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Travelling Companions: Emerging Diseases of People, Animals and Plants Along the Malawi-Mozambique Border

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Abstract Humans, animals and plants suffer from similar types of diseases (e.g., fungal, viral etc.). These can "emerge" as new diseases by expanding their geographical range or by jumping species (from plants to plants, or from animals to humans). Emerging diseases place an additional burden on developing countries which are often struggling to manage the diseases they already have. New diseases spread through weather, insects or other vectors, or by the movement of people, animals or goods. This study examines the role of cross-border travel in the spread of diseases. A survey of travelers and of residents along the Malawi-Mozambique border found that most cross it frequently and that they rarely travel empty-handed, often taking plants and animals with them. People also cross borders seeking medical attention. Attempting to limit travel would hamper an already struggling economy, where many people make a living by producing, processing or transporting plants and animals for food. Cross border travel per se may pose slight danger for the spread of diseases, if governments can collaborate on sharing information about the status of diseases within their border.

Keywords Emerging diseases · Human health · Crop pests · Animal health · Travel · Cross-border relations · Malawi

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Introduction

Emerging diseases are ones that have spread geographically, adapted to additional hosts, changed pathogenesis or are recently recognized (Anderson *et al*. 2004). A zoonotic disease is one that affects both animals and humans. It may or may not involve a vector (e.g., insect). Many zoonoses have a long history with humans, such as rabies. But a disease that has recently jumped from animals to humans, such as Lyme disease (a bacterium carried from deer and rodents by ticks) is also a new or emerging disease (Wang *et al*. 1999). The concept of emerging diseases was first applied to humans in the early 1990s (Lederberg *et al*. 1992). It has also been applied to animal diseases, e.g., when livestock diseases spread to wildlife (Daszak *et al*. 2000). Wildlife can also play a role in spreading disease among domesticated animals, e.g., foot and mouth disease in Africa (Sumption *et al*. 2007), or highly pathogenic avian influenza between wild birds and poultry. Many emerging human diseases are now thought to be of animal origin, e.g., Ebola, dengue, SARS, HPAI (H5 N1), and how they emerge has attracted recent scrutiny (Wolfe *et al*. 2007).

Plant diseases can emerge by jumping the species barrier to other plants, although not to animals. The International Plant Protection Convention requires countries to report plant pests and diseases, but lack of funding often limits reporting (Anderson *et al*. 2004). Plant diseases often have

many more hosts than animal diseases, making surveillance more complicated.

Emerging human, animal and plant diseases in Africa can be particularly difficult to control. Without systems to monitor or control movement between jurisdictions, trade, cross-border travel, food aid and other forms of movement have helped pass new diseases across the continent. Poorly-funded and understaffed government agencies are often unable to adequately monitor this traffic. Once a disease arrives in Africa it spreads more or less unimpeded across the continent. Initiatives under the aegis of the African Union aim to replicate the success of the model of the Centers for Disease Control (CDC) in the US, with improved monitoring and surveillance of infectious disease through "virtual" centers such as the East African Centre for Infectious Disease Surveillance (EACIDS) or the Southern African Centre for Infectious Disease (SACIDS). While cross border travel is a big issue to governments and intergovernmental agencies, people on the ground have a more relaxed attitude about borders and the risks entailed in crossing them. And while travel does affect disease, it does so in qualitatively different ways for plant, animal or human hosts.

Few scholars have examined emerging human, plant and animal diseases together.[1] The combined effect of human, crop and livestock diseases can be devastating. For example, Rugalema *et al*. (2009) found that communities near Lake Victoria were dealing with AIDS at the same time that bacterial wilt and other diseases were wiping out their staple food crop of plantains. Villagers were quick to lay blame on foreigners and expressed concern that the increasing ease of travel was linked to the spread of disease. Respondents blamed poor regulation (e.g., quarantine, vaccination) by Ugandan and Tanzanian officials for the spread of animal diseases, and the failure to restrict movement for the spread of crop diseases, especially in the vegetative planting material of bananas and cassava.

