality (UNICEF 2009, WHO 2010).

Burundi is currently rated the 3rd most impoverished nation worldwide (World Bank 2011). VHW found that 90% of households had a monthly income less than 60,000 Burundian Francs, or about 50 USD (VHW unpublished data 2008). This money

was shared amongst an average household size of seven people (VHW unpublished data 2008).

The international community has largely failed Burundians, and the Burundian government was forced to implement a cost-sharing health system due to lack of funds. This means that public clinics charge fees for consultations, lab tests, and treatment. MSF (2004) found, in many situations, a simple consultation for malaria would cost 200-300% of weekly income. They argue that cost-sharing systems exclude approximately one million Burundians from care. Additionally, if patients are unable to pay costs, they will be imprisoned in the public hospitals until their bills can be paid. (HRW 2006) In the event they die, their bodies will be held until a family member pays their bill. This is both official Burundian policy and is actually carried out – I met imprisoned patients in the public hospitals.

Even if Burundians can afford care, it is often difficult to transport themselves to a rare clinic or hospital, considering that there are fewer than 250 physicians serving all of Burundi's eight million people (WHO 2010). Lastly, public clinics are in miserable disrepair. I personally visited many that showed lack of hygiene, privacy, or medical equipment.

The major public medical facility in the Bururi Province is found in Rumonge, where a French-trained surgeon works two days per week. The operating room is in horrible condition (Figure 4). They are completely lacking in pathology, only having access to one microscope and one x-ray machine.

Figure 4. Rumonge's operating room (Courtesy VHW)

3. METHODS

3.1. Setting

VHW operates a small, community-run clinic that focuses on primary care, nutrition, and infectious disease treatment. It is funded mostly by US-based private donors although it receives some medications, such as antiretrovirals, from the Burundian Ministry of Health. The clinic sees approximately 1,500 patients per month, a number that is steadily increasing.

Outpatients come to the clinic throughout the day, but most arrive early in the morning. Demographic data, such as name, age, origin, alcohol use and refugee status, are recorded by hand into a notebook.

There were a total of 60 Community Health Workers employed by VHW. Following the Partners in Health *accompagnateur* model, CHWs' primary purpose was to support treatment of patients undergoing treatment for HIV and TB. Each CHW served 1-5 patients. They had received a training session normally less than a week long because VHW cannot currently support housing. They are trained in basic health, such as hygiene and sanitation, as well as HIV and TB treatment. Each CHW was supervised by a head CHW who lived in his or her area. CHWs were paid a base salary and received an additional amount per patient they served. HIV and TB patients need to take regular medication to reduce the viral and bacterial loads, respectively. CHWs serve as the essential link between the clinic and the HIV/TB patients by administering directly observed therapy (DOTS) to patients two times per day. CHWs walked to

patients' houses and literally deliver and observe them taking the HIV and TB medicine.

3.2. Patient data collection

During the day, clinic staff conduct a short interview with each patient, asking a set of clinical and demographic questions. Each patient is assigned a specific patient ID which they keep in their health notebooks. The answers are recorded onto paper. At the end of the day, this paper data is entered into a Microsoft Access Database table called *Patients*. A wide variety of information was collected (Table 1).

Patient demographic and clinical data was collected from September 3rd, 2010 to March 23rd, 2011. This data contained information on 10,401 patients.

Additionally, two other important tables were formed. A *Consultations* table was created in Microsoft Access that included all relevant data for each clinical consultation. This table contained the patient ID, three symptom fields and three diagnosis fields. Each symptom and diagnosis was assigned a specific code to allow for easy searching and identification. Additionally, a field concerning

Field
Sex
Birthday
Colline
Zone
Commune
Province
Civil Status
People in Household
Alcohol Consumption
Cigarette Use
Traditional Healer Attendance
Water Source
Education Level
Refugee Status
Profession

Table 1. Selected clinical and demographic information collected in Patients table.

the outcome of the consultation was present. The *Consultations* table contained data on 11,525 consolations.

Lastly, a *Triage* table contained basic vital information collected at the triage station, such as height, weight, temperature, blood pressure and arm circumference.

3.3. Data management

Although the data were originally gathered and stored in a Microsoft Access Database, it was transferred to a MySQL database for ease of manipulation. A locally-running version of XAMPP was used to run PHP scripts to analyze the data. These programs can be found in the web appendices.

3.4. GIS mapping techniques

The geographic information systems (GIS) map was created using ArcGIS made by ERSI. A base map (in SHP and MXD formats) of southwestern Burundi was obtained from data gathered by the UN Office for the Coordination of Humanitarian Affairs (OCHA) in 2004 (Web Appendices).

I encountered a significant amount of difficulty involved in aligning the geographic data from the *Patients* table to the data provided by OCHA. Burundi is divided into 17 provinces, which are divided into 117 *communes* (communities). These communes are divided into 2,639 *collines* (literally hills, but similar to a village) and furthermore into 9915 *sous-collines* (sub-hills, or neighborhoods).

Unfortunately, when many of the patients were asked which *colline* they reside in, they often mentioned their *sous-colline*. A good example is Kigutu, the *sous-colline*

of the clinic itself. Many patients responded that Kigutu was their *colline*, when in fact Kirungu is their *colline* and Kigutu is their *sous-colline*.

Each of these levels had an administrative code associated with it, called a P-CODE. The P-CODE for Kigutu is 003BDI003009009001. Each segment represents the "ancestry" of the area, e.g. Lane County is the City of Eugene's parent, Oregon is Eugene's grandparent.

For Kigutu, the first six characters ("003BDI") designate the nation, Burundi. The following three ("003") represent the province Bururi. The next two sets of three ("009" and "009") represent the *commune* (Vyanda in this case) and *colline* (Kirungu), respectively. Finally, the last three characters ("001") designate Kigutu.

Although the OCHA map information had a resolution down to the *sous-colline* level, the clinical data contained only a *colline* field populated with a mixture of actual *collines* and *sous-collines*. Therefore, I decided to map to the resolution of the *colline.* In order to make the alignment work, I thus needed to link each *sous-colline* with its "parent" *colline*. OCHA provided a database which does this; it had a list of *sous-collines* and their ancestors. However, one problem was that many *sous-collines* had multiple names, i.e. there are two "Buvara" *sous-collines* in Burundi, so a simple match was not sufficient. I thus designed a program (Web Appendices) that searched for the clinical *colline* in the OCHA *sous-colline* and *colline* fields, and only linked the two together if they had matching communes and/or provinces. This removed the possibility that patients would be assigned to the wrong duplicate-named *sous-colline*.

Still, more problems arose. Multiple *collines* listed in the *Patients* table did not exist in the OCHA database as either *collines* or *sous-collines*. I deduced this was due to either the new appearance of a *colline* since 2004 (when the OCHA data was collected), the nicknaming of a *colline* something other than its actual *colline* name, or misspelling of the *colline* name. Upon further examination, I found that 59 patients were from Tanzania, 4 were from the DRC, and 2 were from Rwanda. These were excluded. Additionally, there were 221 patients from unidentified *collines* with total density less than 20 patients. Additionally, I could not find some larger *collines*, such as Gashaha (with 300 patients visiting in the period studied), Karonda (with 246) or Karirimvya (with 233). To substitute, I was able to find approximate latitude and longitudes for each of these *collines* via satelliteviews.net. These points were then added to an ArcGIS map and I was able to visually discern in which *colline* they belonged. Additionally, there was a problem mapping the center of urban areas. The map provided by OCHA listed each center of urban areas (such as Rumonge) as a *centre-urbain*, but patients would instead give the actual name of the city. This left each *centre-urbain* on the map empty of patients.

I was unable to find Gihwanya (52) or Kayenkoko (33). Lastly, 137 patients listed no *colline*. Thus, I was forced to exclude a total of 423 patients from the geographical analysis due to inability to map their location. A map was created showing density from each *colline* (Figure 5).

3.5. Developing a model for CHW Placement

In order to determine where to place new CHWs, I needed to create a clear and logical model. I began by creating a variable that represented the need of a specific *colline* for CHWs regardless of its current CHW coverage. This was called *Gross CHW Need* (GCN) per *colline*. To determine how much need each *colline* had for a CHW, I looked at the abundance of cases of specific diseases. For example, if there were 100 cases of gastritis from Kirungu and 1000 cases of gastritis from Mutambara, Mutumbara would arguably need more CHWs.

However, this does not take into account the severity associated with each of these diseases. Using the same example, if all 100 patients from Kirungu were HIV-positive and the 1000 patients from Mutambara had only gastritis, I would have to place more CHWs in Kirungu since HIV is a far more severe disease. To measure disease severity, public health researchers divide the effects of disease into two categories: *mortality*, or the number of deaths due to a disease in a population over a given amount of time, and *morbidity*, or the propensity of the disease to cause illness in a population. Thus HIV/AIDS has a higher mortality (more deaths per year) and morbidity (more disability and pain) than the common cold.

To further quantify morbidity and mortality, a system was developed by the World Bank in 1990 that allows morbidity and mortality to be directly added. Using surveys measuring global preferences for diseases, the World Bank determined a consensus on the severity of each disease. These severities were labeled *Disability Weights* (DW) and represent the quality of life with the disease compared to a healthy life. For example, blindness has a disability weight of 0.6. Thus, in this model, six years

of blindness is equivalent to ten years of healthy life. If an individual went blind for ten years, she would incur a "loss of healthy-life years." In this case her *Years Lost due to Disability* (YLD) would be four years. In addition, *Years of Life Lost* (YLL) measures years of life lost to premature death, which is the life expectancy minus the age at death. When YLL and YLD are combined, they give us a Disability-Adjusted Life Years Lost (DALYs).

$$DALY = YLL + YLD$$

The DALY measurement was used to calculate the severity of the different diseases present in VHW's catchment area. In order to determine these values, a DALY per incident case was derived from WHO Africa sub-region E statistics (Global Burden of Disease 2004). *Incidence* is a measure of how many new cases of a disease occur in a given time period in a population. However, some longer diseases' severity are better measured by *prevalence*, or how many people are living with the disease in a given time period in a population. For example, perhaps Kirungu had an outbreak of HIV/AIDS in the 1990s and 100% of the population was infected. An measurement of incidence for 2010 in Kirungu would be zero, even though the colline would arguably have a very high need for CHWs. Conversely, the prevalence of malaria (which only lasts two weeks at most with treatment) at any time is much less useful than how many cases of malaria have occurred in the area over a certain time period. Thus, diseases were categorized as prevalence-based and incidence-based for the calculation of severity (Table 2).

Lastly, the model needed to take into account the ability of the CHW to cause change in the population. Generally, CHWs are able to affect the population through *prevention* and *treatment*. However, this varies by disease. For example, CHWs have very little impact on people affected by Downs Syndrome since they have little training in the matter. However, they can have a great effect on both the prevention and treatment of HIV/AIDS by delivering medication and educating patients about condom use. This variable was entitled *CHW efficacy*. It was broken into two parts: a prevention efficacy score and a treatment efficacy score. Each efficacy score was based on a comprehensive literature review of best practices (Table 2, Appendix 2).

Disease	Prevention Efficacy Score	Treatment Efficacy Score	Total Efficacy Score	Severity
HIV/AIDS	0.5	0.5	1	3.9 DALY / patient-year
TB	0	0.5	0.5	14.9 DALY / incident case
Child malnutrition	0.5	0	0.5	0.12 DALY / patient-year
Malaria	0.5	0	0.5	0.28 DALY / incident case
Diarheal disease	0.5	0	0.5	0.07 DALY / incident case

Table 2. Diseases used for GCN model. Information based on September 2010 - March 2011. Note that severity of and HIV and child malnutrition are measured by DALY/patient-year as opposed to DALY/incident case. DALY measurements (GDB 2004). Scores for each efficacy were based on a literature review of best CHW practices (Appendix 2).

Thus, the model for *Gross CHW Need* (GCN) per disease per *colline* was based on three variables: abundance (*A*, measured in either prevalence or incidence in the patients seen from September 2010 – March 2011), severity (*S*, measured in DALYs per incident case or per patient-year[1]), and efficacy (*E*, measured as described above). Five

[1] To normalize the severities, the severities of diseases measured per patient-year were divided by two since the study only covered 6 months.

diseases were investigated: HIV, TB, malnutrition, malaria, and diarrheal disease. For example:

$$GCN_{Kirungu\text{-}HIV} = A_{Kirungu\text{-}HIV} \times S_{HIV} \times E_{HIV}$$

Each disease was then summed to find the total GCN per colline.

$$GCN_{Kirungu} = GCN_{Kirungu\text{-}HIV} + GCN_{Kirungu\text{-}malaria} + GCN_{Kirungu\text{-}TB} \ldots$$

Once each total GCN per *colline* was found, it was compared to current CHW coverage in order to determine *Unmet CHW Need*, or *UCN*. CHW coverage, or *CC*, was determined by how many CHWs were living in a given *colline* or adjacent *colline* and is referred to as coverage points.

To compare GCN per *colline* with CC per *colline*, the variables needed to be normalized as a percentage of their respective totals. For example, let us imagine that Kirungu had a total GCN of 15, while all the *collines* together had a total GCN of 100. This means that 15% of all gross need for CHWs in our area is in the Kirungu *colline*.

Additionally, let us imagine that there are five CHWs working in Kirungu or an adjacent *colline* out of a total of 100 total CHWs coverage points. This means that Kirungu has 5% of the CHW coverage even though it has 15% of the gross need, resulting in a deficiency in 10% of the total coverage. This figure represents the unmet or *Net CHW Need*. NCN is a measurement of the needed change in distribution, measured as a percentage of the workforce. A positive value indicates the *colline* needs more coverage while a negative value indicates the *colline* has a surplus of coverage. In the above example, Kigrunu needs more CHW coverage. Multiplying this percent deficiency by the workforce size gives an estimate of number of actual CHWs needed.

