

# A University Driven Approach to Engaging Communities in Solving Complex Health Problems at the Human-Animal-Environmental Interface: A One Health Demonstration Site Survey in Kilosa District, Tanzania

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## Abstract

In light of the increasing global demographics, disease emergence and intensified encroachment on natural habitats, meeting the needs of the community and safeguarding their health is becoming a significant challenge. Engaging communities in one health activities is one way to ensure that they are involved in the planning, implementation and management of activities and interventions right from the beginning. The One Health Central and Eastern Africa (OHCEA) network of veterinary, environmental and public health institutions have been developing regional collaboration sites (One Health Demonstration Sites) for capacity building, outreach, and applied research in One Health where students, faculty, communities and government representatives work together to address joint complex health problems in long-term research, training and outreach at the human-animal -environment interface.

In Tanzania, Kilosa district located close to Mikumi national park was identified as a perfect site. Villages surround the national park and are in close interaction with wild animals. Environmental issues such as flooding have happened in this area, there are internally displaced communities, and farmers live in conflict with pastoralists, wildlife authorities and the government.

Faculty and students from Sokoine University and Tufts University performed a baseline survey of this area with key stakeholders in mind, and a focus on the different one health activities and interventions possible and the roles and responsibilities of the community in the demo site. Existing field based programs and attachments were reviewed, a situational analysis was conducted to allow for the engagement of local and national stakeholders in order to assure that activities are aligned with priorities and existing activities. Specific human health, animal health, and ecosystem challenges and impacts were identified, e.g. local human, livestock and wildlife diseases, habitat fragmentation, edge effect, biodiversity loss, around which training modules and/or curriculum could be developed for prospective trainees in public health, veterinary medicine, nursing and environmental health consistent with One Health themes and competencies. Focus group discussions were held with the community. Various community leaders as well as district level government and civil society officials exchanged ideas on how to implement the one health demonstration site.

The Kilosa region was found to be strategically positioned in terms of cultural resources and vulnerable populations as well as endemic or threatened wildlife species. Rabies, Rift Valley Fever and milk borne (Bovine Tuberculosis and Brucellosis) as well as water borne zoonoses were identified by community members as priority diseases that would be intervened effectively using one health approach. There was ongoing conflict among pastoralists, farmers, the national parks administration that presented opportunities for research and novel intervention systems. Community support and existing infrastructure for ongoing activities including influx of

trainees and research staff was considered adequate. Potential opportunities for the demonstration site to contribute to the local economy by virtue of employment, improved subsistence resources, conservation and sustainability, biodiversity protection, improved recreation or appreciation by tourists were present as well as future opportunities for community-based participatory research and training. The presence of ongoing stakeholder conflict presents opportunities for investigation and intervention by community members, the government and the universities working together using a one health approach. The survey provided prospects for engaging the community from the initial planning and execution stages of the demonstration site.

## 1. Introduction

Recent studies forecast that the toll on the world's economy of a pandemic with impact similar to the 1918 influenza pandemic would exceed \$ 4 trillion (Osterman, 2005). Even short lived and geographically focused outbreaks of recent zoonotic diseases can be devastating as evidenced by the recent Ebola outbreak in the West African region. In today's globalized world, the speed with which newly emergent diseases can surface and spread raises serious public health, economic, security and development concerns. Infectious diseases continue to threaten the well-being of the world. All populations are vulnerable to these emerging threats and we need to be able to strengthen the capacity of all high risk countries to prevent spill over from happening. The continuing threat from infections such as avian influenza, Rift Valley fever, Nipah virus and Ebola, urgent issues such as increasing global trends in anti-microbial drug resistance have raised awareness of the interdependence of human health, animal health, the economic security and the need for more systematic and cross- sectoral approaches to identifying and responding to global public health emergencies. Early detection and rapid response will be central to minimizing their impact on our social and economic stability. Engaging communities and the public and creating opportunities for them to participate in mitigating infections right from the planning stages is important for the success of any response program. Preventing disease at the human animal ecosystem interface requires a strategic approach that promotes cross-sectoral collaboration, encourages policies, systems and processes that are critical for minimizing health risks at all levels from the community to the international arena, and targets capacity building efforts to those places and populations where the need is the greatest.

Reducing the threat posed by new emergent infectious diseases requires a One Health approach that builds on the understanding that the future wellbeing of humans, animals and the environment are inextricably linked. Putting One Health into action requires that professionals from multiple disciplines have an understanding and appreciation of the links among human, animal, and environmental health, and the importance of and commitment of working together to address health challenges. One Health is a cost-effective, sustainable, and practical approach to find solutions for problems which need holistic, multidisciplinary approaches, particularly in resource-constrained countries. Additionally, having resources available and mechanisms in place to promote and facilitate multidisciplinary collaborations are essential to make One Health collaborations a reality. While there is a growing recognition of One Health, it has to be translated from concept into actions through country level activities that are relevant for specific situations. Activities need to be considered at community, district and national levels.