This paper reports the results of a study commissioned in 2009 by the FAO Multi-Partnership Program (FMPP) project "Analyzing the linkages between population mobility and biosecurity risks to rural livelihoods and food security" on the movement of people in a sample of districts in Malawi on the border with Mozambique to better understand the risks that travel places on human, livestock and crop health, and to recommend ways of managing those risks.[2] Nearly everyone in southern Malawi makes a living producing, processing or transporting food. Travel is brisk across the border, and for many reasons, sometimes to transport crops, seeds or animals, but even when people make the trip just to visit relatives, plants and animals are frequent travelling companions. The central hypothesis of this study was that many people who had sought refuge in Malawi during the civil war in Mozambique left their children in school in Malawi when they returned to Mozambique to work their old farms, initiating constant cross-border traffic that facilitated the spread of plant, animal and human diseases. Our results revealed a more complex and more interesting picture.

Malawi has a predominantly agricultural economy; main exports are tobacco, tea and sugar. Agriculture employs about 80 % of the workforce, earns over 80 % of foreign exchange, and makes up 39 % of the gross domestic product (GDP). Smallholders contribute over 70 % of agricultural GDP and estates produce the rest. Smallholders grow maize and other food crops, while estates produce high value export crops (Government of Malawi 2001). With 52.4 % of the population living below the poverty line (MK 44 [$0.29] per person per day) (Government of Malawi 2008), malnutrition is rampant: 43.2 % of children under five are stunted and another 22 % underweight (NSO 2005a). The maternal mortality rate is high, 984 deaths per 100,000 births in 2004 (NSO 2005b). HIV/AIDS prevalence is estimated at 12 %.

Malawi shares borders with three countries (Zambia to the west and northwest, Tanzania to the north and northeast and Mozambique to the central west, south and east). The border with Mozambique is the longest, measuring about 1,400 km, covering half of Malawi's international boundary. Malawi is divided into three regions (Central, North and Southern) and divided further into 28 districts. The Southern Region is the most populous, with 5,876,784 people, 45 % of the national population (Table 1). The entire Southern Region is surrounded by Mozambique. South of Dedza, in Ntcheu district, there are long stretches of highway that run right on the border. The people on the east side of the asphalt are in Malawi, and those on the west side are in Mozambique.

Many refugees arrived in Malawi in the 1980s during the civil war in Mozambique. At the peak of the crisis, there were about 1.2 million Mozambican refugees in Malawi (Zetter 1996). There are no reliable data on how many Mozambican refugees stayed in Malawi, or how many people continue to travel back and forth between the two countries. Long-term border officials thought that most of the Mozambicans had returned home. But Malawians in general, including these officials, did not perceive people from neighboring districts of Mozambique as being very foreign. "Malawi is just a finger poking into Mozambique. We are all brothers," one educated Malawian said, explaining the Malawians' tolerant attitude about Mozambicans living and travelling in Malawi.

[1] One exception was a study by the FAO in Tanzania and Uganda, west of Lake Victoria, which found that the local people used similar names and concepts to describe the diseases of people, animals and plants (Rugalema and Mathieson 2009; Rugalema *et al*. 2009; see also Bentley *et al*. 2009).

[2] The study area is environmentally and socially homogeneous, divided by the colonial powers in the late nineteenth and early twentieth centuries (Pakenham 1991) and thus we do not deal with biogeographical barriers, such as a sea or a mountain range.

Table 1 Population of Malawi, the regions and study districts

	Year		
	1987	1998	2008
Malawi	7,988,507	9,933,868	13,066,320
Southern region	3,965,734	4,633,968	5,876,784
Northern region	911,787	1,233,560	1,698,502
Central region	3,110,986	4,066,340	5,491,034
Study districts			
Dedza	411,787	486,682	623,789
Machinga	301,849	369,614	488,996
Mwanza	60,305	63,220	94,476
Chikwawa	316,733	356,682	438,895
Mulanje	419,928	428,322	525,429

NSO 2008

Malawi has approximately one formal border post per district, generally along highway crossings, every 50 km or so. Most of the Malawi-Mozambique border is uncontrolled, allowing free movement of people, goods and livestock. At the few formal border posts officials check truck cargos to charge duty and they inspect seed and animals, but otherwise there is limited inspection.

Methods

Five districts were selected for study: Dedza, Machinga, Mwanza, Chikwawa and Mulanje (Fig. 1). Two sites in each district, one at a formal border and one at an informal one, were selected by representatives of the District Assemblies of the five districts. [3] Each district contributed two or three experts (a veterinarian, a crops specialist and a public health official) who joined the 12 data collectors and three study supervisors, who spent three weeks in the field collecting the survey data.