So in this case, if VHW employed 60 CHWs, Kirungu would need an additional six hired. This process was completed for the top 200 *collines* (Appendix 6).

$$\frac{GCN_{colline}}{GCN_{total}} - \frac{CC_{colline}}{CC_{total}} = NCN_{colline}$$

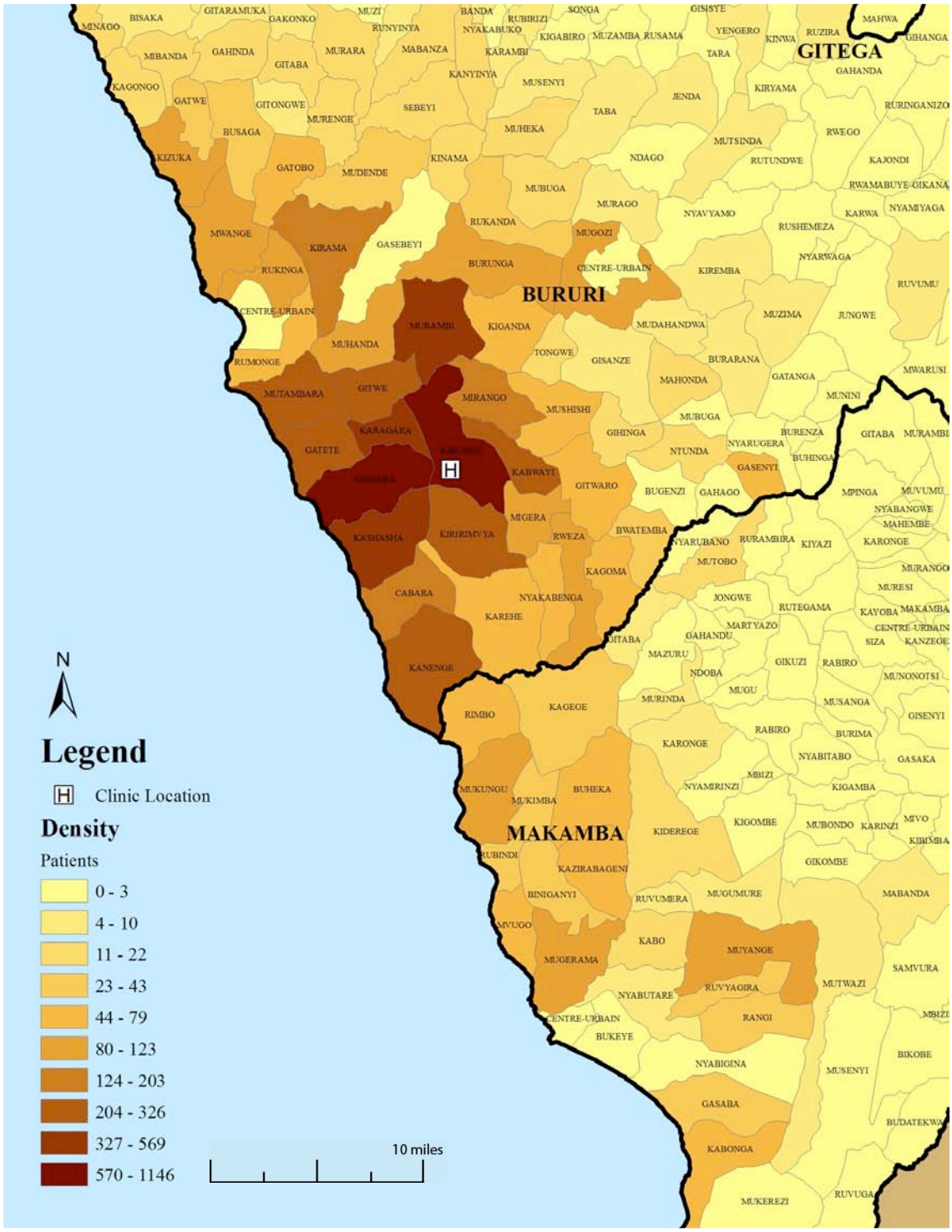

Figure 5. Number of patients seen at clinic from various *collines* September 2010 - March 2011.

4. RESULTS AND DISCUSSION

Most of the data used in this section rely on data about patient visits. In many analyses, I look at the number of cases seen for a disease from a specific *colline*. Although this approach can provide interesting and useful data, it has many limitations. Number of cases per *colline* is a function of not only how many patients became sick in a given *colline*, but also how many were sick enough to seek out a physician. People too sick may not have been able to reach the clinic. It is also complicated by agency – some populations will have access to transportation and food for the journey to the clinic, while others will not. Some groups may prefer traditional healers over biomedical care. Additionally, there are other health centers in the area (namely the public medical facility in Rumonge) that patients may prefer. Thus our data cannot be used to estimate prevalence or incidence per *colline*, but it can serve as a potential correlate to compare differences in patients based on their home *collines*.

4.1. Patient epidemiological profile is characterized by infectious disease and malnutrition

It is well-established that the developing world shoulders the majority of the burden of infectious disease worldwide. In fact, almost all deaths from infectious disease are in low-income countries (WHO 2004) although these diseases are often easily preventable and treatable. The epidemiological profile of VHW's patients during the study period shows that infectious diseases are large-scale problems in Burundi (Table 3). Of the top 50 most-used diagnoses during the study period, 60.3% of total diagnoses were

infectious diseases, 11.1% were malnutrition, 6.3% were pregnancy-related and 22.3% were non-communicable conditions (Appendix 3).

Diagnosis	Consolations that included this diagnosis
Intestinal parasites	1845
Malnutrition	1326
Gastritis	1165
Malaria	994
Arthritis and pain	992
Pregnancy	740
Lower respiratory infection	660
Urinary tract infection	586
STIs	499
Hypertension	331

Table 3. Most-used diagnoses September 2010 - March 2011. Data are collapsed into categories. Malnutrition includes diagnosis of moderate malnutrition, severe malnutrition, kwashiorkor, and marasmus. Gastritis includes pylori and non-pylori. Malaria contains diagnosis of suspected and confirmed. Arthritis and pain includes diagnosis of arthritis, pain, and lower back pain. Pregnancy was determined by a diagnosis of 1st, 2nd, or 3rd trimester. Lower respiratory infection includes diagnosis of pneumonia and TB. STI's include HIV/AIDS. Hypertension includes controlled and not controlled. See appendix 3 for full data.

Although Table 3 provides a good overview of common diagnoses made during the study period, it does sufficiently reveal which diseases are most important, as diseases vary widely in severity. For example, one diagnosis of HIV is far more important in terms of morbidity and mortality than one diagnosis of gastritis. To measure this impact, I can use Disability Adjusted Life Years, or DALYs (Methods). Measuring common diseases by DALYs, WHO found that respiratory infections, HIV/AIDS, and diarrheal disease are the three largest forms of morbidity and mortality in Burundi, followed by a mixture of communicable and non-communicable conditions (Table 4, WHO 2004).

Condition	Disability-adjusted years of life lost in 2004 (per 100,000)
Respiratory infections	6272
HIV/AIDS	5773
Diarrheal disease	4343
Cardiovascular disease	3916
Maternal conditions	3251
Perinatal conditions	3107
Neuropsychiatric conditions	2694
TB	2333
Malaria	2169
Sense organ disease	2162
Malignant neoplasms	1556
Nutritional deficiencies	1440
Non-communicable respiratory diseases	1357
Non-communicable digestive diseases	1233

Table 4. Disability-adjusted years of life lost in Burundi in 2004 per 100,000 by condition (WHO 2004).

The DALY data (Table 4) give a more accurate picture of the relative importance of common diseases and conditions in Burundi. By comparing the national DALY information with the common conditions seen at the clinic, I can develop a view of which diseases are most important for our region. Additionally, the model must acknowledge that the efficacy of CHWs varies by disease, such that CHWs can provide better prevention and treatment services for some diseases than others (Methods).

Taking these three variables into account (number of diagnosis, DALYs, and CHW efficacy), five conditions were identified that had a high number of diagnoses, high DALYs, and CHW efficacy. These conditions were: HIV/AIDS, TB, malnutrition, malaria, and diarrheal disease.

4.2. Approximately half of patients seen are returnees

Refugees and internally displaced persons face some of the largest challenges in Burundi, especially in the southwest region. The brutality endured over almost 40 years of ethnic violence has irreparably damaged the psychological, physical, and economic wellbeing of millions of people. Currently, thousands of these former refugees and displaced people are returning to Burundi. They are referred to as "returnees."

. It is uplifting to note that these returnees are not lacking in hope. A specific returnee, Anne, comes to mind. She has no land, and her house was of poor construction. She complained of water pooling up in her house, the difficulties of returning to Burundi without a community, and a lack of access to food. However, her strength and daily hope for the future of Burundi overpowered her sorrows. She excelled at her janitorial job and has aspirations to become a licensed midwife.

It is estimated that between the 1972 and 1993 conflicts, roughly two million people were displaced (Watt 2008, IFRCRCS 2006). This figure is likely drastically low, since many moved to families or friends' houses and are not reported as "displaced," and these figures often don't include "temporary displacements." Since 2002, the United Nations High Council for Refugees (UNHCR) has facilitated the return of refugee from Rwanda, Tanzania and the DRC to their former lands in Burundi. Between 2002-2009, 496,000 refugees have returned from outside nations, mostly from Tanzania. Bururi alone received over 30,000 returnees, while Makamba (the province south of clinic) received roughly 112,000 (UNHCR 2009). UNHCR reports that lack of access to land is one of the primary challenges, especially for the 1972 returnees, who

are often unable to find their families' previous land and are lacking a social support structure to accommodate them while they find land.

Since 2003, UNHCR has begun the construction of integrated villages, or "peace villages," in the main areas of returnees. These villages provide basic housing, agricultural land, access to basic services, and some income-generating projects, focusing on generating mixed-ethnicity communities for returnees. However, there have recently been problems with access to water and health services in many of the integrated villages (Integrated Regional Information Networks 2010). UNHCR has constructed 15 villages, three of which (Mutambara, Buzimba, and Busebwa) are in the catchment area of the clinic.

In the study period, 49% of patients were returnees (Table 5). There were significant groupings of refugees in the southern *collines* and in Mugara, which may be due to large amounts of violence there in 1972 (Figure 6).

Refugee status	Patients
Returnees	49.2 (1655)
Repatriated	35.8 (1207)
Displaced	13.3 (448)
No movement	50.8 (1710)
Total	100 (3365)

Table 5. Percentage of patients by refugee status September 2010 – March 2011. Returnees refers to repatriated and displaced.

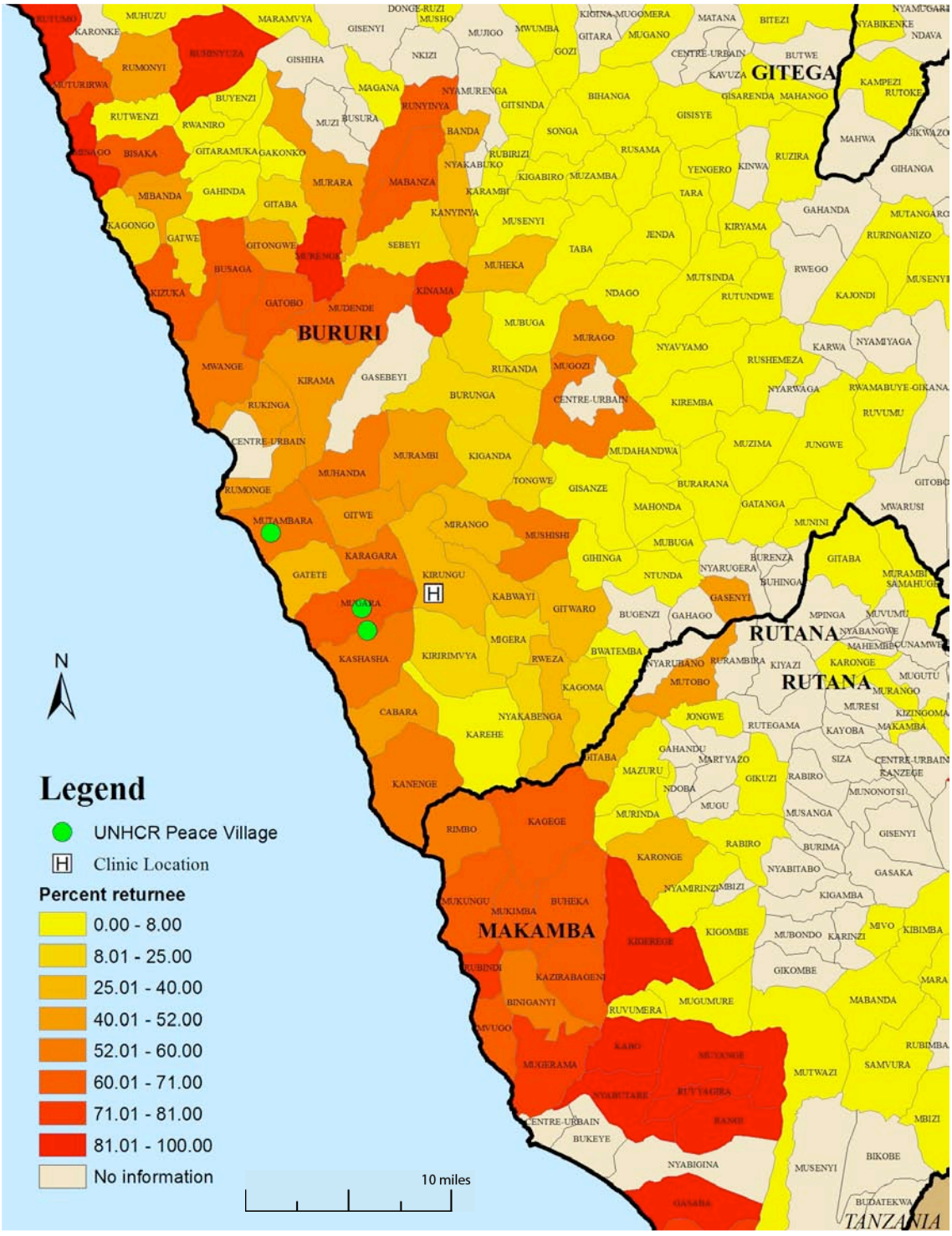

Figure 6. Percentage of patients with returnee status per *colline* September 2010 – March 2011

4.3. Returnees show equal or better health and demographic indicators.

Because of the lack of social, natural, and economic resources available to returnees, it would be expected that returnees would have lower health and demographic metrics Farmer (2001) has shown that there is a significant correlation between economic status and HIV/AIDS rate. Wexler (2003) showed that Burundian refugees had a poor understanding of HIV/AIDS transmission, with only one out of 20 understanding that condoms can be used to prevent HIV/AIDS transmission, and only one of five having ever used a condom. Often, women refugees are widowed and are forced to search for relationships for economic support, often involving sex. Additionally, Wexler (2003) found that 2% of households were headed by children in her study group. These children are more at risk of engaging in transactional sex and being victims of sexual abuse.

Additionally, it would make sense that returnees, who don't have economic connections to the surrounding area, would show higher rates of unemployment. This may lead to a lack of access to other goods and services, such as bed nets, water, or healthcare.

Interestingly, our data show the returnees having equal or better health metrics than those with no movement (Table 6).

Condition	Non-returnee	Returnee	Total
Malnutrition diagnosis (U5)	6 (103) *	2.4 (39) *	4.2 (142)
Malaria	14.3 (245) *	11.6 (192) *	13 (437)
HIV-positive	3.5 (59)	3.7 (61)	3.6 (120)
TB-positive	1.3 (23)	1.6 (26)	1.5 (49)
Diarrheal disease	13.9 (238)	12.5 (207)	13.2 (445)
River / lake water	16.3 (279)	14 (232)	15.2 (511)
Seen traditional healer	25.6 (438)	28.3 (468)	26.9 (906)
Unemployed	28.7 (491) *	15.4 (255) *	22.2 (746)
Competed Sec. or Univ.	11.2 (191)	12.7 (210)	11.9 (401)
Total	100 (1710)	100 (1655)	100 (3365)

Table 6. Percentage of patients diagnosed for condition or demographic metric from September 2010 – March 2011 by returnee status. Parenthesis shows n-value. Percent refers to percent of patients with returnee status who have been positive for the variable, i.e. 11.6% of returnee patients (n=192) have been diagnosed with malaria at least once between September 2010 – March 2011. Values with asterisk are significantly different (chi-squared, $p < 0.05$).

