



Evaluating and Managing Zoonotic Disease Risk in Rural Tanzania

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Health for Animals and Livelihood Improvement (HALI) Project

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Daily workloads and livelihoods in rural communities depend heavily on the availability of natural resources. When water is scarce, workloads increase, as more distance must be traveled to acquire adequate supply for consumption, hygiene, and livestock. In addition, water limitation brings people, livestock, and wildlife together, increasing contamination of the limited water sources as well as the potential for disease transmission. Nowhere is the risk of waterborne illness and zoonotic disease more important than in the high HIV/AIDS (Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome) prevalence regions of East Africa. Assessing the impacts of zoonotic diseases like bovine tuberculosis (BTB) on health, economic livelihoods, and conservation requires a multi-disciplinary approach. Support from the Global Livestock Collaborative Research Support Program (GL-CRSP) is allowing an objective assessment of emerging zoonotic disease on health and livelihoods in pastoral communities within the sensitive Ruaha region of Tanzania. Project research has identified several pathogens including BTB in wildlife and livestock in the Ruaha area, along with low levels of zoonotic disease awareness among the pastoralist communities. Project results will inform management and policy to evaluate water quality for public safety and ecosystem health.

Background

Unprecedented human population growth and human-induced environmental changes have resulted in increased numbers of people living in close contact with wild and domestic animals, especially in developing countries. This increased contact together with changes in land use, including livestock grazing and crop production, have altered the inherent ecological balance between zoonotic pathogens (i.e. diseases that can be transmitted from animals to people and vice versa) and their human and animal hosts. In fact, zoonotic pathogens, such as avian influenza and tuberculosis, account for the majority of emerging infectious diseases in people (diseases that appear in a population for the first time or are increasing in prevalence or geographic distribution; Taylor et al., 2001).

Intimate linkages of human and animal health are not new nor are the serious consequences of zoonotic diseases, like plague and influenza. Nowhere is this more important than in the developing world, where availability of natural resources determines daily workloads and livelihoods. Water resources are perhaps most important, as humans and animals depend on clean water for health and survival, and sources of clean water are dwindling due to demands from agriculture and global climate change. As water becomes more and more scarce, animals and people are squeezed into smaller and smaller workable areas. Contact among infected animals and people then increases, facilitating disease transmission. When this situation is

complicated by co-infection with HIV/AIDS (Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome), the results can be catastrophic to families and whole communities and ultimately, the environment through impacts on human capacity, natural resource management and land use (Ogelthorpe and Gelman, 2007).

Assessing the impacts of zoonotic diseases and resource limitation on health, economic livelihoods, and conservation requires a multi-disciplinary approach, uniting specialists from a wide variety of fields including medicine (veterinary and human), ecology and conservation, sociology, and economics. In 2006, the Health for Animals and Livelihood Improvement (HALI) project was initiated to find creative solutions to these problems by investigating the impact of zoonotic disease on the health and livelihoods of rural Tanzanians living in the water-limited Ruaha ecosystem. HALI addresses these complex disease and natural resources issues using the "One Health" paradigm, stressing that the health of domestic animals, wildlife, and people are inextricably linked to the ecosystem and natural resources on which all depend (Osofsky et al., 2005).

Project Rationale

The biologically diverse and economically important Ruaha ecosystem is seriously threatened by seasonal drying of the Great Ruaha River (GRR). Since 1993,

uncontrolled agricultural water diversions and intensive livestock grazing at the source have caused the normally perennial GRR to stop flowing for longer periods each year. The costs of water disruption are significant and far reaching. First, pastoralists that have traditionally used the GRR to water livestock have been forced to find other sources. Water restriction has decreased the area available for grazing and increased the concentration of livestock using dwindling water sources. Pastoralists suspect that this process has increased disease transmission at watering holes and has led to decreased forage quantity and quality. The effect of these factors on herd productivity, however, has not been quantitatively assessed. Another major cost of river drying has been the loss of wildlife tourism potential, both for Ruaha National Park (RNP) and for the village-managed Pawaga-Idodi Wildlife Management Area. Tourism in this part of Tanzania is concentrated in the dry season, when wild animals are visible near perennial water. The spatial distribution of surface water has declined over 60%, leading to a comparable decline in high-potential areas for tourism. This reduction in wildlife viewing area is particularly significant for village economies struggling to diversify their economic base beyond livestock and rice production.