Five hundred and forty-seven households were selected at random in the 10 sites from a list provided by the Extension Planning Areas (EPA) of the Ministry of Agriculture and Food Security (Table 2). A questionnaire was administered to the household heads eliciting data on household members' disease histories, occupations and patterns of mobility. Qualitative data (e.g., on reasons for travelling, attitudes about health and travel) were collected through 49 focus group discussions and 39 key informant interviews with government officials and local leaders and a survey of 87 travelers. Data were entered with CSPro and analyzed using SPSS (tallying, trending, cross-referencing and identifying similarities and differences between issues).

[3] A formal border is one where the Malawi Government has an official check point, with authorities such as Immigration, the Malawi Revenue Authority and police. The informal borders are active crossing points with no border authorities on the Malawi side (although there often were Mozambican officials).

Overview of Study Districts

Dedza District

Dedza District is in the Central Region. Major crops are maize, beans, soybeans and groundnuts. The formal border post is about one km from Dedza Town. Villagers around the formal border have their farm land in Mozambique. The informal crossing point was Njonja, about 50 km northwest of Dedza Town, where about 300–500 people cross the border every day. Most illegal exports of tobacco to Mozambique move through Njonja. There is public transport there, so people come from both Malawi and Mozambique to buy agricultural seeds and livestock. People from Mozambique also come to receive medical treatment in Malawi. People crossed the border into Mozambique to farm, visit friends and relatives, for livestock, crop and general trade, sex work, and employment (formal and casual).

Machinga District

The staple crops are maize and rice (also sold as cash crops), cassava and pigeon peas. The district has two lakes: Chirwa and Chiuta on the border, which local people cross in small boats. The study sites were Nayuchi Border Post and Chikweo informal crossing point, each about 2 km from one of the lakes. Malawi is landlocked and the Nayuchi border post is the main gateway to the Indian Ocean Port of Nacala, 800 km away in Mozambique. The railway line runs from Blantyre (the largest city in Malawi) to Nayuchi, then to Nacala Port and hauls much of Malawi's imports. An estimated 10,000 people gather in Nayuchi every Thursday to wait for the train from Blantyre. Since Mozambique's civil war the passenger train no longer runs to Nacala but stops at the border, but several freight trains a week from Nacala still enter Malawi at Nayuchi.

Mwanza

Mwanza is a major producer of oranges and tangerines. It is west of Blantyre and is the main gateway to South Africa through Mozambique and Zimbabwe with the largest border post in Malawi. The formal border is about 5 km from the border with Mozambique, leaving a no-man's land between the border post and the actual borderline. The informal border was Mpandasoni village, which depends on Mozambique for most of its services such as health centers, markets, maize mills and others. However, Mozambicans use Mwanza District Hospital for specialist health care. Mpandasoni

Fig. 1 Study districts

villagers buy livestock in Mozambique and farm there as well. People also cross the border for trade, sex work, and jobs.

Chikwawa

The main cash crop in Chikwawa is cotton, while maize, sorghum and pearl millet are staple food crops. Foot and mouth disease is endemic in this area, well-known for its abundant livestock. It is situated in the Lower Shire Valley at about 800 ft above sea level, mainly on the flood plains, and regularly floods when it rains upstream. The stagnant water becomes a breeding ground for mosquitoes, increasing the risk of malaria and waterborne diseases, particularly cholera and dysentery. Chikwawa has the largest sugar estate and mill in Malawi with annual production of about 30,000 t of sugar. This attracts job-seekers and truck drivers. As the home of the Majete Wildlife Reserve and Lengwe National Park, Chikwawa is also a destination for national and international tourists. Many people come to Chikwawa to buy livestock, most of which are transported live to Blantyre for slaughter.

Mulanje

Mulanje Mountain, reaching a height of 3,000 m above sea level, is the main tourist attraction in Malawi. The district is a major tea growing area, and so much land is devoted to tea that people rely on imported maize from Mozambique. People from Mozambique travel to Mulanje for tourism, trade, the tea industry, social relationships, farming, and to use hospitals and health centers just over the border.

Results

Human Health

The 547 survey respondents provided data about diseases in their households during the previous 5 years. Malaria was the most prevalent illness at all the sites, with respiratory problems in second place, followed by headaches, diarrhea and skin diseases (Table 3). These findings are consistent with the Welfare Monitoring Survey of 2006 (NSO 2007).