There are many problems associated with this data. First, there were likely issues with translation and understanding in responding to the survey. The survey questionnaire is in French (Appendix 5), and each nurse had to translate the questions to Kirundi, which was likely extremely variable. Even if they were translated well, words like “repatriated” or “displaced” are fluid and don’t have exact equivalents in Kirundi. As discussed above, many people moved during the war to friends’ or families’ houses, but may have not been categorized as “displaced.”

Furthermore, since this data was self-reported, there are possible reasons for each patient to modify his or her answer. Patients may have been worried that revealing their displacement status would affect their access to care. Although the clinic staff is somewhat ethnically heterogeneous, patients might have been hesitant to reveal their

movement history since it could indicate ethnicity. Larger numbers of Hutus were displaced during the conflict than Tutsis within the southwest (Watt 2008).

Even with these caveats, the data provides an interesting view into the difference between those identifying as returnees and non-returnees.

Returnee patients were less than half as likely to be seen for a malnutrition consultation. Returnees also showed lower malaria consultations and a lesser amount of unemployment.

This could have a variety of explanations. First, as discussed above, these data are not only a function of actual health, but also a decision process to come to the clinic. The malnutrition and malaria difference could be due to returnee populations being accustomed to these conditions and not seeing them as pathology needing treatment. Since large amounts of the returnee populations I serve are an extended distance to the south, perhaps they only attend the clinic for more serious diseases (Figure 6).

A more uplifting explanation might be that UNHCR is producing real results, and that these statistics indicate that they have been supporting returnees with adequate bednets and nutrition packages. The increased employment for returnees may indicate either a reason for them to return or increased employment opportunities, offered by income-generating activities at the UNHCR peace villages (Figure 6).

Furthermore, it may be largely a question of demographics. More analysis needs to be done on exactly who the returnees are. Families with large amounts of children or those with few connections in Burundi might be less likely to return from Tanzanian refugee camps, skewing our sample size.

4.4. Malnutrition affected 21% of patients under five years old.

Malnutrition is a lack of sufficient nutrition to the point where it causes pathology. It affects approximately 800 million people worldwide, most of them children. Its symptoms include weight loss, failure to thrive, mental impairment, wasting, and slowed development in children. Over 20,000 people die every day globally from malnutrition-related illness (Encyclopedia Britannica 2011). Two advanced forms of malnutrition are somewhat common in Burundi, kwashiorkor and marasmus.

Kwashiorkor (literally "child deposed from breastfeeding") is a severe protein deficiency. Often found in developing and war-torn societies, it is caused by a diet overly focused on carbohydrates such as cassava. Common symptoms are peeling skin, potbelly, edema, irritability, weakness, fatty liver, and discolored skin and/or hair. From September 2010 to March 2011, kwashiorkor was diagnosed in 94 patients under 5 years old (U5).

Marasmus is a more serve form of malnutrition in which a patient receives neither adequate protein intake nor caloric intake. Wasting and stunting are common symptoms. Long term marasmus results in permanent mental retardation. In the six month period studied, 64 U5 patients were diagnosed with marasmus. I was very close with a patient with a particularly bad case of marasmus that was heightened and complicated by HIV co-infection.

Malnutrition and hunger are significant issues for the Bururi province and the immediate area surrounding Kigutu. A basic food survey done by Village Health Works in Kigutu (unpublished data, 2008) found that 56% of participants had gone to sleep hungry at least once in the last month due to lack of food, while 19% had gone a 24-hour period without eating. Additionally, 80% of households worried about being able to feed their members.

Burundians are primarily agriculturists, with 90% of households producing their own food (D'Haese 2010). The primary food consumed in our catchment area is cassava, a root vegetable with very little nutritional value. It is high in calories, but contains almost no protein or nutrients. It is easy to grow and has thus remained popular, as much of the agricultural knowledge was lost during the war. Most are able to supplement their cassava with rice, beans, and/or potatoes. Additionally, beef, goat, chicken, and fish are available to those who can afford it. Often animals are not eaten and serve as a form of savings and method for obtaining social status. Fishing is a significant part of life near the lake, and one third of respondents in the above survey had eaten fish within the last 24 hours. The primary sources of food are from people's own gardens (64%), from the market (28%), from a work-for-food agreement (4%), or from a family member or friend (5%).

These poor health outcomes are largely the result of lost productivity related to conflict. D'Haese *et al.* (2010) found that agricultural productivity decreased 83% from 1996 to 2007 in northern Burundi. They found that 75% of households characterized themselves as being highly food-insecure, which is similar to VHW's 80% of

households worrying about food. D'Haese *et al.* (2010) attribute this to a variety of causes: the displacement of farmers due to conflict, loss of infrastructure and livestock, inefficient production systems, trouble accessing seeds, and virtually no access to credit services. These causes seem very fitting for the area surrounding Kigutu as well. The patients attending the clinic are approximately 50% refugee or IDP (Table 5), meaning that lost infrastructure and knowledge are likely an important component of decreased productivity.

The lack of nutrition has very discernable impacts on Burundians. Nationally, 57% of children show stunting, and 8% show wasting (Rossi *et al.* 2009). Severe malnutrition rates nationally were between 1 and 4% (UNICEF 2004). A study conducted by the WHO in 2000 in southern Burundi found a 0.8% prevalence for severe malnutrition and an 8.3% prevalence for moderate malnutrition (WHO 2009). The effects are clearly visible for the patients of the Kigutu clinic as well (Table 7).

Condition	Prevalence in U5 patients
Kwashiorkor	5.0 (89)
Marasmus	3.6 (64)
Severely malnourished	11.0 (196)
Moderately malnourished	10.0 (178)
At-risk for malnourishment	16.5 (293)

Table 7. Prevalence of malnutrition in U5 patients September 2010 – March 2011. Shown as percentage of all U5s. N-values are in parenthesis.

The data show that 11% of under-five (U5) patients who visited from September 2010- March 2011 displayed diagnosable signs of severe malnutrition. This was determined by any of the following criteria: diagnosis of kwashiorkor; diagnosis of marasmus; diagnosis of kwashiorkor-marasmus; a weight-to-height ratio three standard

deviations below the mean; edema (which is considered diagnostic of malnutrition in U5 patients).

A similar percent of U5 patients showed moderate malnutrition, characterized by a weight-to-height between 2 and 3 standard deviations below the mean. In total, this means that approximately 21% of the clinic's U5 patients were considered malnourished.

This data was mapped to the area surrounding the clinic (Figure 7). There is a noticeable trend of low amount of malnutrition prevalence in patients from the far north and far south. Comparing this to the returnee map (Figure 6) confirms that areas of high returnee populations rarely visit the clinic with malnutrition issues. The geographical perspective may confirm our suspicions that lower rates of malnutrition in returnees might be due to the relatively low severity of the condition and the high cost associated with transportation to the clinic.

Interestingly, it seems that closeness to the lake (where fishing is more popular) does not seem to correlate with malnutrition rates.

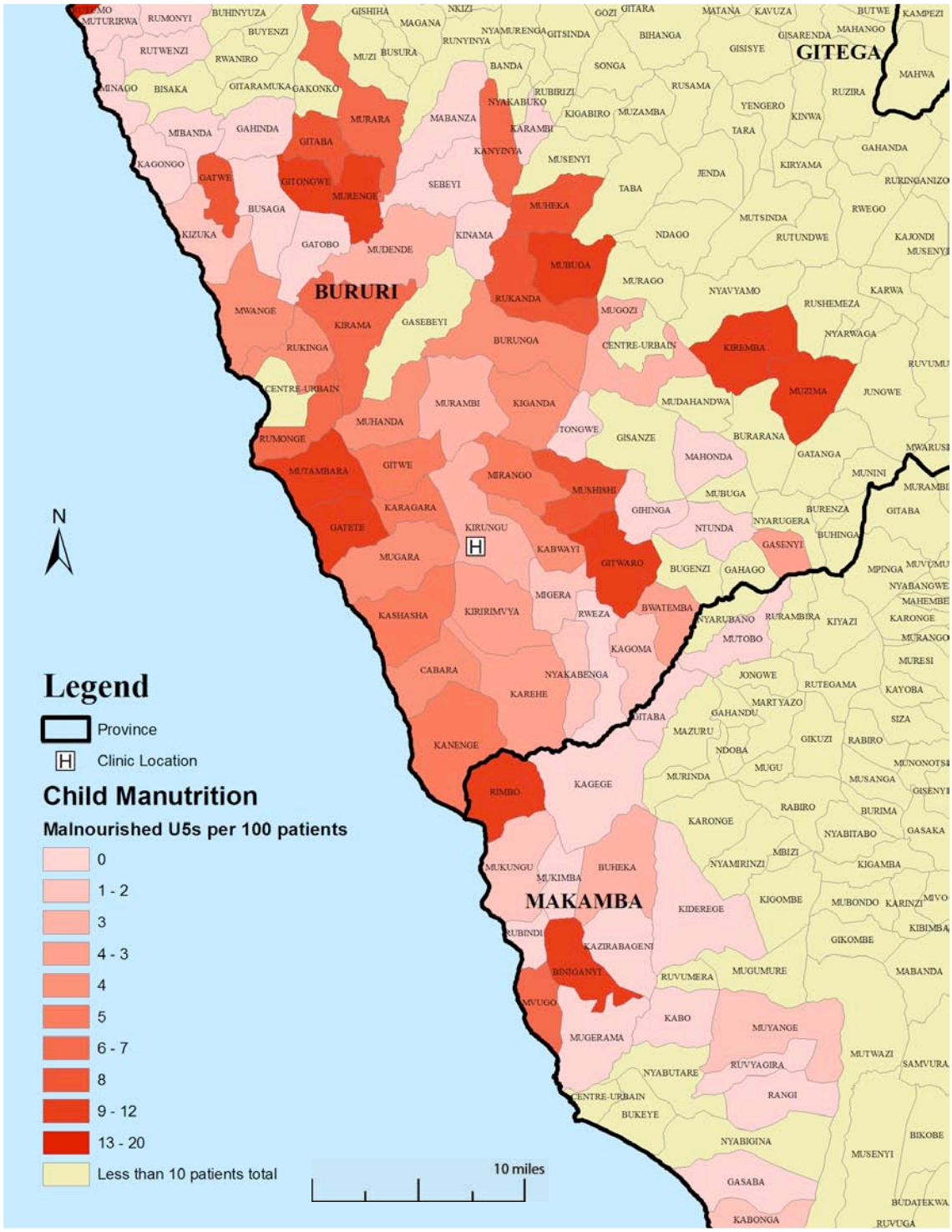

Figure 7. Malnourished patients under five years old per 100 patients per *colline* September 2010 – March 2011. "Malnourished" was defined by being diagnosed moderately or severely malnourished (defined above) one or more times from September 2010 – March 2011. *Collines* with less than 10 total patients were excluded.

4.5. Malaria incidence is highest in low-altitude *collines* near Lake Tanganyika.

Malaria is a parasitic infection that causes upwards of one million deaths per year, mostly in African children. The causative agent is a parasite from the *Plasmodium* genus. Various forms exist, but almost all cases in Burundi are caused by *Plasmodium falciparum*, the most deadly strain. It is a vector-borne disease transmitted through the *Anopheles* mosquitos. Malaria's transmission is a function of ecology and environment; it is responsive to changes in temperature, rainfall, and humidity, which all affect the formation of standing water, the breeding grounds of the *Anopheles* mosquito. Symptoms normally befall the patient within 10-15 days of being bitten. Fever, chills, headache and vomiting are common symptoms. Children often present cerebral malaria, anemia, and respiratory problems. They are particularly at-risk due to a lack of protective immunity. Treatment is often sulfacoxine-pyrimethamine. Prevention is normally focused on the distribution of insecticide-treated bed nets and the spraying of houses to prevent mosquito entrance (WHO 2011).

Malaria is one of the largest public health issues facing Burundi. In 2009, there were 1.7 million cases of reported malaria, which resulted in over 59,000 reported deaths (WHO 2009b). USAID (2010) notes that half of U5 child mortality is due to malaria, and over 60% of outpatient visits nationally are malaria-related.

Malaria is a very significant problem for Burundians surrounding the clinic. There were 1,028 cases of malaria (confirmed or suspect) in 963 patients, representing 8.9% of consultations from September 2010 to March 2011. Compared to national

statistics, this seems low. This may have to do with some shielding of the population from malaria due to the relatively high altitude and low temperature of the clinic, though mosquitos are still present. This hypothesis seems supported by data, as the areas in the hills have less cases per 100 patients than those lying near the lake (Figure 8). Talking with patients, some described how poor housing construction allowed water to accumulate within their homes and provided breeding grounds for the mosquitos. These patients noted that they and their children were particularly at risk and many were annoyed by the sound of mosquitos disrupting their sleep!

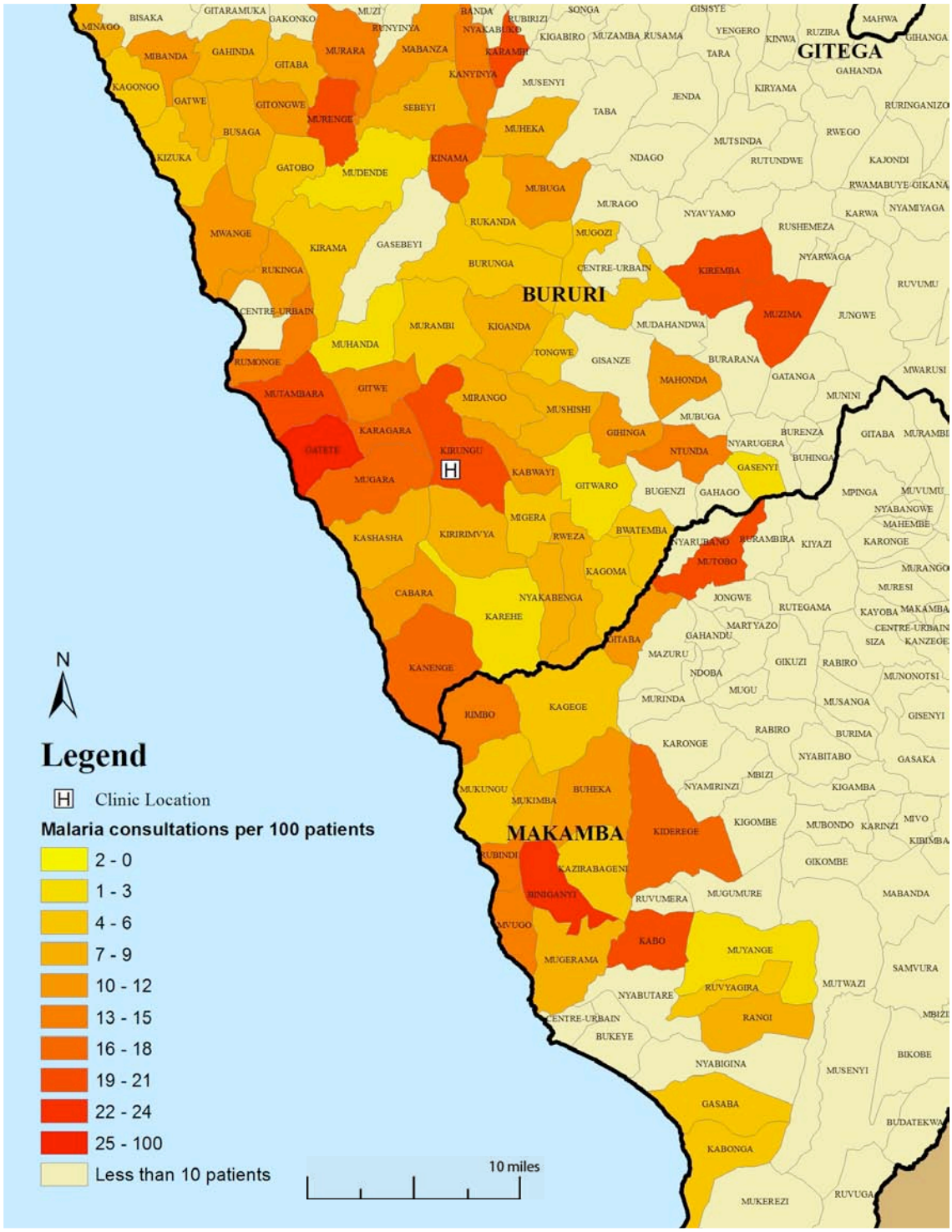

Figure 8. Malaria consultations per 100 patients per *colline* September 2010 – March 2011. *Collines* with less than 10 total patients were excluded.