One Health Central and Eastern Africa (OHCEA) is a network of universities in Central and Eastern Africa which are collaborating to build One Health capacity and academic partnerships between the member institutions in the region. OHCEA membership includes 18 Central and Eastern African Schools of Public Health and Schools of Veterinary Medicine, and US partner institutions: The University of Minnesota (UMN) and Tufts University.

OHCEA was formed from members of HEALTH Alliance, an existing network of six schools of public health from six countries in central and eastern Africa namely the Democratic Republic of Congo (DRC), Ethiopia, Kenya, Uganda, Tanzania and Rwanda working to strengthen public health education and systems, including emergency preparedness and response.

The OHCEA network's vision is to be a global leader in One Health, promoting sustainable health for prosperous communities, productive animals and balanced ecosystems. OHCEA seeks to expand the human resource base needed to detect and respond to potential pandemic disease outbreaks, and increase integration of animal, wildlife and human disease surveillance and outbreak response systems. The overall goal of this collaboration is to enhance One Health policy formation and implementation, in order to contribute to improved capacity of public health in the region. OHCEA is identifying opportunities for faculty and student development and institutional strengthening that meet the network's goals of strengthening OH capacity in OHCEA countries (OHCEA, 2010).

OHCEA has been developing Regional collaboration sites (One Health Demonstration Sites) for capacity building, outreach, and applied research in One Health where student, faculty community and government work

together to address joint complex health problems in long-term research, training and outreach at the human-wildlife-livestock-environmental interface. Three countries have already engaged in the demonstration site and sites of interest identified: DRC, Uganda and Tanzania. A regional team from all six OHCEA countries are in the process of developing an aligned curriculum for student field attachment to demonstration sites and are working on reviewing regional commonalities at the OH intersection. Specifically, OHCEA and US faculty are working together to review existing field-based programs and attachments, conduct situational analyses and undertake planning/preparation for each site engaging local, regional and national stakeholders to assure that activities align with priorities and existing activities. These sites are viewed as a center of attachment for multidisciplinary sets of students from different institutions working together with communities to identify and resolve community based one health related challenges. In Tanzania, Kilosa district bordering the Mikumi national park was identified as a potential area for the location of the demonstration sites.

## 2. Baseline Survey Approach

A One Health demonstration site baseline survey was done to clearly identify, articulate and document the One Health themes and problems in the Kilosa area, to gather information prior to the start of the One Health demonstration site, meet with faculty, community members, and local government officials with knowledge and stakeholder-level engagement and involvement in the sustainable success of the Kilosa district demonstration site. It was also done to assess opportunities for collaboration and field-based OHCEA field attachments, research and service to strengthen One Health competencies and to allow for multiple stakeholders to develop public health interventions collaboratively. This would then be used as an information base against which to monitor and assess progress and effectiveness during implementation of the One Health demonstration sites, as well as for setting performance targets and ensuring accountability to stakeholders.

### 2.1 Demonstration Site Pre-Assessment Criteria and Site Visit

Prior to the site visit, demonstration site assessment criteria were developed to characterize the site, identify important site-specific One Health themes and topics for study and research and identify data gaps (Table 1). The community and stakeholder involvement and presence was key to the selection procedure because the community and local leadership, both government and private needed to be engaged in the planning and implementation process of the whole demonstration site. Community support, adequacy of existing infrastructure and accessibility of the site to visitors (geographic location, communications infrastructure, internet facilities and visitor's facilities) was also important because it had to be a site that would be able to accommodate an influx of students, trainees, research faculty and support staff from the surrounding universities.

Through a combination of direct observations, background information provided by respondents, and local officials, review of available maps, surveys and reports, stakeholder interviews and meetings with the local community members the team conducted a baseline survey guided by a set of criteria developed prior to the demonstration site visit. Using semi-structured interviews and interactive participatory techniques such as focus group discussions, and key participant interviews, direct observation and visualization techniques, a baseline survey that provided a starting point for efforts to collect and organize site-related materials into an accessible library for future use by the community, students, faculty and government and private organizations working within the Kilosa area was developed. The survey aimed to understand how different stakeholders including community members, government officials from multiple ministries perceived and identified one health related problems in their community and if approaches to interventions would differ based on the stakeholders. The District Veterinary Officer, and Emergency Response Coordinator, accompanied the team for a full day of visits to selected villages within the district. The interim Mikumi park ecologist was also interviewed. These officials raised several issues of concern for the district, including outstanding questions and/or data gaps that could form the basis of future collaborative research activities and interventions. Table 1 shows the assessment criteria developed prior to the site survey