According to health officials and local residents, Mozambique has few health facilities along the border, so many Mozambicans travel to seek medical care in Malawi, which may contribute to spreading diseases (Fig. 2). In 2009 an unknown disease was reported in Neno District (formerly part of Mwanza), which the US Centers for Disease Control (CDC) and the World Health Organization ultimately identified as typhoid fever (Government of Malawi 2009), which is uncommon in Malawi.

Occupations

Fifty-nine percent of respondents reported farming as their main occupation (source of livelihood), followed by trading (an average of 19 % in the five districts). More people are traders in Machinga (40 %), followed by Mulanje (28 %),

Table 2 Households surveyed by district and study site

District	Site	Formal border crossing sites	Informal border crossing sites	Both types of sites
Dedza	Dedza	61	0	61
	Njonja	0	64	64
Mwanza	Mwanza	39	0	39
	Mpandasoni	0	64	64
Mulanje	Mloza	49	0	47
	Mathambi	0	46	46
Chikwawa	Kunyinda	63	0	63
	Chapananga	0	62	62
Machinga	Nayuchi	41	0	41
	Chikowe	0	58	58
	Total	254	293	547

then Mwanza (14 %), Chikwawa (10 %) and Dedza (8 %). Day labor (*ganyu*) was reported as their main occupation by 19 % of respondents in Mwanza and 10 % in Dedza. Farming is more common at informal borders (63.5 % of respondents) than at formal ones (36.5 %), whereas paid employment was more important at the formal borders than at the informal ones. Most respondents make a living by producing crops and animals or by moving them.

Seasons of Human Health Risks

In group discussions, community members said that during the rainy season, when food stocks are low and sanitation is poor, households are at risk of water- and food-borne diseases. In the dry season there is more risk of sexually transmitted diseases, due to easier mobility, trade and disposable income, particularly after selling the harvest. In the dry season people dig open wells in the *dambos* (small wetlands). Latrines are uncommon and so surface water and shallow wells are often contaminated and dysentery can spread easily.

Community Perceptions of Origin of Diseases

Unlike Rugulema *et al.*'s (2009) study of the Ugandan/Tanzanian border, few Malawians blamed disease on foreigners. The majority of respondents (63 %) said disease originated in Malawi. Only about 3 % thought that disease had come across the border from Mozambique. Communities downplay the links between human, livestock and crop disease and human mobility (Fig. 3). Travelers, when asked why they got sick, gave rational responses. They knew that malaria came from mosquitoes, cholera from drinking bad water and

Table 3 Most common human diseases reported by respondents

	Dedza	Machinga	Mwanza	Chikwawa	Mulanje	Total
Malaria	89.6	56.6	83.5	70.9	76.3	75.9
Respiratory	24.8	18.2	30.1	26.8	37.6	27.2
Headache	12.8	29.3	26.2	28.3	28.0	24.5
Diarrhea	10.4	17.2	18.4	17.3	19.4	16.3
Skin diseases	4.0	9.1	8.7	6.3	10.8	7.5
Coughing	4.8	9.1	5.8	2.4	1.1	4.6
Anemia	6.4	4.0	6.8	2.4	0.0	4.0
Epilepsy	5.6	2.0	6.8	3.1	1.1	3.8
Chronic illness	1.6	3.0	12.6	1.6	0.0	3.7
Tuberculosis	6.4	1.0	2.9	0.8	2.2	2.7
Pneumonia	0.8	4.0	3.9	0.8	1.1	2.0
Heart problems	2.4	4.0	2.9	1.6	0.0	2.2
Eye disease	1.6	5.1	0.0	1.6	1.1	1.8
Toothache	0.8	1.0	0.0	1.6	5.4	1.6
Kwashiorkor	0.0	3.0	3.9	0.0	1.1	1.5
Cholera	0.0	3.0	0.0	0.8	2.2	1.1
Asthma	1.6	2.0	0.0	1.6	0.0	1.1
Ulcers	1.6	1.0	0.0	0.8	1.1	0.9
Marasmus	0.0	1.0	1.9	0.0	0.0	0.5
Sexually transmitted infections	0.8	0.0	0.0	0.0	2.2	0.5
Bilharzias	0.0	3.0	0.0	0.0	0.0	0.5
AIDS	0.8	0.0	0.0	0.8	0.0	0.4
Other diseases	6.4	12.1	1.0	7.9	1.1	5.9

Fig. 2 A Mozambican ambulance at Mwanza district hospital. The health care system in Mozambique brings patients to this hospital in Malawi

AIDS from risky sexual partners, but did not explicitly associate travel with the spread of pathogens.