4.6. HIV/AIDS prevalence may be higher near well-traveled roads.

HIV/AIDS is the number one cause of death in Burundian adults, killing 12,000-17,000 yearly. Prevalence in the general population is 3.0% overall, with 4.4% in urban and 2.8% in rural areas. Sex workers were found to have a 29% prevalence in the rural areas, and 46% in urban areas (UNAIDS 2010). UNAIDS (2010) additionally estimates that there are 230,000 Burundians living with HIV/AIDS, and that only 17,500 have access to ARVs.

The majority of transmission occurs through heterosexual contact, though in children under nine, vertical transmission is the primary form.

The overall high prevalence is likely attributable to the war as well. As Lyons (2006, 185) states, "War is one of the worst *risk milieux* for STDs. Not so frequently mentioned, however, is one of its main consequences, refugee camps, and even less mentioned are the increasing numbers of internally displaced populations." Unfortunately, Burundi is not lacking in any of these factors, and reports a higher vulnerability in rebel groups, the armed forces, sex workers, refugees, IDPs, and uneducated youth (UNAIDS 2010).

The Bururi Province has similar HIV/AIDS rates to the majority of the county. Rumonge reports a 5-9% prevalence, and Bururi as a whole reports a 1.8-2.5% prevalence (UNAIDS 2010).

During the time period studied, the clinic saw a total of 352 HIV/AIDS cases, representing 3.4% of patients. This number seems reasonable; inpatient clinic data has a

strong sampling bias since it is attended by only sick people. However, there were likely many more HIV-positive patients that were seen, but not everyone is tested for HIV unless they show symptoms, are pregnant, or ask for a test. Future studies should attempt to test every pregnant women seeking antenatal care, as this is often an effective sample to generalize from.

The HIV data were mapped to the area surrounding the clinic, along with the roads in the area (Figure 9). This map highlights the role roads may play in transmission, where the areas to the west and southwest have significant road infrastructure and higher HIV rates. This likely has to do with migrant populations moving between roadside settlements and urban areas, where HIV rates are higher. This seems to be especially true for the main thoroughfare in the area, running along the coast of Lake Tanganyika. This road provides a two hour drive to Bujumbura, where HIV rates are highest in the country. Along with public transportation, this road hosts service providers, NGO personnel, army vehicles and salesmen, all which may be involved in HIV transmission.

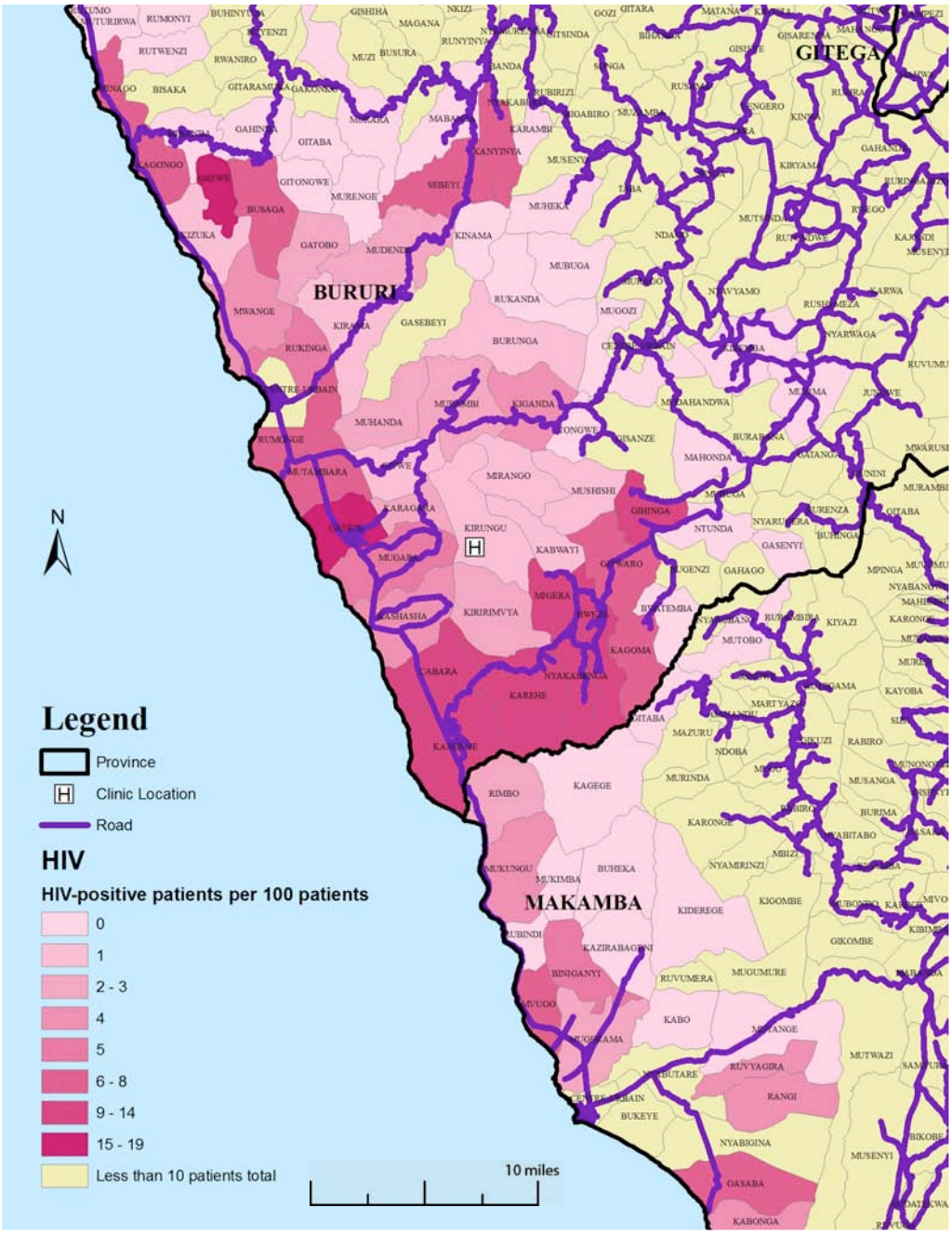

Figure 9. HIV patients per 100 patients per *colline* September 2010 – March 2011. *Collines* with less than 10 total patients were excluded. Roads shown in gray.

4.7. River or lake water as primary drinking water source is a risk factor for diarrheal disease.

Diarrheal disease is a catch-all phrase for a variety of infections that cause diarrhea, or the passage of loose/liquid stool three or more times per day. It is caused by bacterial, viral, or parasitic infections in the intestinal tract, is spread through contaminated water or food, and is often associated with malnutrition. Rotavirus and *Escherichia coli* are the two most common causative agents. Treatment includes hydration and the administration of Oral Rehydration Salts (ORS) along with zinc supplements. If left untreated, the patient will become dehydrated. They may exhibit the symptoms of loss of consciousness, low blood pressure, and high pulse (WHO 2011).

Diarrheal disease is the second highest cause of death in children under five and causes more pediatric deaths worldwide than HIV/AIDS, malaria, and TB combined (WHO 2011, IOWH 2010). This is largely due to a lack of access to clean water and basic sanitation. Worldwide, about a billion people have no access to clean water and 2.5 billion lack access to basic sanitation.

There were 1331 cases of diarrhea during the study period at the clinic, representing a symptom in 11.5 percent of all consultations. Of these 508 were in children under five. Much of this is likely due to poor water sources in the area, such as rivers or lakes which are utilized by about 16.6% of our patient population (Table 8).

Water Source	Diarrhea-affected patient	Non-diarrhea-affected patients	Total
Spring	15.4 (176)	17.6 (1190)	17.3 (1381.4)
Tap	64.5 (737)	66.4 (4488)	66.1 (5289.5)
River or lake*	20.1 (230)	16 (1082)	16.6 (1332.1)
Total	100 (1143)	100 (6760)	100 (8003)

Table 8. Patients' primary sources of drinking water in percent by diarrhea-affected status. N-value shown in parenthesis. Patients presenting with one or more incident cases of diarrhea from September 2010 – March 2011 were categorized as diarrhea-affected. Categories with asterisks are significantly different (chi-squared, $p < 0.05$).

This means that access to clean water is a major problem for many of our patients. In fact, I found that using a river or lake as your primary source of drinking water constituted a risk factor for presenting with diarrheal disease during the study period (Table 8). To further interrogate this issue, cases of diarrheal disease per 100 patients and unsafe water (defined here as river or lake water) were mapped (Figure 10). These maps can assist in planning water and sanitation projects.

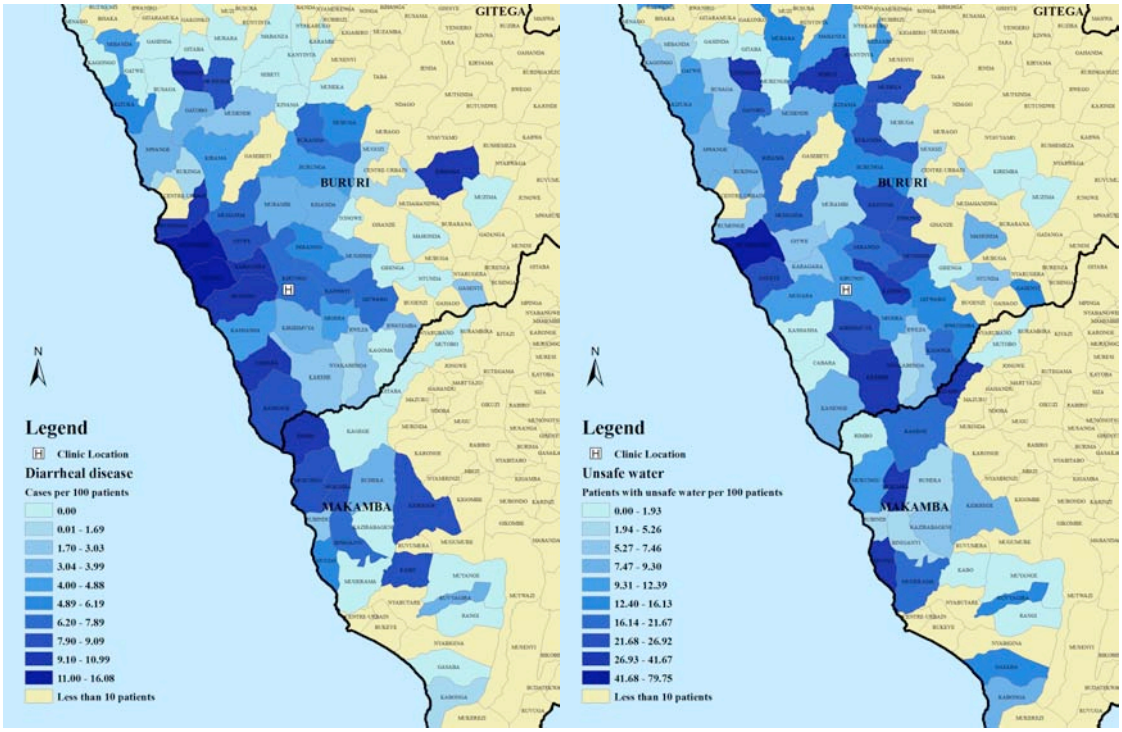

Figure 10. Cases of diarrheal disease (left) and unsafe water source (right) per 100 patients per colline September 2010 – March 2011. *Collines* with less than 10 total patients were excluded.

4.8. Tuberculosis is concentrated in densely populated areas.

TB is a bacterial infection caused by *Mycobacterium tuberculosis.* It is a serious global health threat, killing 1.8 million people annually (WHO 2011b). It is transmitted from person-to-person through coughing, sneezing, or spitting. Although billions are infected worldwide, it is often not symptomatic and is referred to as "latent TB." TB is now often associated with HIV/AIDS, as TB can become symptomatic as patients become immune-compromised. Additionally HIV-positive individuals are at increased risk of initial infection. Co-infection is often the case in VHW's catchment area, as a co-infection map shows TB cases generally coming from areas of higher HIV/AIDS prevalence (Figure 12).

The poor are often more vulnerable to TB than others. Many of the poor in the area surrounding the clinic had housing conditions that were not conducive to respiratory health. TB has been shown to be moderately linked to poor indoor air quality (WHO 2011b). One patient, an 11-year-old boy, was previously perfectly healthy, but lived in a small house with his mother and six other relatives. Cooking was done inside the small (perhaps 12"x12") structure, and a thick layer of ash developed on the inside of the roof. He developed active TB, but was treated successfully through DOTS.

TB is a significant problem in Burundi, becoming symptomatic in 357 out of every 100,000 people. In the study period, there were 68 cases of TB diagnosed, 6 of which were extra-pulmonary. Looking at the map (Figure 11), it appears that TB is

concentrated on the coast, near the main road. This makes sense as those areas have the highest density. Houses in these areas are built closely together, especially in and surrounding Gatete.