In addition to direct impacts of restricted water flow, transmission of zoonotic diseases are likely to increase with reduced water availability, as people, wildlife, and livestock are increasingly forced to share dwindling and lower quality water sources. For example, in South Africa, buffalo herds with higher rates of bovine tuberculosis were more sensitive to drought, had higher numbers of endoparasites, and experienced more rapid loss of body condition during the dry season (Caron et al., 2003). With the drying of the GRR, the spatial distribution of buffalo has declined nearly 33% in the GRR portion of the Park (Wildlife Conservation Society-WCS, Aerial buffalo count, 19-20 October 2004, unpublished data), compressing herds into a smaller area where potential for disease transmission is higher and forage competition is more severe. The risk of disease is intensified as water quality is diminished through increased fecal contamination and stagnation of the remaining dry season watering holes. Previous research in the Rungwa-Ruaha ecosystem and in other regions of Tanzania illustrates that the area is a hot spot for zoonotic diseases of significant public health importance. In addition, the traditional practices of pastoralist groups in the region may put them at increased risk of infection.

A critical question that has only recently been explored is the role of bovine tuberculosis (BTB) in the current global human tuberculosis epidemic (Cosivi et al., 1998). Nearly 40,000 new cases of tuberculosis (human, bovine, or atypical strain) are diagnosed per year in Tanzania (NTLP - National Tuberculosis and Leprosy Programme, 1996), with anywhere from 21-77% of Tanzanian tuberculosis

patients also infected with HIV (Range et al., 2001). The extra-pulmonary form of tuberculosis (EPTB) in humans is often associated with BTB infection from ingestion of animal products and has been documented in 17% of the tuberculosis cases in Tanzania (NTLP, 1996). Many pastoralist groups in Tanzania have practices that might increase their exposure to BTB (and other zoonotic diseases), including consumption of raw or fermented milk (prepared without boiling) or raw blood, eating un- or under-cooked meat, and housing livestock within human dwellings (Mfinanga et al., 2003).

The BTB strain is more commonly found in regions with a high ratio of cattle to people (Kazwala et al., 1993). Testing of cattle in and around the Ruaha ecosystem showed that 51% of herds had cattle reactive to BTB by intradermal skin tests, with reactor prevalence being highest in the hot dry lowland areas nearer to the park (Kazwala et al., 2001). Furthermore, the Usangu region adjacent to the park is a hot-spot, with over 80% of cattle skin-test positive for BTB (Iringa District Livestock Office, unpublished data). Bovine tuberculosis strains have also been isolated from milk samples from pastoral cattle in the region (Kazwala et al., 1998).

Although investigators know that BTB is present in livestock bordering the protected areas of the Ruaha ecosystem, nothing is known about the disease in the landscape's wildlife. Bovine tuberculosis has had population impacts on buffalo and lion in Kruger National Park, South Africa (Michel et al., 2006) and has emerged as a serious ecosystem-level health threat. This threat is compounded by the complete lack of knowledge regarding the impacts of BTB in local wildlife or their potential role as a reservoir for the disease.

The utilization of dwindling dry season watering holes by humans, livestock, and wildlife not only exacerbates the risk of BTB transmission among these populations, but exacerbates the transmission risk of other important zoonotic diseases, such as brucellosis and water-borne diseases (toxoplasmosis, cryptosporidiosis, giardiasis, and bacterial enteric pathogens). Information about the spatial, temporal, and demographic patterns of disease in human, domestic animal, and wildlife populations is needed to control and limit zoonotic agents of public health and economic importance. Additionally, the underlying land-use determinants of disease and the socioeconomic barriers to control and prevention must be explored (Patz et al., 2004).

Accordingly, the Health for Animals and Livelihood Improvement Project (HALI) was created to assess the impact of the interactions between water and disease in the Ruaha ecosystem by simultaneously investigating the biophysical, socioeconomic, and policy issues driving the

system. The research priorities for HALI were determined through a stakeholder meeting and informal interviews with affected pastoralist communities. An overwhelming consensus emerged from diverse stakeholders including pastoralists, multiple levels of government, non-profit organizations, and academia that a significant proportion of the rural population in the Ruaha landscape is affected by water-related diseases, and these diseases are affecting health, agricultural productivity, food security, and biodiversity in the region (See box below).