## 3. Survey Results

### 3.1 Kilosa District

Kilosa District is one of the six districts of the Morogoro Region of Tanzania. Its administrative seat is the town of Kilosa. Kilosa covers 14,918 square kilometers (5,760 sq. mi) and is located approximately 300 km inland from the coast along one of the old East African caravan routes stretching from Bagamoyo to the eastern part of Democratic Republic of Congo (Nduwamungu et al., 2004). It comprises mostly flat lowland that covers the whole of the eastern part called Mkata Plains. There are seven villages in this area, namely Twatwatwa, Mbwanje, Msowero, Mabwegere, Luhoza, Kiduhi and Mfilisi, with the Twatwatwa village occupying the largest portion of about 32,000 ha (Nduwamungu et al., 2004).

Table 1. Pre- survey assessment criteria (baseline plan)

	Type of information/ Assessment criteria developed	Source of information	Data collection methods
1	Specific human health, animal health, and ecosystem challenges and impacts, e.g., local human, livestock and wildlife diseases, habitat fragmentation, edge effect, biodiversity loss, around which training modules and/or curriculum can be developed for prospective trainees in public health, veterinary medicine, nursing and environmental health consistent with One Health themes and competencies;	Community members, executive officials of Kilosa district, including veterinary department, health, agriculture, environment office and wildlife department, Tanzania national parks officials	Semi structured interviews, key informant interviews focus group discussions
2	Regional significance of the selected sites in terms of cultural resources, vulnerable populations, habitats, endemic or threatened species;	Community members, literature review, Sokoine university faculty	visualization maps of the area
3	Community support and adequacy of existing infrastructure for ongoing activities involving influx of trainees, teaching, research, and support staff.	Community members, executive officials of Kilosa district, traders	written literature and previous materials
4	Potential for the demonstration site to contribute to the local economy by virtue of employment opportunities, improved subsistence resources, conservation and sustainability, biodiversity protection, improved recreation or appreciation by tourists	Community members, executive officials of Kilosa district, including veterinary department, health, agriculture, environment office and wildlife department, Tanzania national parks officials, traders	
5	Examples of, and/or future opportunities for community-based participatory research and training.	Community members, executive officials of Kilosa district,	
6	Expectations of various stakeholders of the potential human, animal, and environmental health and economic benefits to the community of the demonstration site;	All stakeholders	
7	Accessibility to visitors (geographic location, communications infrastructure, internet facilities and visitors' facilities that allow for demonstrations and training sessions for large numbers of students	Community members, executive officials of Kilosa district, literature review	
8	Level of engagement and successes or challenges in prior collaborations among range of local stakeholders representing community, business, health care, NGOs, local and regional government, and educational representatives	Local government officials and community members, local NGOs present in the region	
9	Presence of ongoing or resolved issues and stakeholder conflicts and degree to which such issues present opportunities or obstacles to success in the teaching and learning environment.	Community members, executive officials of Kilosa district, literature review	

The topography of the district varies significantly and can be divided into three zones:

Flood plains comprising both flat and undulating plains extend to the foothills in the west with several rivers, the major ones being the Wami and the Ruaha. Maasai and Sukuma. Pastoralists occupy the central parts. This area is prone to seasonal flooding because the soils are black cracking clays and poorly drained in the central parts. In the peripheral western part, sediment fans are of black fertile soils, making them suitable for a range of crops, such as maize, cotton and sisal (Kajembe et al., 2013).

The plateau is situated in the north of the district, with an altitude of around 1,100m, made up of moderately fertile well drained sandy soils characterized by plains and hills that are intensively used for maize production and livestock keeping (Kilosa District council report, 2010).

The Highland area in Kilosa is represented by three mountains: Ukaguru, Rubeho and Vidunda (5) running from north to south on the western side of the district, with an altitude up to 2,200m.

Land in Kilosa can basically be divided into five zones: agricultural (37.5 per cent), natural pasture (33.5 per cent), Mikumi National Park (22.5 per cent), forest reserves (5.5 per cent) and urban areas, water and swamps (1 per cent) (KDC, 2010). Both agriculture and livestock grazing are practiced on general, village and private lands, while Mikumi National Park and forest reserves are controlled areas and state owned. There are a few village forests established from general lands and are included in the pasture land category. (Kilosa District Council report, 2010)

Ethnically the Kaguru are the most dominant population but Kilosa is inhabited by many tribes who came to the district as workers in the sisal estates as early as the beginning of the 20th century (Kajembe et al., 2013). Even after the collapse of the sisal industry, many people settled in different areas in the district but mostly in or

around the estates where they were employed. The pastoralist communities such as the Maasai and the Sukuma use the area close to the Mikumi national park for grazing their animals.