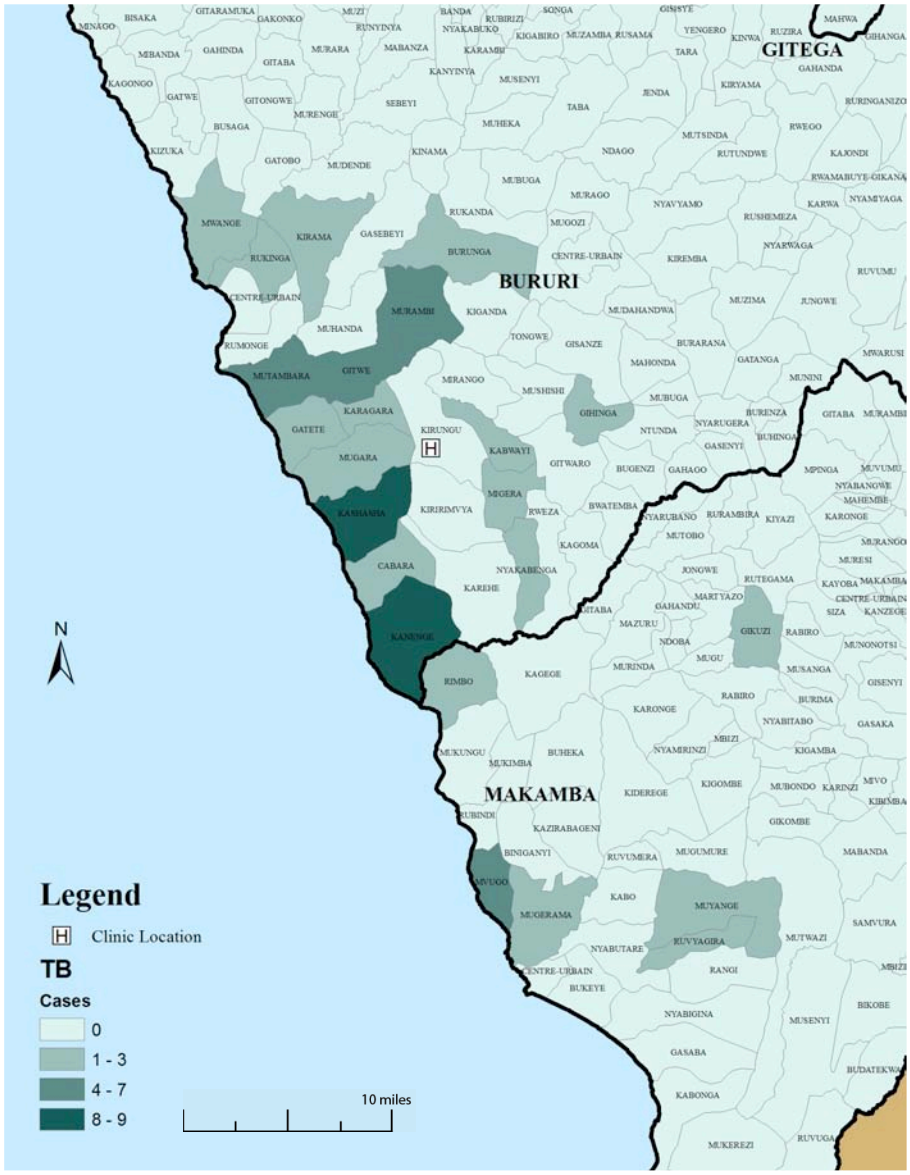

Figure 11. Cases of TB per colline September 2010 – March 2011

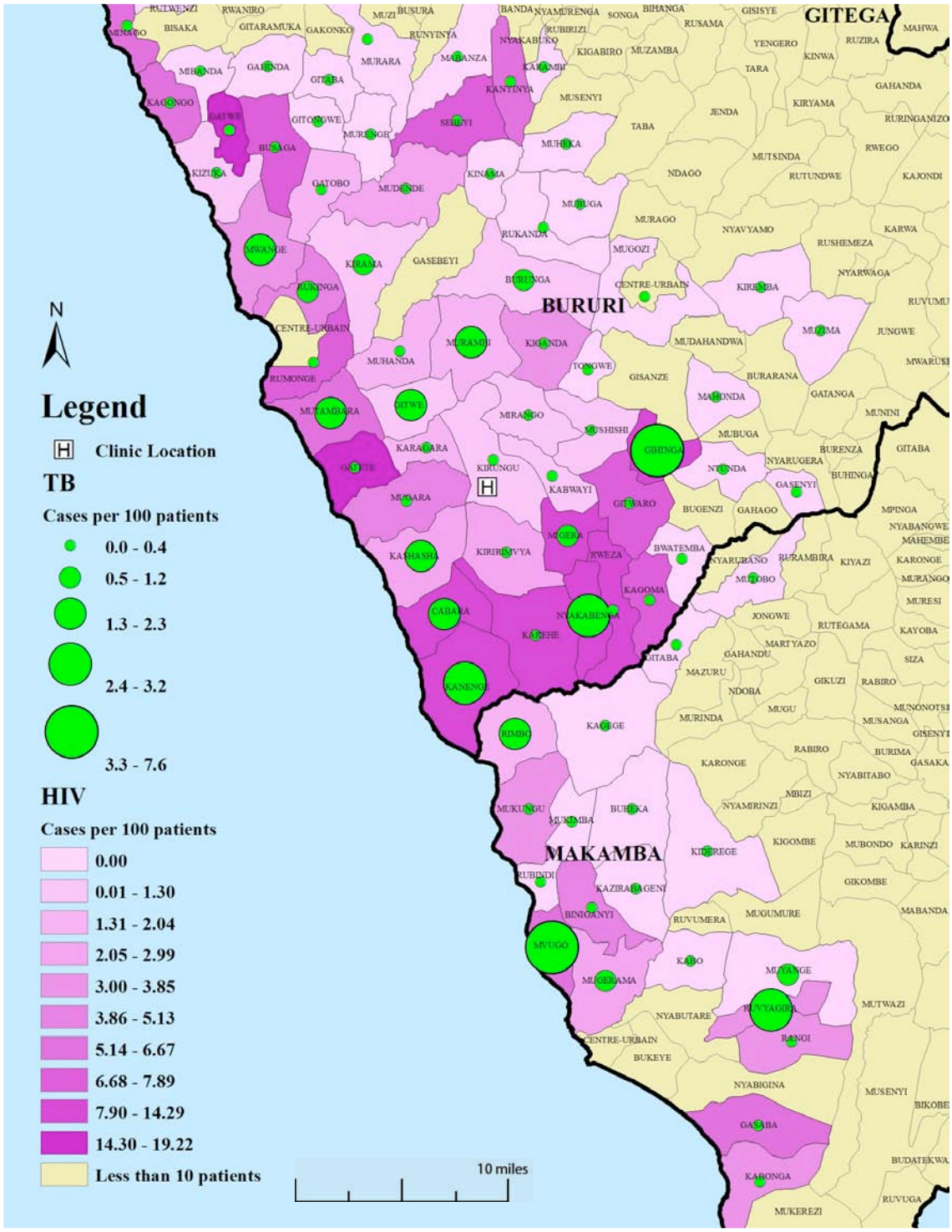

Figure 12. HIV and TB cases per 100 patients *per colline* September 2010 – March 2011.

4.9. CHW program should be expanded to the western section of the catchment area.

Using the methods discussed above (Methods), I calculated Gross CHW Need (GCN) for each *colline*. For any given colline, its GCN as a percentage of the total GCN for all *collines* represents the ideal percentage of the CHW workforce that would be assigned to cover that *colline*. I then compared that to actual CHW coverage as a percent of the whole. This was mapped as a two layer map (Figure 13).

To make a more quantitative assessment, I subtracted GCN as a percentage of the total from CC as a percentage of the whole. This gave us a *colline's* unmet need, or *Net CHW Need* (NCN). NCN represents the percentage of the workforce that should be redistributed to cover the *colline*. A positive value indicates that the *colline* has a need for CHWs, a negative value indicates it has a surplus of CHWs. Using these metrics, I were able to calculate how many CHWs should be redistributed in the current workforce and how many should be hired from each *colline* if the program is expanded to 500 CHWs (Table 9).

Additionally, I were able to map NCN. This shows the geographical distribution of VHW's hiring priorities (Figure 14). It appears that the area west of the clinic, especially to the northwest and along the coast, is in need of more CHWs. I imagined this was due to the higher rates of TB and HIV in those areas, since those diseases were heavily weighted in severity.

There are many limitations to this model, and I were forced to make many assumptions when creating it. First, our ratings of CHW efficacy are quite arbitrary. I conducted a literature review (Appendix 2), and found that CHWs were effective at

treating and preventing some disease and not others, so I assigned the efficacy values accordingly. Obviously, I cannot accurately predict and quantify this so easily. It serves as a very rough estimate.

Additionally, there are problems with using only a six-month period for the study. There could be fluctuations in patient loads during different times of the year depending on weather, work, or harvesting patterns. Abundance of patients with a specific disease might not actually indicate the amount of disease in a given *colline* for reasons discussed above.

Lastly, the severities of various diseases are additionally hard to quantify, and likely vary throughout cultures and conditions. Even with these problems, the model does serve as a quantifiable and logical way to determine CHW placement.

Colline	CC (% of whole)	GCN (% of whole)	NCN	Change in CHW for Current Program	Recommended additional CHWS if expanded
Mugara	6.84 (16)	11 (229.4)	4.2	3	51
Kanenge	3.85 (9)	10.7 (221.5)	6.9	4	51
Gatete	5.13 (12)	10.2 (212.3)	5.1	3	48
Kashasha	4.7 (11)	6.8 (141.9)	2.1	1	31
Mutambara	2.99 (7)	6.8 (140.4)	3.8	2	32
Cabara	4.7 (11)	5.4 (113)	0.7	0	24
Kirungu	5.56 (13)	4.1 (85.7)	-1.5	-1	18
Murambi	0.43 (1)	3.7 (75.9)	3.3	2	18
Gitwe	0.43 (1)	3.4 (71.3)	3	2	17
Mvugo	0 (0)	2.6 (54.7)	2.6	2	13

Table 9. Top 20 *collines* by CHW Coverage (CC), Gross CHW Need (GCN), Net CHW Need (NCN, and Recommendations for CHW Placement. CHW Coverage and Gross CHW Need are expressed as percentages of their respective wholes. N-values are in parenthesis. Recommended changes are based on unmet need (Methods).

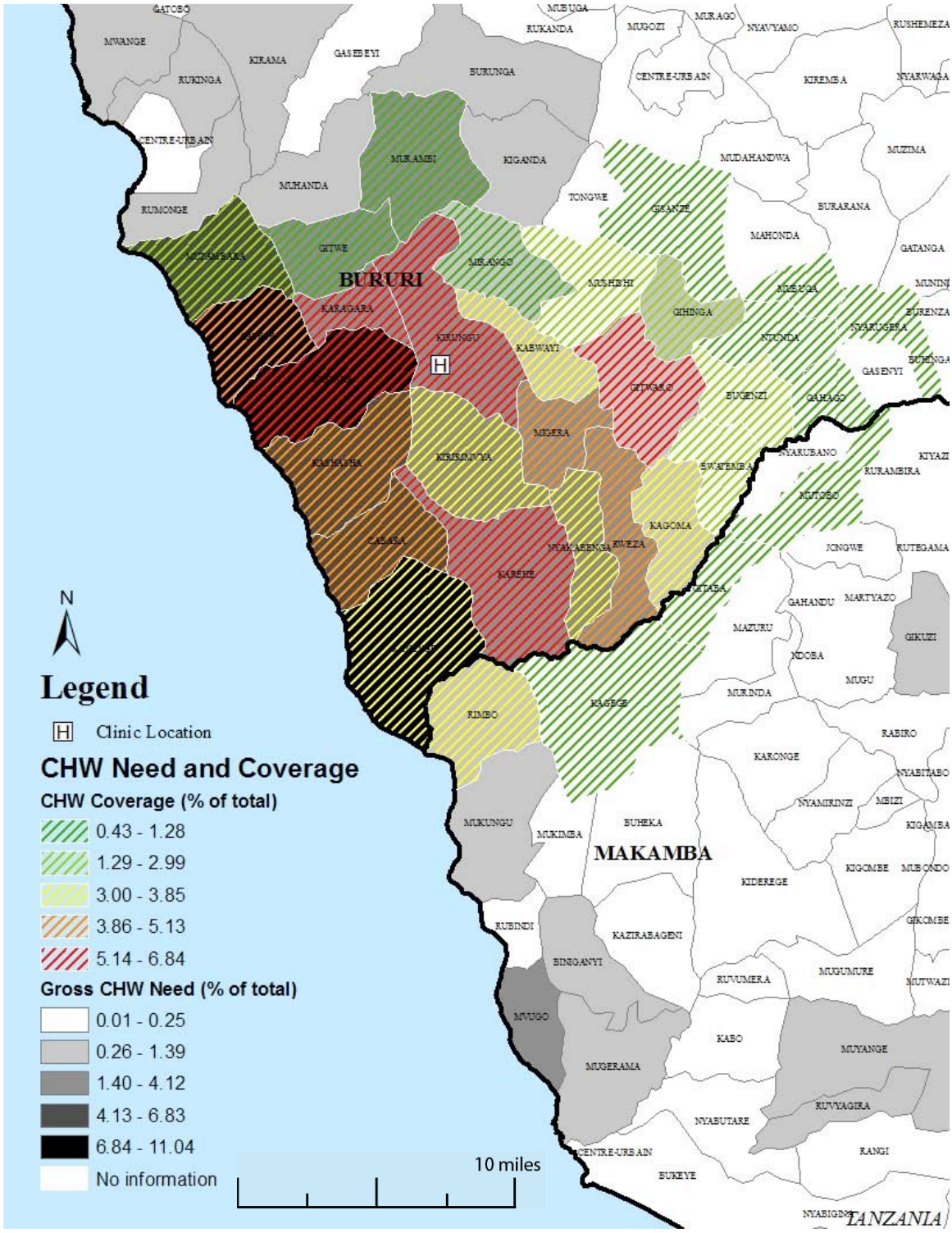

Figure 13. CHW coverage (as a percentage of the whole) and Gross CHW Need (as a percentage of the whole) based on September 2010 – March 2011 statistics.