Considering the problems and needs as defined through the local community meetings and the stakeholder planning workshop, the HALI project seeks to: 1) assess the prevalence and transmission ecology of zoonotic diseases (BTB, brucellosis and water-borne pathogens) among wildlife, livestock, and pastoral and agropastoral communities; 2) assess the effects of water (river and other water bodies) management on the presence, abundance, and severity of disease impacts; 3) assess how water management and disease affect the health and livelihoods of agropastoral and pastoral communities; and 4) strengthen the zoonotic disease education and research capacity of the Faculty of Veterinary Medicine at Sokoine University of Agriculture, Morogoro, Tanzania.

HALI project team members are accomplishing these goals by testing wildlife, livestock, and their shared water sources for disease; interviewing pastoralist households; introducing new diagnostic techniques for disease detection; and training Tanzanians of all education levels about zoonotic disease.

Preliminary Findings

Research activities from the first year of the project have already yielded significant findings. Researchers have discovered bovine tuberculosis present in wildlife inside the community wildlife management area bordering Ruaha National Park and are continuing to sample wild animals to determine which species are most affected and the geographic distribution of infection in the ecosystem. They are sampling pastoral livestock with partnering households to determine the current prevalence of BTB in agricultural animals and to assess whether or not disease in livestock is related to water limitation or proximity to wildlife. Investigators have isolated disease causing bacteria and parasites that can be passed between animals and people from sampled water sources and are gathering information

about how people use these water sources. Preliminary findings from wet season surveys of pastoralist households indicated that 68% of 70 participating households did not believe illness in their families could be contracted from livestock, while 40% of these households also did not believe illness in their families could be transmitted from wildlife. Additionally, 75% of these households did not believe sharing water sources with livestock or wildlife was a disease risk.

Practical Implications

Preliminary results showing that BTB is present in both wildlife and livestock in the Ruaha ecosystem indicates that these species have interacted in the past. The Ruaha ecosystem is at the juncture of the East and southern African faunal zones and is one of the largest intact conservation areas remaining in Africa. An accurate assessment of the diseases that could threaten the persistence of key species, such as buffalo and lion, is essential for conserving the region's unique biodiversity and its ecotourism earning potential.

Perhaps more importantly, it is crucial to recognize that these diseases are present at the local level, as people depend on meat and milk from potentially infected animals for their food. Determining the prevalence of these and other zoonotic

diseases affecting livestock will guide subsequent disease prevention efforts aimed at improving livestock productivity through improvement of health and the protection and expansion of trade and food security.

Second, education regarding zoonotic diseases is urgently needed in pastoralist communities. Collecting detailed data regarding food consumption and water use habits, illness in livestock and people, and access to healthcare will help tailor disease education efforts. In the meantime, team members are educating livestock owners at each project household. Tuberculin skin tests are administered and interpreted with the owners present, and households with positive reactor cattle are advised on disease prevention.

Finally, findings from this project will be used by the Rufiji Basin Water Office to evaluate water quality for public safety. HALI data will aid in the development of water management strategies that maximize water flow for people, livestock, and wildlife, thereby improving the health and livelihoods of local people, as well as habitat for wildlife and ecotourism.

HALI stakeholders agreed that the highest priority diseases for study were pathogens that:

- 1) Are impacted by water use issues
- 2) May severely affect human health (especially individuals with HIV/AIDS)
- 3) Adversely affect livestock health and productivity
- 4) Threaten the persistence of endangered species

Further Reading and References

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The Health for Animals and Livelihood Improvement (HALI) project was established in 2006 and is a stakeholder-driven research and capacity-building program to assess the effects of zoonotic disease and water management on animal health, biodiversity, and livelihoods in the Ruaha ecosystem, Tanzania. The project is led by Dr. Jonna Mazet, University of California, Davis. Email: jkmazet@ucdavis.edu.



The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East and West Africa, Central Asia and Latin America.

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