More than 80 % of people in the Kilosa area depend on livestock, agriculture and forest based resources for their livelihood. Uses of the forest include harvesting wood for charcoal, firewood and timber, women foraging for forest fruit and products for food. Unsustainable extraction contributes to degradation of forests in the area. As is the case in many areas in Tanzania, fuel wood is a major source of energy for cooking in the villages with most of it being collected from forests around the household landscapes (Kajembe et al., 2013).

Identification of Kilosa as a demonstration site was based on prior work conducted by Professor Mdegela of Sokoine University (Mdegela, 2012; Killewo, 2012) and contacts he had in the area, complex natural and cultural landscapes, and the challenges and opportunities for applied research and training of students and faculty identified. The Kilosa District site is not one specific location but rather a constellation of villages, roads, farms, enterprises, landscapes, people, ethnic groups, domestic animals and wildlife. Together these entities form several natural, social and political ecosystems that are especially suited toward participatory research and collaborative interventions among students and faculty and the various communities (Figure 1 showing map of Kilosa District).



Figure 1. Map showing Kilosa District and site for Survey

### 3.2 One Health Themes Identified

Considering that the ultimate challenge in most communities and countries is to protect biodiversity and ecological services through proper resource management while meeting the needs of people and safeguarding their health, the multifaceted issues identified in Kilosa district presented opportunities for multidisciplinary investigation and intervention by community members, government and the universities and engagement of all stakeholders from the planning stages. Various one health related themes, challenges and opportunities surfaced and were deliberated upon during the survey process.

Wildlife, livestock and people live in close proximity in this community, making the area a potential “Hot spot” for emerging pandemic threats. Evidence of deforestation, declines in soil fertility, impacts of recent flooding and possible effects of climate change were observed throughout the district. Questions on whether, how and the extent to which these conditions have impacted source, vector, host relations, food and water security in the area present valuable areas of inquiry. Other areas of importance also associated with driving disease emergence and spread included communities and settlements encroaching on natural wildlife habitats, development, construction, extractive industry, farmer-herder conflict, water management, deforestation, habitat fragmentation. Local veterinary and ecology officials described several local issues and questions that are multidisciplinary, illustrate the One Health concept, and would be fitting for both field-based learning and faculty-led research.

These all indicated that unless human activities were carefully planned and managed, valuable ecosystems in this area would continue to be impaired or destroyed and disease would continue to jump species, expand geographically or become entrenched in animal populations thereby having significant implications on the health of both humans, animals and the environment. Key issues identified included zoonotic diseases, Human wildlife conflict, livestock and land use management generated conflicts, misuse of antimicrobials and pesticides, gender inequity, environmental degradation, flooding and displacement, impact of tourism on wildlife and local communities,

### 3.2.1 Zoonotic Diseases

Zoonotic diseases have been reported in the community. Local veterinary officials reported relatively recent outbreaks of Rift Valley Fever, African Swine Flu, and rabies though disease prevalence's and incidences among local pastoralists, agriculturalists, and others was not known. The extent of diagnostic resources was reported to be lacking. Future research projects in the demonstration site addressing this area would provide information on zoonotic diseases. A student project could involve an investigation of record-keeping and data availability from local district clinics. Endemic zoonoses in the area were reported to include: Rabies (2012 - 11 cases reported in Kimambu clinic); as well as 12 dog bite cases recently in Kilosa health center, Rift Valley Fever (outbreak in 2010) indicated by storms of abortion in goats, Bovine tuberculosis, and African swine flu (outbreak in 2012). Brucellosis is considered to be endemic in the community and since milk is not processed on a regular basis, it is suspected that some of the undulating fevers reported by the human clinics maybe from Brucellosis and not Malaria. This has however not been investigated and provides an opportunity for communities and researchers to work together. Diseases affecting wildlife and domestic animals have also been reported. Foot and Mouth disease has been reported in buffaloes which act as reservoirs. Recently there was an outbreak of African swine fever that started in the warthogs in the national park.

### 3.2.2 Human and Wildlife Conflicts in National Park Areas and Their Management

In the Mikumi area, conflict between humans and wildlife has been going on for a very long time. The relative frequency of reported conflict with wildlife is significantly and inversely related to human density on lands adjacent to protected areas. Consequences of human-wildlife conflict is considered both direct, including injury and death from encounters with dangerous animals, and indirect, including loss of crops and livestock and damaged infrastructure. The problematic wildlife species are mainly elephants that are known to destroy people's crops and occasionally kill people. The interaction of livestock with wildlife is notable in Kiduhu and Mkata villages. This creates conflict with the national park management units. Human-wildlife conflicts have become more frequent and severe over recent years as a result of human population growth, extension of transport routes through national parks and expansion of agricultural and industrial activities which together have led to increased human encroachment on previously wild and uninhabited areas. According to the park ecologist, the encroachment of the community has extended over 500 meters into the park boundary. In the northern part of the park in Maharaka, Mkata, Khangali, Ihombwe and Mhanda villages, there is even more severe encroachment. The previously defined animal movement corridors that connect Mikumi, Zumba and Ruaha are shrinking because of human settlement. Due to climate change, water is drying up and surface water has become scarcer. Competition for the available water, natural habitats and resources has increased resulting in animosity between people and wildlife and challenges to food and economic security, one of the drivers for poaching.