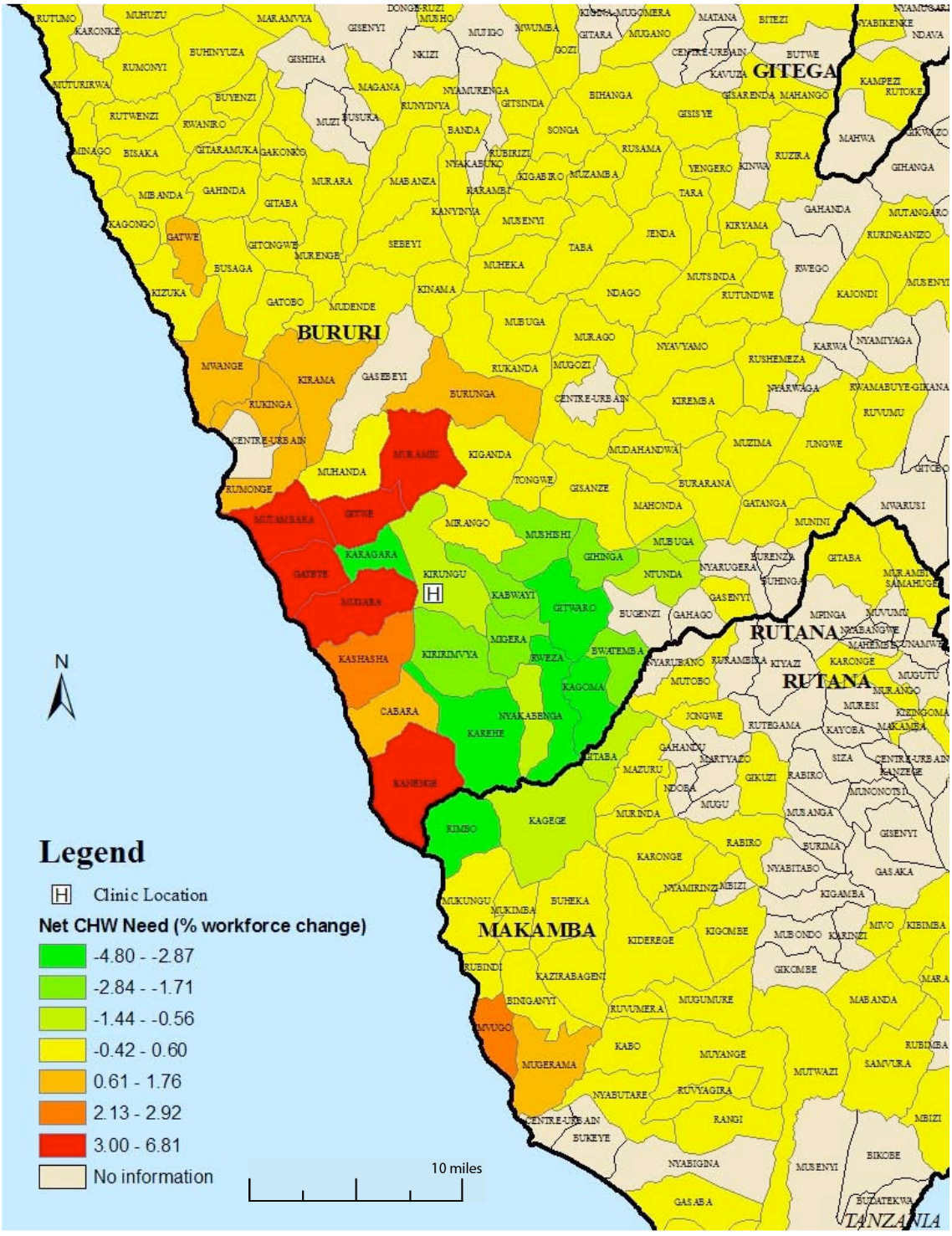

Figure 14. Net CHW need (as a percentage of workforce change). Positive values (red and orange) indicate a need for CHWs. Negative values (green and light-green) indicate a surplus of CHWs.

5. CONCLUSION

I found that the epidemiological profile of the patients was characterized by infectious disease and malnutrition. Additionally, I encountered a variety of other interesting findings, such as river/lake water as a risk factor for diarrheal disease and roads as a possible risk factor for HIV/AIDS. However, the most interesting of our findings were (1) the unexpected difference between health metrics of returnees and non-returnees and (2) the ability to create a CHW-placement model using GIS software.

5.1. Rethinking returnee health in Burundi

There is good reason to expect that returnees from refuge and internal displacement would exhibit lower health indicators than non-returnees, as discussed above. However, I found that returnees had equal or better health and demographic metrics than non-returnees. There are a wide range of possible explanations and caveats. However, it may point to a larger more unfortunate picture of conflict in Burundi in which those who remained were just as traumatized (physically, mentally, and economically) as those who were forced to leave.

Regardless of the explanations, our findings do put into question the larger initiatives focused specifically on refugee and returnee health, such as the US State Department grant discussed in the introduction. Considering that non-returnee patients under five are twice as likely to be malnourished than their returnee counterparts, perhaps the State Department should focus its efforts on overall health instead of focusing on supposed risk populations. This seems especially true for southwest Burundi, where a crippling poverty affects returnees and non-returnees alike.

5.2. GIS as a human resources for health tool

To determine CHW placement, I built a model for CHW need that included disease abundance and severity. Additionally, it included CHW's efficacy to prevent or treat various diseases. Our study proves that GIS software can effectively be used to visualize health data in a human resources context.

5.3. Future directions for research

It is necessary to adjust the geographic data collection system to address the caveats discussed throughout the paper. First, an official list of *collines* and *sous-collines* needs to be implemented into the MS Access database. Patients should be asked if they live in the urban center to avoid the *centre-urbain* matching problem (Methods).

To further interrogate the returnee health question, additional questions should be asked, such as "to where were you displaced?" or "why did you return to this area?" These sort of open-ended questions might allow for a more in-depth analysis of the returnee situation, and could be followed up with a more focused quantitative survey.

The diet data from section 4.4 was gathered from an unpublished study done by Village Health Works in 2008. It had a small sample size (around 50). It should be repeated on a wide scale, determining major food sources, income sources, and demographics.

6. EPILOGUE

This thesis left me with more questions than answers. I suggested some possible further directions in the above section, and I would like to implement those within the coming years.

I learned a lot through the course of my research for this paper. Before I went to Burundi, I had never used a GPS device. I taught myself ArcGIS for the project while I was in the field, and quickly realized what a powerful tool it can be. Additionally, I fully stretched my programming skills, as I'd never dealt with datasets of this magnitude (~500,000 data points). Lastly, in the tradition of the Clark Honors College, I feel I have explored well beyond my field of biology and into the realms of statistics, anthropology, planning, geography, and management.

Although this paper makes use of some very basic epidemiological concepts, there are many more tools that could be used to interrogate this data. This next summer, I'm joining an epidemiology lab in San Francisco to study Chagas disease in Brazil. I'm planning on learning a host of epidemiological techniques that I can use to further explore the data. I'd like to determine risk factors for the various conditions I discussed above. I'd like to learn how to "back-calculate" incidence and prevalence estimates from the data as well.

Since I am still working closely with VHW, I have full access to the research process and can recommend additional questions to be asked. This is a rare opportunity for an undergraduate with no formal public health training, and hopefully I can continue to benefit the organization by asking the right questions.

I plan on spending the next few years doing epidemiology research, then entering an MD and/or PhD program. I hope to use data from VHW throughout my studies to find more effective ways to serve our patients.

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8. APPENDICES

Appendix 1: History of Burundi

Pre-colonial history

Determining the Pre-colonial history in Burundi is no trivial matter. The more than fifty years following Burundian independence were marked with political and ethnic violence, and subsequently small progress in the areas of economic development, education, or health. However, the origins of this violence are not well understood and constitute a continuing battle, where myth and history clash between Western, Hutu, and Tutsi historians. This, combined with a lack of recorded pre-colonial history, make much of Burundi's past shrouded in mystery. As renowned historian Rene Lemachand states, "The difficulties involved in separating historical fact from fiction are nowhere more daunting than in Burundi" (Lemachand 1994: 34).

Burundi's geography is unique and important in its story. It is a small, landlocked country shaped like an arrowhead pointing south. It is extremely mountainous and it situated with Lake Tanganyika marking its Western border. It borders Rwanda to the north and Tanzania to the south. It landmass, 10747 square miles, is roughly the same as Maryland (Kreuger 2004). The climate is tropical -- very humid and warm at lower altitudes but cooler at higher levels, with mountains exceeding 9000 feet in height. The climate and geography made Burundi a very fertile area, producing large crop yields, while the hilled populations were isolated from malaria. Ultimately, these resources allowed for a quick growth in population, and now

Burundi is one of the most densely populated nations in Africa (Watt 2009). This has caused significant soil erosion and once-fertile areas now lay unplanted.

Although the official language is French, very few people outside of Bujumbura speak French. All are fluent in Kirundi, which is very similar to Kinyarwanda. The southern half of the country has a significant amount of Kiswahili speakers because of influence and migration to and from Tanzania.

Ethnicity is a defining theme in Burundian history, and it is normally more complex and subtlety-ridden than most nations. The ethnic makeup of Burundi consist of Hutu, Tutsi, Twa, and Ganwa. Although no accurate census data has been collected for over 80 years, it is estimated that about 85% of the population is Hutu, 14% Tutsi, while less than 1% are Twa or Ganwa. However, it has been suggested that over 70% of Burundians are of mixed ethnicity (Watt 2008). Additionally, as I shall see, ethnicity is rather fluid and poorly defined.

The generally accepted pre-colonial history includes an initial settlement by the Twa, or pygmie people, latter to be overrun by Bantu migrants (supposedly forming Hutus) from the west. From where or when the Tutsi people entered Burundi is hotly contested. Many have claimed that Tutsis entered the nation after Hutu settlement and came from the North, bringing cows to Burundi.

The kingdom of Burundi was started by Mwami Ntare Rushatsi around the year 1680 (Watt 26). The seat of the kingdom was in the central plateau of Burundi. Although the defining lines of the Burundian kingdom changed to some extent over time, it was more or less a similar size and shape as it is today. The royal class was

made of a unique ethnicity called Ganwa. The Ganwas allowed Tutsis and Hutus some high-up positions, such as guarding the royal drums (a large part of Burundian culture). Tutsis, who were generally pastoral, served higher positions in government. The Twa served as musicians and dancers for the royal court. These positions were not obtained by right, but were the result of enough skill or hard work that people from one ethnic group were able to re-identify with another ethnic group. This was often possible for Hutus with significant wealth, being able to undergo *kwihutura*, or de-hutuization (Watt 2004).

Renee Lemarchand takes a unique stance on the history of ethnicity in Burundi. He argues that these ethnicities are much less pronounced than the "tribes" of other nations. Indeed, Hutus and Tutsis speak the same language, dance the same dances, and intermarry. Some claim there are phenotypical traits that differ (Tutsis having long, thin bodies and Hutus having short, stalky bodies), but exceptions abound. Even the Tutsi president Boyoya was once almost killed for being mistaken as a Hutu!

Since such ethnicities have little to do with culture or appearance, Lemarchand argues that the terms refer more to a traditional social order. In fact, Hutu's root comes from the Bantu word for "social son" (10). This ties in with Burundi's long history of gift-giving and culture of client relationships. The feudal-like contract was made between a poorer individual (a "Hutu") to a more wealthy individual (a "Tutsi") through a gift of cows, land, or women. This gift-giving was a form of social order and control. Kirundi even has specific verbs for "to give a gift then to take it back" and "to show appreciation for a gift from a superior." (Lemarchand 1994, pg.11) This "social

harmony" allowed for a consistent social order in pre-colonial Burundi. The majority of tension over rule came between specific Ganwa princes, battling over the throne (Lemarchand 1994, pg. 37). The Ganwa thus attempted to garnish support from Hutus and Tutsis, and maintained many Hutu elements throughout the royal traditions. Court ritualists and healers were largely Hutu. Thus the Ganwa ruling class served as a unifying force in the nation, preventing radical polarity. The entrance of colonialism changed this order.

Additionally, the idea of family status or clans was important, especially among Tutsis. The Banyaruguru (composed of the Bezi and Batare sub-clans) and the Bahima displayed tension which would later be responsible for significant amount of violence.

Colonialism in Burundi

The colonial powers used the social system they found to control the populace, and in many ways changed and escalated the ethnic tensions. Germans captured Burundi and present-day Rwanda and ruled "Ruanda-Urundi" from 1904 to 1916, ruling through the King and his Ganwa Princes (Watt 28). When the Belgians took over in 1916, this style of indirect leadership continued, with some changes. Although theoretically ruling Ruanda-Urundi under the mandate of the League of Nations, it was still a *de facto* colony (Watt 28). From the 1920s to 40s, the Belgians broke administrative districts up and reformed them, including many areas under Hutu control. By 1945, only 35 of the original 133 chiefdoms existed, and none were controlled by Hutus. Economic and natural disaster pushed some rural communities to act out violently, killing Tutsi, Ganwa, and Europeans (Lemmarchard 1994: 51). Watt (2008) argues that the Belgians

integrated their observations in Burundi into a preconceived model of racial theory that was popular in Europe at the time (these theories would have been particularly germane to Belgians considering the French-speaking Walloons were oppressing the peasant Flemish). Additionally, poor Belgian historiography methods (leaning largely on the reports of one Tutsi close to the Belgian lead civil servant) led Belgians to believe that Tutsis were decedents of Ham, the son of Noah. Their supposedly fairer skin and thinner features were thus evidence of a distant relation to Ethiopian and Caucasian roots. This "Hamatic myth" became the official narrative of the Belgians, allowing justification for their preference of Tutsi leaders.

In Rwanda, a Hutu-led revolution occurred from 1959-1962, forcing hundreds of thousands of Rwandans into Burundi. Although Rwanda's situation was quite different and had a much longer history of polarization, some of the concepts and language used to justify the Hutu's massacres of Tutsis was imported into the Burundian psyche.

After the Second World War, the United Nations was formed and Ruanda-Urundi became a Trust Territory under Belgian administration, and pre-independence elections were held. In 1948, two political parties emerged in Burundi: Christian Democratic Party (PDC) and the Union for National Progress (UPRONA). The PDC was led by a notoriously pro-Belgian constituency of Batare Tutsis. Uprona, however, offered a promising nationalist candidate, Prince Louis Rwagasore. Rwagasore, the son of the last king, was vocally pro-unity. Although Tutsi, he had married a Hutu and had a characteristic Hutu appearance that solidified his popularity (Lemarchand 1994). The Belgians distrusted this nationalist with "pro-communist, anti-Belgian" leanings.

Rwagasore was elected in Burundi's first democratic elections and was killed three weeks later, in 1962, by a PDC-funded assassin. Lemarchand suggests that Belgian administrators were involved or at least turned a blind eye before the assassination.

Post-colonial Burundi

Rwagasore's death was a great tragedy for ethnic unity in Burundi, and set the stage for the coming years of conflict. Hutu and Tutsis fought over power over the next four years. In 1965, a Hutu Prime Minister was killed by a Tutsi immigrant. Most of the Hutu leadership was killed in an abortive coup in Bujumbura. In 1966, Capitan Michel Micombero from the Hima clan of Bururi province removed the monarchy and declared a republic, though it was in practice a military dictatorship. Micombero is generally regarded as the worst of Burundi's leaders, developing a National Revolutionary Council to run the nation and excluding all Hutus from the army.

This repression came to a head in April of 1972 and resulted in Burundi's first genocide. It began in Rumonge, 10 miles northwest of the Kigutu clinic, where 300-500 Hutus seized control of the armory and radio station, killing thousands of Tutsis in the process. The reprisals by the Burundian government were harsh. Nearly every educated Hutu was killed, especially in the Bururi and Makamba provinces (Lemarchand 1994). The army would steal vehicles and go directly to secondary schools to kill the educated students. Lemarchand calls this an attempt by the Tutsi elite not only "decapitate a potential counter-elite but to spread terror throughout the entire Hutu community and thus create an enduring sense of fear and submission among the living and the unborn--in short, to teach a lesson that would be remembered by generations to come"

(Lemarchand 1994:102). An estimated 200,000 Hutus were killed, and 150,000-300,000 fled the country, mostly to Tanzania or Rwanda (Watt 2008).