Three percent of all households had lost a family member in the previous 5 years from one of the diseases listed, especially cholera, malaria and AIDS. Between 2004 and 2008, health workers in Mwanza reported 772 cases of cholera at the border, with four deaths. Other districts also recorded deaths due to other causes: in Chikwawa, 5 % of all households had lost a member to a mobility related disease, 5 % for Dedza, and 2 % each for Machinga and Mulanje. In November 2009, cholera broke out again in Machinga and six people died (*Guardian* 2009). In Malawi, the main way of addressing the spread cholera is the distribution of posters urging people to wash their hands, which is of limited value since much of the population only has access to river water.

Conditions for Human Disease Transmission

Sanitation is poor along the border; most water points are streams shared between Malawi and Mozambique. Some streams and wells are shared with livestock and wildlife. Sanitation (e.g., latrines) at trading centers and market places was also poor. Truckers at the border often have a day or two of free time while processing paperwork and waiting for inspections and there was open commercial sex work at almost all sites visited.

Livestock Health

Seventy percent of households surveyed kept some species of livestock. The highest number was in Chikwawa (83 %), followed by Mwanza (79 %), Dedza (72 %), Machinga (60 %) and Mulanje (51 %). Livestock is more common along the more rural, informal borders.

Chickens are the most common livestock species since they are affordable and easy to manage when allowed to range free. Most households keep local chickens which are resistant to many diseases. But all 10 sites reported Newcastle disease killing poultry every year. Goats are also cheap and easy to manage and were the second most frequently kept animal (Fig. 4). In the predominately Muslim district of Machinga, few households keep pigs or dogs.

Foot and mouth disease (FMD) in cattle, Newcastle disease (NCD) and African swine fever (ASF) are present in all study areas (Chikungwa 2008). Livestock movements and disease outbreaks are seasonal. During the dry season people move their animals long distances in search of fodder and water. In the rainy season diarrhea (viral and bacterial) is common in young cattle and goats. Coccidiosis in poultry is common in the rainy season. Mastitis (bacterial), pneumonia (viral or bacterial), foot rots (fungal) are common in the rainy season from January to July because of mud and cold, but occur largely because of poor hygiene in the corral, and long distance travel is less important in their spread. Livestock tend to have more worms and ticks from October to April when the

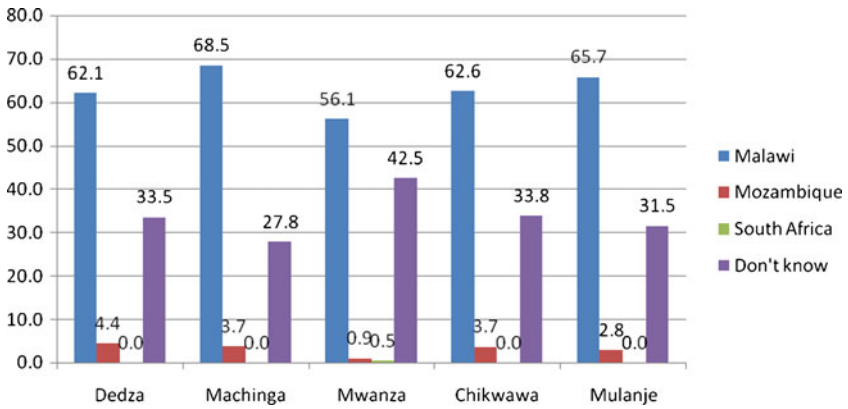

Fig. 3 Where community members think diseases come from

rain provides a favorable environment for their breeding and growth. Tick-borne diseases also occur in wildlife, which can be a reservoir for these diseases, including ASF. Village livestock assistants said that when there is an ASF outbreak in Mozambique, many of the sick pigs are slaughtered and much of the meat enters Malawi.

Most livestock in Malawi is left to graze on the open range, which the border communities share with Mozambique. Livestock also share grazing areas with wildlife which puts them at risk of contracting diseases (FAO 2008, Stories on Malawi 2008). In Chikwawa district in 2003, 2007 and 2008 there were outbreaks of FMD which is thought to have spread from wild buffalo from nearby Lengwe National Park after they broke through a fence and grazed with local cattle (Matita 2003).