In the Twatwatwa village, pastoralists' lifestyles have changed. They have become more sedentary, fencing the land, building houses and increasing human activity within the national park area. The Tanzania National Parks Authority (TANAPA) which protects animals within the parks has given district councils the responsibility of protecting animals within the management areas. TANAPA together with the district councils have engaged the communities in community outreach and conservation programmes in an attempt to educate people close to the parks on issues especially related to disease transmission.

### 3.2.3 Livestock, Land Use Management, and Human Conflicts

Infectious diseases of grave concern to human health are emerging from wildlife and livestock with greater frequency in areas with limited resources for disease prevention and control. Responding effectively requires engagement of and coordination with communities, public field workers, district council leaders, any other stakeholders in both human and animal health, as well as social and environmental sciences. Kilosa District supports free grazing (range), especially by Maasai and Sukuma communities who are the main pastoralists in the district. There are also some intensive farmers who keep large herds of dairy animals however, the most families own a few cattle, sheep, goats and chicken. Many local farmers acknowledged the existence of disease

especially in relation to their close proximity to the national parks. In some villages, it was reported livestock herders like the Maasai had conflict with the crop farmers. The DVO explained that sometimes the conflict resulted in the crop farmers poisoning the animals of the pastoralists with pesticides. As an attempt to minimize conflict between farmers and livestock keepers, the land in Kilosa has been divided between land suitable for grazing and land for agriculture. Within the land set aside for grazing, there are 8 settlements identified as pastoral villages. However, the continuing influx of migrating pastoralists to Kilosa district has increased the competition over agricultural and grazing land. In 2012 angry crop farmers killed fifteen Maasai cows for grazing in their farmland (Benjaminsen, 2009).

Livestock poisoning is especially frequent during the dry season when there is water scarcity. Kilosa District is known to have had frequent and serious conflicts between farmers and pastoralists due to poor land-use plans, poor institutional structures and insufficient land resources (e.g. water, pasture) for livestock (Benjaminsen, 2012). In some villages like Kinugu agropastoral village, the farmers hire plots where they allow the pastoralists to feed their animals for a fee thereby reducing the conflict.

#### 3.2.4 Misuse of Antimicrobials and Pesticides

Beyond the question of land entitlement and resource scarcity, additional issues regarding the distribution, use and misuse of antimicrobials in pastoralist communities and use and misuse of pesticides in agriculturalist communities were identified by the respondents. Veterinary drugs are widely distributed in the pastoralist villages, and the misuse of these drugs was identified as a potential problem. Questions were raised regarding the presence of unsafe levels of antimicrobials present in slaughtered animals as a result of excess treatment prior to slaughter and the health implications for consumers. Those present were not clear whether antimicrobial surveillance was happening at all or whether it was adequate. The use of traditional veterinary medicines among pastoralists was noted though their extent was not known. It was suggested that a catalogue or some documentation of traditional veterinary medicines would be a valuable demonstration site project.

On agricultural land, community members described the widespread use of pesticides in the area among small farmers. Anecdotal reports indicated the sale of pesticides in small quantities without proper labels and instructions. Several questions remain as to the specific pesticides most widely used, volume of use, how they are obtained, stored, handled, and disposed. Exposure levels among children, adults especially women, domestic animals and wildlife are not known. Women are also mostly involved in agricultural production and crop farming. They therefore tend to administer pesticides to their crops. Occupational environmental risks linked to these pesticides have not been investigated. Inadvertent poisonings of people mistakenly consuming improperly stored pesticides were also mentioned by respondents noting opportunities for education and intervention to reduce exposures and environmental contamination.

#### 3.2.5 Environmental Pressures: Deforestation, Flooding and Displacement, this Section is Very Interesting but can We Present as an Example/Opportunity for Community-Engagement?

The two major forces of deforestation within Kilosa District are forest clearing for agriculture and plantations, and extraction of biomass for energy consumption, partly a result of an increasing urbanization and population growth (Kajembe, 2013, Mdegela, 2012, Killewo, 2012; OHCEA, 2011). Kilosa heavily depends upon the forest as a source of charcoal and firewood. In addition, timber production and bushfires are also seen as other significant causes of deforestation. As is the case in many other areas in Tanzania, fuel wood is a major source of energy for cooking in the Kilosa villages. It is worth noting that the energy balance in Tanzania is characterized by biomass (wood fuel – charcoal and fuel wood) use, which accounts for about 90 per cent of energy consumption in rural areas and 75 per cent in urban areas (Kaale, 1998).