The next 15 years were characterized by harsh Tutsi military dictators, such as Jean Baptiste Bagaza and Pierre Buyoya. Under Bagaza (1976-1987), Hutus were excluded from schools. He implemented a family-planning program which frightened Hutus and appeared to many as a eugenics policy. Buyoya (1987-1993) had a somewhat more progressive policy, eventually acknowledging the Hutu political parties, Frodebu and Palipehutu. In 1993, a real election was held, with Buyoya as the Uprona canidate, and a charismatic Hutu named Melichior Ndadaye. In Burundi's second democratic elections, Melichior Ndadaye won and became President in June 1993. He changed the face of the government, integrating Hutus into top positions.

By October, Burundi's experiment with Hutu-led democracy was over. Ndadaye, along with most of the Hutu leaders, were assassinated in October 1993 by the Tutsi-controlled army, sparking a 13-year conflict. Krueger (2007) claims that the assassination was orchestrated by Buyoya. Within the first few days, Hutus attacked Tutsis throughout the countryside, killing upwards of 50,000. An interim puppet president was appointed, Hutu Cyrien Ntaryamira, who in 1994 joined Rwandan President Juvenal Habyarimama on an infamous flight home from Tanzania. The flight crashed, igniting the notorious genocide in Rwanda, and flaring the violence in Burundi. Buyoya stepped in as President though a *coup* in 1996. Bujumbura and upper leadership of the political parties attempted peace agreements, however war raged in the

countryside. In total, about 300,000 were killed, and upwards of 1.7 million displaced, mostly to Tanzania (UNHCR 2009, IFRCRC 2006).

During the war, two main Hutu rebel groups formed. The first emerged from the Hutu political party Frobedu and was called the Nation Council for the Defense of Democracy and its armed wing, the Front for the Defense of Democracy (CNDD-FDD). The second was formed from Palipehutu and called itself the Front for National Liberation (FNL). During peace accords at Arsusha, Buyoya agreed to hand over power to Hutu Domitien Ndayizeye in 2003. In 2005, the CNDD-FDD signed a peace agreement, and former CNDD-FDD solder Pierre Nkurunziza was elected President. In April of 2006, the FNL signed a peace agreement, officially ending the civil war. Nkurunziza won the 2010 elections and is the current President.

Appendix 2: CHW Programs

HISTORY OF CHW PROGRAMS

Community Health Worker programs are an essential functioning component of many nation and local public health programs in both developing and developed nations. CHW programs have been shown to make measurable differences in community health outcomes and provide medical access in areas that otherwise would receive no treatment.

The idea of healthcare workers has been around since the inception of humankind. Throughout the history of Egypt, Mesopotamia, China and India, one sees the appearance of healers -- specialized workers who claim to use their tools and

knowledge to remove the signs and symptoms of disease. However, the majority of early practice was largely theoretical and lacked backing evidence.

It is widely regarded that Greek physician/scientist Hippocrates is the "father of modern medicine." During his lifetime *(*about 460 BC – about 370 BC), he argued that diseases had a scientific, environmental cause and that the study of treatment was separate from the study of religion. Hippocrates' theories on medicine became what is now referred to as modern medicine, Western medicine, allopathic medicine, or biomedicine. Many of the jobs once fulfilled by untrained healers are now undertaken by practitioners of allopathic medicine.

Unfortunately, this type of treatment did not spread quickly to all areas of the world, and some traditional healers exist in almost every context. Traditional healers use methods such as herbalism or spirituality to solve medical issues. In many cases, these healers are a vital part of the religious, cultural, and social functioning of communities. CHWs, in comparison, are trained in modern medicine (although some can be trained in both paradigms). They generally promote evidence-based, allopathic treatments supported by physicians. These CHW have been referred to as 'family welfare educators', 'health promoters', 'health volunteers', or 'village health workers" (Frankel 2).

CHWs have become popularized in many developed areas because of the rising cost of treatment by physicians and the migration of medical practitioners to urban centers. In other less-developed-areas, medical practitioners never had a foothold in rural areas,

and their relatively new appearance in urban centers is growing outward with the assistance of CHW programs.

The largest CHW program in modern history was undertaken by the People's Republic of China, originally starting in the 1950's. Chinese leader Mao Zedong announced their official formation in 1965 as a response to Western, "imperialist," medicine. The barefoot doctors served populations of 400 each and had training in first aid, traditional techniques, family planning, health education, immunizations and some environmental supervising (Silver 1975). They normally had graduated from secondary school and had undergone a three-to-six month training in these techniques (Silver 75). They were paid about half of the salary of a fully-trained physician (Zhang 2008: 1865). However, some "affirmative action" was made to include the rural poor, sometimes allowing middle-school graduates entrance into their medical programs. Mao encouraged these barefoot doctors to walk "with two feet," meaning to incorporate modern medical techniques with traditional Chinese methods. His foci were prevention before treatment, an emphasis on the poor and rural; and integration with Communist party activities. The program ended in 1985, with the barefoot doctors either joining other professions or attending longer formal medical programs. It's been noted that the transformation to "village doctors" led to a larger focus on treatment and a decline in focus on public health (Zhang 2008: 1866).

Some of these aspects were eventually realized to be positive by those in Western practices such as valuing the roles of the elderly, using familiar treatments, letting non-physicians focus on primary care, and focusing on the rural poor.

The definition of the "Community Health Worker" was first clearly designated at the 1986 Yaounde Conference. They were defined as "members of the community where they work; should be selected by the communities; should be answerable to the communities for their activities; should be supported by the health system but not necessarily a part of its organization; and have a shorter training than professional workers' (WHO 1987).

After the growth of nations, federal governments used community workers for a variety of other projects, such as agricultural outreach or community development. The first major recognition of the powerful role of community health workers occurred at the 1978 International Conference on Primary Health Care at Alma Ata. The popularity of CHW programs can be accounted for by a few things. First, coverage -- having a community member there to connect with citizenry. The low cost of training and implementation allows for large spread.

Secondly, CHW programs recognize the limitations of biomedical-only interventions. Health strategies that incorporate the social, environmental, and political context in which health occurs are much more effective at producing positive health outcomes (PHO).

Seeing CHW in the dual manner is important to understanding their effectiveness. They are not only the practitioner, expanding basic but life-saving healthcare services to areas that were formerly uncovered, but they are also the recipients of treatment and can therefore work synergistically to tackle the more root causes of disease.

REVIEW OF OTHER CHW PROGRAMS

Ethiopia

Although some argue that Ethiopia is a potential candidate for Millennium Development Goals fast-tracking, they still have some of the worst health statistics in the world. The majority of its Community Health Workers are part of the ambitions national Health Extension Program (HEP), where they are referred to as Health Extension Workers (HEW). The HEP was founded to cover the lack of primacy health care access due to a dearth of practicing healthcare professionals in Ethiopia. The HEP was founded in 2003 and aimed to have two HEWs for each health outpost that serves a population of 5000 (3). By the end of 2007, over 17,600 HEWs had been trained. (Herman). HEWs are female, must have a high school education, and undergo a 1-year training program. They are members of the community in which they serve. The training covers a wide variety of subjects, including latrine construction; STI, TB and malaria control; first aid emergency measures; family planning; immunization; nutrition; reproductive health; and hygiene.

Ghana

The Ghana Health System takes a unique approach to CHW programs, using a more highly-trained worker to serve a larger population and employing volunteers to assist. This program began in 1999 with the creation of the Community-based Health Planning and Services (CHPS) program. It is similar to Ethiopia in many ways. The original CHWs in Ghana receive 2 years of training and are referred to as Community Health Officers, or CHOs. In a similar fashion to Ethiopia, CHOs serve a population of

4500. The program is initiated by district health managers, and 53 districts have implemented the program, providing 310 CHOs. The goal is to reach 5280 by 2014 (Aquatah 2006) CHOs operate a small Community Health Compound (CHC). The CHC is normally open one day per week and contains a refrigerator for medication, an examination room, and one to two other rooms with beds for patients. There is a separate building for the CHO to reside in. Some larger CHC might have state-registered nurses for more complex cases. The CHO is directly responsible to the 4,500 patients in his or her catchment area. Additionally, a group of volunteers health workers is selected by the community to assist the CHO (GHWA 2008).

Rwanda

Rwanda's CHW program is based loosely on the CHW model implemented by Partners in Health (PIH), and is most similar to the current CHW program being implemented by VHW. Before the Rwandan involvement with PIH, they designed their own CHW program focused on village volunteers. Each village (of about 100-250 households) selects four CHWs. Two are called *binomes* and do mostly case identification; they search for people displaying common disease such as malaria and pneumonia and refer them to a health clinic. Another CHW serves as a maternal health worker, making sure pregnant women have access to maternal health services. Lastly, there is a CHW in charge of social interactions in the community and creating reports on community health. Additionally, if the village is working with the cooperation of a PIH clinic, they are assigned two additional CHWs focusing on infectious disease

treatment and prevention. The CHWs are trained over a week-long session. CHWs receive payment in a performance-based form through cooperatives.

BEST PRACTICES

It has been suggested that six areas are important for the success of CHW programs: selection and inspiration; initial training; guidelines and protocols; supervision, support and relationship with the formal health services; remuneration and structure; and political support (Herman). Herman suggests two other criteria (alignment with institutional strengthening, and flexibility with changing society) which I think are somewhat out of the scope of this thesis.

Selection and Inspiration

It has been established that successful CHW programs choose CHWs from the populations in which they serve, and that they choose the most motivated candidates. Oftentimes, persons living with HIV/AIDS (PLWH) are ideal choices because they are motivated and have an understanding of the difficulties of living with HIV/AIDS (Herman). However, sometimes the physical demand of work are overwhelming, especially considering the many miles CHWs are required to walk on a consistent basis. In Ethiopia, HEWs are chosen by the elders in the communities which they serve. I was unable to find any indication that they preferred PLWHs.

In Ghana, CHOs are not selected by the community, and are not a part of the community. This often leads to a high attrition rate, and most CHOs don't serve for more than three years at the post. Since they are not from the chosen community, they spend most of their time away from the spouses and families, which proves difficult. It

is additionally difficult to recruit unmarried individuals because they are looking to find spouses in their communities. Considering there is over a two-year investment in the training of these CHOs, this seems like a vital drawback (GHWA 2008).

In Rwanda's program, CHWs are elected via a democratic process by the community. They had to be literate and be well-respected by the community.

Initial Training

Training should be wide and focus on the ability of CHWs to effectively communicate with their patients. Obviously, there is going to be a wide variation throughout the health world on the level of training. However, training in the basics of hygiene, infectious disease, and HIV/TB treatment is of primary importance, followed by family planning, nutrition, and first aid.

In Ethiopia, HEWs receive a year of initial training in a wide variety of skills. This may explain some of the program's success, but also is an expensive option that most states and NGOs are currently unable to take.

In Ghana, CHO training is beyond most other programs. The MOH operates six regional community health nursing training schools (CHNTs) in addition to the four national training schools where CHOs are trained over a two-year period. The goal is to keep CHNTs in rural areas to avoid losing medical talent to urban areas. However, these CHNTs are overcrowded and lack needed resources (fiscal and otherwise). Additionally, the MOH has put together training programs for the local health volunteers and communities (GHWA 2008).

CHWs undergo a one-week initial training in basic health matters. There are modular course which CHWs undergo that are chosen by each specific clinic.

Guidelines and Clarity

CHW programs need to use simple, effect protocols to delineate which tasks are undertaken by CHWs, and which are undertaken by more qualified professionals. Often CHWs are assigned to many tasks and are unable to complete them, or have a varied history of success (Herman).

CHWs in Ethiopia are given a very large set of skills, but may not be in a position to use all of them. Their mission may be compromised by their overburdened load.

In Ghana, CHOs are additionally potentially overburdened. Guidelines for incentives are poorly understood. Acquah (2006) reported concern that CHOs were overworked and that stress from lack of interaction with family was placing them under undue stress.

Matthews (2008) argues that CHWs in Rwanda are often overburdened and unclear on what to do. There is a "tension between the empowering benefits of becoming a CHW and the costs of undertaking the role as a volunteer" (pg 6). Additionally, CHWs were unsure how to handle the balance between biomedical practice and traditional healing techniques.

Support from Formal Health Sector

Support comes in a variety of fashions, but can be broken down into: supervision, training, supplies, and social support. Supervision is a key component to

the functioning of the system by making CHWs accountable. Continued training, or "refresher courses," are needed in many cases since CHWs are not formally trained in health or medicine and are often overwhelmed by the amount of information they are required to learn. Supplies, such as medication, diagnostic tools, and sanitation tools are vital for CHWs to complete their mission. Additionally, more basic supplies such as clothing, notebooks, and pencils are required in settings of extreme poverty. Social support is an important aspect in maintaining both the quality of care and the retention rate. Evidence suggests that professional health care providers often look down on the lesser-trained CHWs and do not provide the team cohesion necessary for an effective program.

In Ethiopia, HEW are given a large amount of support from the formal health sector. Each HEW is assigned to a specific health outposts, and they receive supervision and support from both the local health outpost and the federal office (Herman). However, it as noted that the health outposts are often lacking in supplies (HEEC 2007). In Ghana, the CHOs are lower-level nurses, so in some sense are a part of the formal sector. Many have experience in hospital settings. There are no physicians at the community health compounds. Complex or urgent cases are referred to the sub-district hospital.

In Rwanda, each CHW program is linked with a specific clinic, and each CHW group has a specific person in charge of reporting progress.

Remuneration

Although some argue that CHWs should serve as volunteers, the most effective programs have shown that paying CHWs reduces turnover and increases participation by free up time that would otherwise be spent at another job or in agriculture (Herman). Additionally, Farmer (2001) argues that paying CHWs in a human rights issue. Additionally, its been argued that career structure and potential for advancement may place a role in improving CHW motivation and decreasing attrition.

HEWs in Ethiopia have the opportunity for advancement into a nursing position. Remuneration is less than that of a formally-trained health care professional.
In Ghana, CHO is a well-respected title. One must become a Community Health Nurse before receiving a promotion to CHO. They are well-compensated. However, each CHO has at least two non-paid volunteers at the Community Health Compound. One is a community-based volunteer who conducts disease surveillance and offers assistance for the outreach components of the CHOs' work. The other is somewhat of a nurse aid, assisting the CHO in patient care, facility maintenance and security for the compound. Retention has not been good in these programs since little clarity has been made about the exact role of volunteers. Some of the community groups have offered to assist the volunteers with agricultural work, but coverage has been inconsistent (GHWA 2008). Remuneration is the primary problem preventing full-scale success of Rwanda's CHW program. CHWs are given a very large mandate but are not paid and often first tend to work and agriculture-related manners first. They receive bicycles and cell phones, in addition to a "community remuneration fund," but it does not suffice. Matthews (2008)

reports that CHW obligations were nearly a fulltime commitment, and that direct payment was the only way to make Rwanda's problem sustainable.

Political Support

Support from the government is needed to assign tasks to different healthcare workers and provide the political capital and financial resources to allow for the program's existence (Herman).

In Ghana, the Community-based Health Planning and Services program was started in 1999 as part of a 16-year plan to turn Ghana into a middle-income country by 2015 (GHWA 2008).