Charcoal is by far the most preferred source of energy in urban areas, while firewood is mostly used in rural areas. Most of the fuel wood is collected from forests around the household landscapes. Although fuel wood is traded in the area, the value is only determined when transported to the nearest town. Thus, fuel wood is not often traded within the community.

Charcoal production, distribution and sale was observed throughout the district, though it is not clear how many people make a living this way or the impacts from wood collecting in the national park and adjacent areas. Kilosa heavily depends upon the forest as a source of charcoal and firewood. Charcoal is produced by relatively poor people in the community, though because it can be sold at a fairly high price it is actually used by very few people, mostly by those considered well off and civil servants including school teachers. However, everybody is a potential charcoal burner and many engage in charcoal burning when the harvests are poor and charcoal in the markets is scarce. In times of scarcity, charcoal is exported to nearby towns some even sold as far as Dar-es-salaam for higher prices. Charcoal and timber are produced, and often traded illegally, i.e. when harvested without use



licenses, to supplement losses in agriculture in an attempt to meet basic needs in most households (RESPOND, 2012).

It was also the general consensus of the community as well as the public servants that they were either very dependent or quite dependent on clearing the forest for expanding agriculture. Most farmers preferred to expand their plots to non-forested lands. In some places some villages have set aside bylaws, which, amongst other things, hinder expansion of farms into the community forests (this excludes open access forests). Village councils or the village natural resources committees are responsible for routine patrol of the forests and are the issuers of the use licenses. Where offenders are convicted, they are normally punished according to the existing bylaws. However, whole communities are responsible for ensuring that the forests under their guardianship are well protected. The communities are involved in harvesting of other forest resources such as timber and poles in addition to charcoal. Interestingly, these resources attract more men than women. Discussions showed that in some villages many men and women are involved in charcoal-making. It was said that, unlike in the past, women are now more involved with providing for their families than men, taking part in diverse economic activities to secure the family's livelihood. Is there an opportunity here?

Extensive flooding of the Mkondoa River in 2009 caused displacement and establishment of relocation camps as an emergency measure. The Emergency response coordinator reported that these camps remain inhabited today and are a source of conflict between the private land owners and displaced persons whose prior residences were in many cases destroyed. An 8 kilometer berm was recently constructed but it remains to be seen whether the berm will successfully prevent future flooding events. Further areas of inquiry include the impact of flooding on incidence of infectious disease in humans and animals and whether clinic data show any trends after the last flood in 2009 (Figure 2 showing landscape of Kilosa and charcoal harvesting).



Figure 2. Picture showing Kilosa area landscape and charcoal harvesting

### 3.2.6 Road Kill, Tourism and Commercial Impacts

Road kills of wildlife from traffic within and adjacent to Mikumi National Park was reported to be a problem. This is especially during the dry season when animals like Impalas and warthogs come close to the roads in search of water. Severe fines have been imposed on road kill as well as speed limits and rumble strips to detract fast moving traffic. The fines are very severe – up to 15000 for killing an elephant. One way of enforcing these signs are that vehicles that hit animals are confiscated until the fines are paid. The effectiveness of these measures in reducing the number of road kills and which animals are most at risk has not been evaluated. Increased traffic, litter and garbage were noted by the respondents though the extent and nature of impact on district communities is not



known. It was reported that deposition of lead from traffic emissions was known to occur along roadsides where wildlife and domestic animals drink and graze, though the magnitude of this problem and impacts is not well-understood. Truck traffic has increased with the construction of newly paved roads opening up previously isolated or semi-isolated areas. A new tarmac road is planned for the area between Kilosa and Kilangali. The impacts on community health, e.g. incidence of infectious disease, traffic pollution and injuries, has not been studied. Future community-engaged research could involve the availability of data on disease prevalence/incidence and educational materials in circulation on disease risk in these areas.

### 3.2.7 Gender Issues

Labor efforts and resources are known to be differentially distributed among men and women in both pastoralist and agriculturalist communities, however it is not known how these roles impact potential exposures/vulnerabilities to infectious disease. This and how environmental pressures for land and water impacted these roles are future areas of inquiry for students and faculty engaged in the demonstration site. Current and potential markets and organizational/microfinance supports for women-owned or managed small businesses such as vegetable and small animal production, and crafts warrant further investigation. In Maharaka, Kilingani and Mkata villages women make up half the peasant farmers and participate in the local meetings. Of late there has been an increase in women representation as is evidenced by the increasing number of women groups engaged in community initiated projects. Women also spend a lot of time collecting firewood in the forests and foraging for fruits and vegetables. They harvest grass from the national parks used for making crafts and baskets and have been known to clash with the national park rangers because they enter the parks without permission. In Twatwatwa village, there is a women led community based organization in which women make decisions related to their profit making projects. The evolving roles of women in the area, particularly within traditional communities, and relationships between disease incidence and gender roles (e.g. different exposures for men, women, and children) are potential areas for research and community engagement.