I have no information about the political support of VHW's program.

Appendix 3: 50 most-used diagnoses

Diagnoses	Occurences
Intestinal parasites	1845
non-Pylori gastritis	830
Moderate malnutrition	826
Urinary infection	586
Confirmed uncomplicated malaria	568
Pregnancy 3rd Trimester	444
Pneumonia	431
Arthritis	426
Pain	410
Suspected uncomplicated malaria	374
Influenza-like illness	367
Gastritis H. Pylori	335
STI flow	255
Pregnancy 2nd Quarter	231
Pneumonia	229
Marasmus	209
Controlled hypertension	206

Conjunctivitis	202
Dermatosis	196
Allergy syndrome	179
Ulcerative syndrome	175
Scabbies	170
Lower back pain	156
Severe malnutrition	151
Anemia	148
Kwashiorkor	140
Neuropathy	137
STI	128
Dermatitis fungal	125
Gastroenteritis	125
Hypertension	125
Acute Bronchitis	122
Tonsillitis	121
HIV / AIDS	116
Uncontrolled hypertension	109
Asthma	106
Diabetes	98
Epilepsy	88
Pregnancy 1st Quarter	65
Pulmonary TB	62
Paresthesia	57
Headache - Migraine	54
Vaccination	53
Confirmed severe malaria	52
Ringworm	51
Purulent otitis	50
Rhinitis	50

Appendix 4: Mental Health of Refugees and Returnees

Additionally, refugees suffer from significant mental health issues that often go untreated. Fox and Tang (2000) found that 49% of the refugees living in the Gambia (displaced by civil war in Sierra Leone) were in the clinical range for PTSD on the

Harvard Trauma Questionnaire. Jong et al. found approximately 50% of Burundian and Rwandan refugees in Tanzania to have detectable psychopathology. Beyond the trauma associated with torture, violence, and rape, refugees suffer from often neglected psychological stressors, such as loss of social networks, isolation, unemployment, loss of social roles, lack of "environmental mastery," and poverty-related stressors (Miller and Rasco 2004).

Additionally, political violence is uniquely destructive, as it can "foster attitudes of distrust and hostility, destroy previously supportive social relations and undermine faith in social institutions and organizations" (Miller and Rasco 2004). This is particularly true in a nation that has had a polarized ethnic tension for over 30 years. Additionally, rape and gender-based violence often destroy the social fabric of communities by producing trauma, unwanted pregnancies, "children of rape," and stigmatization.

These mental health issues go entirely untreated in Burundi, where not a single registered psychologist or psychiatrist operates, and VHW offers no mental health services (Kidder 2009). Even if clinical mental health services exsisted, Western biomedicine offers little assistance to many of these stressors, which are largely community-related. Miller and Rasco (2004, pg 1) say it best:

> "[The clinical] model emphasizes the provision by highly trained professionals of clinical-based services such as psychotherapy and psychiatric medication. The focus is on healing or ameliorating symptoms of psychological distress within individuals, with little attention paid to mending damaged social relations within communities, or to strengthening naturally occurring resources within families and communities that could facilitate healing and adaptation."

Miller and Rasco (2004, pg 3) suggest there are major downsides to current clinical approaches: (1) refugees have little or no access to mental health professionals, (2) most biomedical mental health models are "culturally alien" to non-Western societies and (3) clinical services do not ameliorate "displacement related stressors." They suggest an alternative mental health treatment model, a paradigm of "ecological community psychology." The ecological framework they suggest is comprised of six guiding principles: (1) psychological problems are often related to people inability to adapt to their environment, while community psychology focuses on helping people adapt or changing the environment; (2) inventions need to be driven by the communities themselves; (3) prevention should be preferred over treatment; (4) local understanding should be integrated into any intervention; (5) interventions should be integrated into already existing social resources; and (6) a focus on capacity-building.

This ecological, community framework may fit at VHW to help guide the healing process. Community psychology may be able to "heal damaged relations within communities so that basic conditions of trust and openness are present" by "facilitating the creation of social networks" and creating "settings within which community members can discover meaningful roles and role-related activities, and carve out new life projects to take the place of those left behind" (Miller and Rasco 2004, pg 27).

To some extent, these principles are already in practice at VHW. The women's committee is an essential guiding component of the clinic. The completion of the community center and the incorporation of language, drumming, singing and computer classes is likely making large strides in facilitating the community healing process.

Continued community support and work on the project, such as the road construction, force formally opposed populations to work together on a common goal. However, the program should be expanded, and I discuss this in Appendix 4.

Appendix 4: Qualitative Recommendations

By reviewing the history and best practices of CHW programs across Africa, a set of recommendations was accumulated. Overall, VHW's CHW seems to be a strong program, effectively covering the areas needed for HIV and TB treatment. However, the mechanics of the program should be improved as VHW prepares for a large increase in CHW numbers. Four changes would significantly improve the program:

First, VHW should implement a more variable remuneration strategy. Results from the survey (Table 7) show that some CHWs have to walk 5 hours to get to the clinic, and up to an hour and a half for their longest patient. Currently, CHWs are paid by their patient load, as described in chapter I. However, after this survey and talking to CHWs, it became clear that some CHWs would spend ~5 hours per day distributing medication, while others would spend less than one hour. In many cases, these CHWs are HIV-positive and are already suffering from low food availability. The time spent distributing medication is time not spent cultivating and has an impact on patient's nutrition. Thus, using a partial hourly wage system might be a more suitable strategy.

Average time to get to clinic:	3.5 hours (1 hour – 5 hours)
Average number of patients:	3 patients (1 patient – 7 patients)
Average time to get to most distant patient:	25 minutes (5 minutes – 1.5 hours)
Modes of transport	walk (35) car taxi (8) bicycle (1)

Table 10. Basic info on Community Health Workers

Second, a system of advancement might help improve motivation and decrease attrition. Ghana's CHOs are well-respected in the community and are able to advance to becoming a nurse. This "biomedical track" lends credibility to the CHW position and

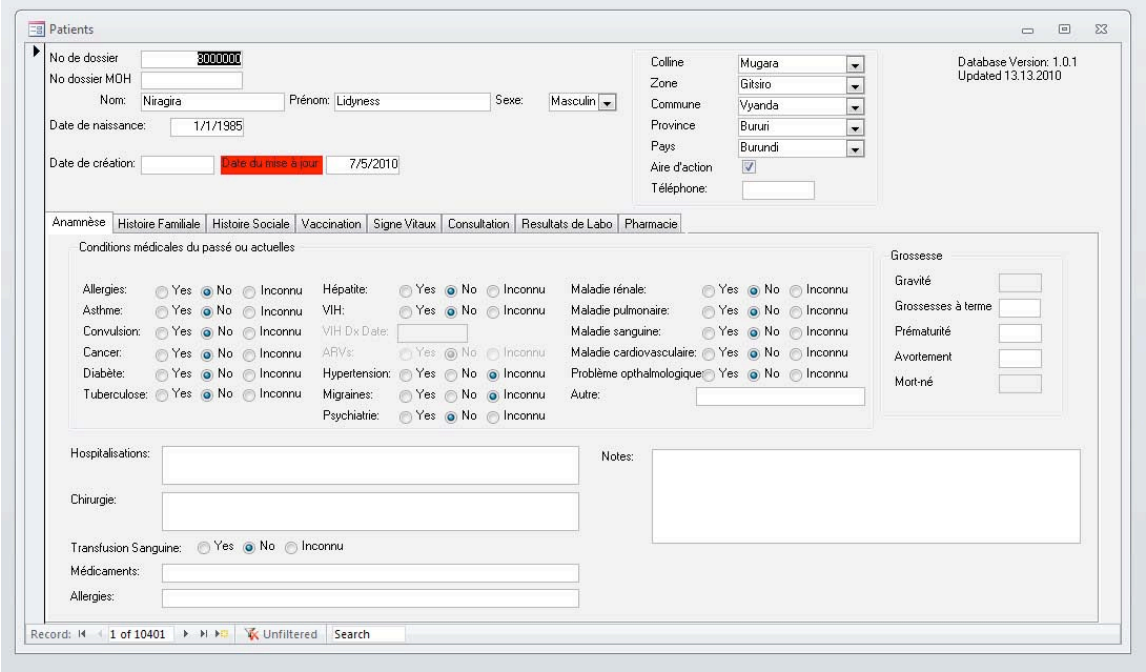
may enhance CHW interest in medicine, clinical care, and public health. Although VHW does not have the current ability to train nurses, it may be able to conceive of a form of advancement such as scholarships or specialty training for top-performing CHWs.

Third, curriculum and scope must be expanded. Current CHWs functionally only fulfill the role of the *accompagnateur* for HIV and TB patients. However, CHWs have proven to be successful advocates for advancement in hygiene, nutrition, malaria prevention, and maternal health. CHWs should be trained in these subjects and given clear guidelines for community outreach responsibilities. A performance-based pay system should be used to allow for more time to be spent on their CHW responsibilities.

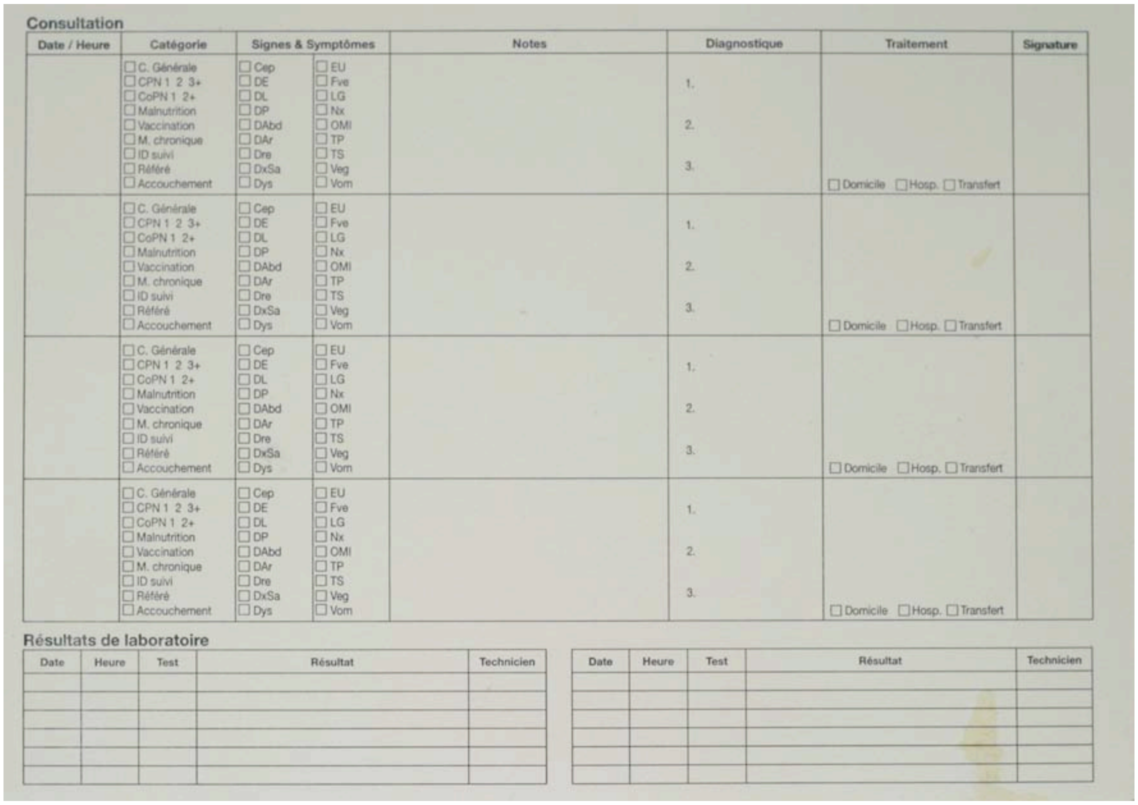
Forth, CHWs should be primary figures in the implementation of an ecological community psychology program focusing on refugees and IDPs. For VHW, this may include having CHW promote the cultural and community events at the clinic, such as the drumming and singing classes. However, CHWs can serve as more than event promoters if trained in a comprehensive community psychology approach. They may be able to plan additional events or groups in their smaller communities and may be able to provide basic counseling services.

Appendix 5: Forms

(A) MS Access data input frontend



(B) Patient data entry form, filled out by nurse



Consultation

Date / Heure	Catégorie	Signes & Symptômes		Notes	Diagnostique	Traitement	Signature
	☐ C. Générale ☐ CPN 1 2 3+ ☐ CoPN 1 2+ ☐ Malnutrition ☐ Vaccination ☐ M. chronique ☐ ID suivi ☐ Référé ☐ Accouchement	☐ Cep ☐ DE ☐ DL ☐ DP ☐ DAbd ☐ DAr ☐ Dre ☐ DxSa ☐ Dys	☐ EU ☐ Fve ☐ LG ☐ Nx ☐ OMI ☐ TP ☐ TS ☐ Veg ☐ Vom		1. 2. 3.	☐ Domicile ☐ Hosp. ☐ Transfert	
	☐ C. Générale ☐ CPN 1 2 3+ ☐ CoPN 1 2+ ☐ Malnutrition ☐ Vaccination ☐ M. chronique ☐ ID suivi ☐ Référé ☐ Accouchement	☐ Cep ☐ DE ☐ DL ☐ DP ☐ DAbd ☐ DAr ☐ Dre ☐ DxSa ☐ Dys	☐ EU ☐ Fve ☐ LG ☐ Nx ☐ OMI ☐ TP ☐ TS ☐ Veg ☐ Vom		1. 2. 3.	☐ Domicile ☐ Hosp. ☐ Transfert	
	☐ C. Générale ☐ CPN 1 2 3+ ☐ CoPN 1 2+ ☐ Malnutrition ☐ Vaccination ☐ M. chronique ☐ ID suivi ☐ Référé ☐ Accouchement	☐ Cep ☐ DE ☐ DL ☐ DP ☐ DAbd ☐ DAr ☐ Dre ☐ DxSa ☐ Dys	☐ EU ☐ Fve ☐ LG ☐ Nx ☐ OMI ☐ TP ☐ TS ☐ Veg ☐ Vom		1. 2. 3.	☐ Domicile ☐ Hosp. ☐ Transfert	
	☐ C. Générale ☐ CPN 1 2 3+ ☐ CoPN 1 2+ ☐ Malnutrition ☐ Vaccination ☐ M. chronique ☐ ID suivi ☐ Référé ☐ Accouchement	☐ Cep ☐ DE ☐ DL ☐ DP ☐ DAbd ☐ DAr ☐ Dre ☐ DxSa ☐ Dys	☐ EU ☐ Fve ☐ LG ☐ Nx ☐ OMI ☐ TP ☐ TS ☐ Veg ☐ Vom		1. 2. 3.	☐ Domicile ☐ Hosp. ☐ Transfert	

Résultats de laboratoire

Date	Heure	Test	Résultat	Technicien

Date	Heure	Test	Résultat	Technicien

Appendix 6. Web appendices

The computer programs used to analyzed the data, along with a full collection of maps produced, visit

`http://alexgoodell.com/scaling-up`