### 3.3 Examples of, and/or Future Opportunities for Community-Based Participatory Research and Training

Several examples of community-based activities were observed and discussions with local area experts resulted in identification of important follow-up projects: All of these examples involve activities such as health education, home visiting, community awareness, immunizations, policy development, social entrepreneurship that could benefit the local economy by advancing health behaviors, vocational skills, and possibly small scale employment opportunities. Local government officers would likely benefit from participation in all of these demonstration site activities.

#### 3.3.1 Wildlife Management Areas

The park ecologist at Mikumi national park noted that poaching has historically been a problem in Mikumi National Park having observed or heard reports of the use of snares to capture elephants, lions, giraffes, rhinos and small ungulates. Questions for future work included an evaluation of which anti-poaching efforts, including education and outreach, have been tried locally and their relative effectiveness. TANAPA is proposing to support the Twatwatwa Wildlife Management Association (WMA) located adjacent to Mikumi, a community based association that would manage wildlife that are not in the parks and use it as new opportunity for community development and income generation. The WMA's can also be engaged in other projects that meet the community needs such as constructing dispensaries or schools. In Maharaka village, a local NGO, Nehema Resource Foundation, has engaged the community in bee keeping activities. Bees have been known to be effective in keeping elephants away from the farms and to generate income. The trends and demands for bush meat, whether increasing or decreasing, and other local factors contributing to these trends was not well understood by those interviewed. While a system of compensation has been established by the wildlife department for farmers who claim wildlife-associated losses, the DVO noted it can take 6 months to a year to be compensated and the amount is minimal, e.g. 40,000 shilling per acre of damage. The District Veterinary officer (DVO) reported efforts to increase local production and marketing of chickens and the availability of a new source of protein was mentioned as a possible way to reduce demand for bush meat and poaching. Micro-financing activities were noted in the area, though the source of these funds was not known.

#### 3.3.2 Potential Areas for Community Engagement

Many themes and issues were identified as potential areas for university, community and government engagement in collaboration efforts to respond to public health threats. Table 2 shows specific themes and areas identified.

Table 2. Potential areas for community engagement

Area/theme	Questions /gaps for future community based participatory research and training
Relatively recent outbreaks of Infectious /zoonotic diseases: Rift Valley Fever (2010?); African Swine Flu (2012), rabies (2012)	What are the disease prevalence and incidences among local pastoralist agriculturalists, others? What data are available from local district clinics? What can be done to improve local diagnostic resources?
Rabies	What is the incidence of rabies in humans from dog bites?
Milk collection network	Are surveillance, monitoring and reporting practices adequate? Who is managing this overall effort? What are the risks of Bovine TB, mastitis, Brucellosis?
Pesticides (occupational and residential use) -	Which ones are used? Volume of use? How are they obtained, stored, handled, disposed? What are exposure levels among children, adults, domestic animals and wildlife? What are opportunities for education to reduce exposures and environmental contamination? Can data on intentional and inadvertent poisonings be compiled to identify opportunities for education and intervention?
Distribution, use and misuse of antimicrobials in pastoralist communities	How are veterinary drugs distributed in the pastoralist villages, and what educational and outreach efforts are needed to prevent misuse? Are unsafe levels of antimicrobials present in slaughtered animals as result of excess treatment prior to slaughter? What are the health implications for consumers? Is antibiotic resistance a problem observed in vet or human clinics?
Charcoal production	What are the impacts from wood collecting in the national park and adjacent areas? How many people make a living this way?
Poaching	Which animals have been targeted and by whom? Which anti-poaching efforts have been tried and has their effectiveness been evaluated? Which education and outreach efforts have been most effective in the community? What are the roles and responsibilities of various stakeholders in these efforts? Are fines and jail sentences levied?
Bush meat consumption	Is bush meat consumption increasing, decreasing and what are the local factors contributing to this trend? Could the Increasing local production of chickens reduce demand for bush meat and poaching?
Gender roles and responsibilities and new opportunities for women	What is the distribution of labor and resources among men and women in pastoralist and agriculturalist communities? How do these roles impact potential exposures/vulnerabilities to infectious disease? How have environmental pressures for land and water impacted these roles? What are the current and potential markets and organizational/microfinance supports for women-owned or managed small businesses such as vegetable and small animal production, crafts, etc.?
Tourism impacts – negative and positive	How has increased traffic, litter and garbage impacted communities?
Road kills of wildlife from traffic within and adjacent to Mikumi National Park	Have fines worked to reduce the number of road kills? Which animals are most at risk?
Flooding of Mkondoa River	Will recently constructed 8 km berm prevent future flooding events? What is the impact of flooding on incidence of infectious disease in humans and animals? Do clinic data show any trends after the last flood in 2009?
Deposition of lead from traffic emissions along roadsides where wildlife and domestic animals drink and graze	What is the magnitude of this problem and impacts?
Ethno veterinary and traditional medicines among pastoralists	What are they and can they be cataloged or documented?
Bee-keeping for elephant control	What is level of use, potential for expansion of use, and effectiveness of these projects for controlling elephants from coming onto cropland?
Wildlife Management Associations (WMA) located adjacent to National Parks	How can they organize and generate money to fund community projects?

### 3.4 Infrastructure and Support

Suitable accommodations for students and faculty conducting field attachments were identified at hostels and camps within Mikumi National Park and Kilosa town. Arrangements can be made for both food and lodging at these facilities. Kilosa village is approximately a 2-4-hour drive (depending on route) from Sokoine University. Motor transport within the district would be needed for students and faculty as reliable public transportation does not exist.

Several opportunities and challenges, some of which fall within several One Health themes, were identified and could be addressed as community-based research projects, trainings or interventions led or supported by the community, the district councils'/government officials, faculty and students from the participating OHCEA universities.

### 3.5 The Role of Sokoine University of Agriculture.

Sokoine university of Agriculture nicknamed SUA was established on 1 July 1984. It is located at 3.0 km from the center of Morogoro Municipality, a 2hour drive from Kilosa and about 200 km west of Dar es Salaam. SUA trains students at undergraduate level leading to degree awards mostly in Agriculture, animal sciences and environmental studies. It also offers graduate level programmes in the same areas. SUA is well positioned and close enough to support demonstration site activities through faculty and students. SUA has been known to offer consultancy and outreach services in areas such as agriculture, forestry, natural resource management, veterinary, rural development, and information and communication technology. Ongoing research by faculty at Sokoine University includes several important areas of relevance to demonstration site communities such as:

- Soil and water management for crop and livestock production (mention of flood in the demo site memo),
- Technology transfer, adoption and agricultural diversification,
- Small and large ruminant improvement for meat and milk production (to what extent are pastoralists involved in these initiatives),
- Food crops improvement including promotion of under-utilised indigenous crops,
- Nutrition and family resources management,
- Farming systems research,
- Improvement and management of natural resources and plantation forests including economics, policy, harvesting and utilisation,
- Livestock diseases and management of disease of public and economic importance in Tanzania

## 4. Conclusion

The Kilosa site is a constellation of villages, landscapes, ethnic groups, domestic animals and wildlife. The presence of ongoing stakeholder conflict presents opportunities for investigation and intervention by community members, the government and the universities working together using a one health approach. Together these entities form natural, social and political ecosystems that are especially suited for multidisciplinary collaboration, participatory research and joint interventions. Villages surround the national park, closely interacting with wild animals. Environmental issues such as flooding and internally displaced communities are present. Ongoing conflict among pastoralists, farmers and national parks administration present opportunities for community and government engagement, research and novel intervention systems. The region is strategically positioned in terms of cultural resources and vulnerable populations as well as endemic or threatened wildlife species. Rabies, Rift Valley fever, bovine tuberculosis, brucellosis and water borne zoonoses were identified by community members as priority diseases that could be used to develop locally led surveillance, disease control and prevention programs. The multifaceted issues identified present opportunities for multidisciplinary investigation and intervention by community members, government and the universities and engagement of all stakeholders from the planning stages.

Community support and existing infrastructure for ongoing activities including influx of trainees and research staff was considered adequate. Potential opportunities for the demonstration site to contribute to the local economy by virtue of employment, improved subsistence resources, conservation and sustainability, biodiversity protection, improved recreation or appreciation by tourists were present as well as future opportunities for community-based participatory research and training.

Key components of the demonstration site endeavor are to transform the student's ways of thinking about public health and promoting public health service delivery to the communities while strengthening existing pre-service

curriculum and graduate level training through field practicums as well as encouraging multidisciplinary collaboration by linking students from multiple fields in human health, veterinary, wildlife and environmental health, and connecting university expertise and students to community needs. Field level responders will work through the demonstration site to build cross sectoral skills and knowledge, thereby creating one health connections and networks, and working together with communities and universities to develop one health research and intervention opportunities. When one health opportunities are operationalized at all levels starting from the community.

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