Many people in Malawi think that much livestock originates from Mozambique. Our study found that animals actually move in both directions, although probably more into Malawi than into Mozambique; 41.3 % of respondents said they brought animals from Mozambique into Malawi. But many (28.9 %) also took livestock from Malawi to Mozambique. Nearly one in four travelers surveyed (22 %) said they were carrying an animal or meat or fish with them at the time of the interview. Chickens are most often transported, followed by goats, pigs and pets. Animals are brought for rearing and breeding (57 %), for slaughter (26 %) and for live sale (10 %) (Table 4). Respondents reported that they import the same species that they export, i.e., the districts that bring in pigs also take pigs out. The trade is local, but in both directions. When respondents were asked how they got livestock in Mozambique to take to Malawi, they reported buying animals (76 %), receiving them as gifts (23 %) and stealing or *kutola pa njira* "I found it on the way" (1 %).

Most respondents (85 %) said they had never had a health problem with animals they brought from Mozambique. Of those who had had animals become sick while travelling, the most common problem was general weakness (44 %), followed by coughing (18 %), diarrhea (15 %) and "depression" (13 %). This suggests that animals become sick more from getting hungry, tired and thirsty while being herded on the road than from communicable disease. Travelers correctly explained that NCD is spread by contact with infected birds, although they saw little danger in taking chickens with them on trips.

Veterinarian services are weak along the border, and human health workers in the area have little contact with the few veterinarians there are, which complicates the management of zoonoses (diseases which affect animals and people.) In Malawi, three people died from rabies in 2008. The Ministry of Health and the Department of Animal Health have combined efforts to help with dog vaccinations, but villagers tend to hide their dogs in the bush and tie them up when the vaccination team comes. They say that if their dogs are vaccinated they are not as aggressive; they will not bark, bite or hunt. They also think vaccination causes abortion in dogs. Most of the study areas are near forests, game reserves or national parks, which harbor tsetse-flies during the rainy season and transmit trypanosomiasis (sleeping sickness), which can be spread from animals to humans by flies.

Plant Health

Maize is the most common crop in all the districts and is the staple food for over 80 % of Malawians. Secondary crops varied between districts and included beans, soybeans, groundnuts, potatoes, rice, cassava, pigeon peas, cowpeas, cotton, sorghum, millet, and sweet potatoes. Almost all farmers said they got their seed from a shop and from their own farm. Malawians buy more seed in the shop than farmers in many countries. One reason for this is that NGOs promote certified seed. Also, the Government of Malawi subsidizes fertilizer and hybrid maize seed. Some farmers will buy hybrid maize seed at its full market price because they appreciate its higher yields and because it tends to mature faster, which helps in managing drought. Farmers

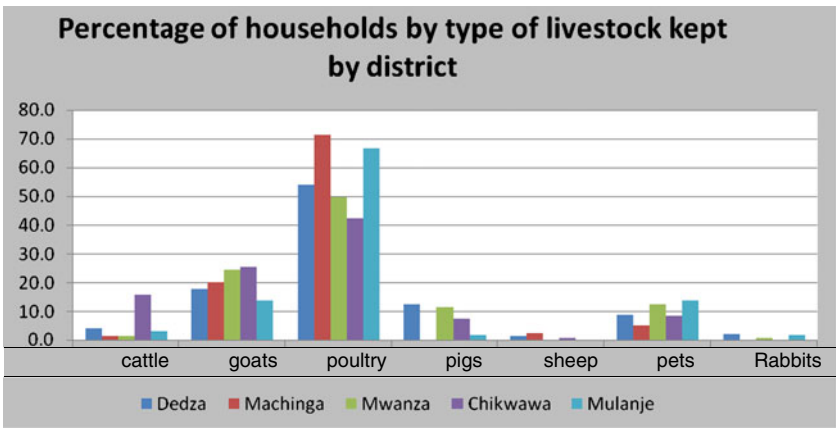

Fig. 4 Type of livestock kept by district

Table 4 Movement of livestock between Malawi and Mozambique

	Dedza	Machinga	Mwanza	Chikwawa	Mulanje	Overall
Livestock species moved out of Malawi						
Cattle	0.0	0.0	1.8	8.7	0.0	2.5
Goats	14.9	8.8	21.4	21.7	5.3	16.3
Poultry	61.7	70.6	67.9	67.4	89.5	68.8
Pigs	10.6	0.0	5.4	2.2	0.0	4.5
Pets	4.3	17.7	3.6	0.0	5.3	5.5
Rabbits	4.3	0.0	0.0	0.0	0.0	1.0
Others	4.3	2.9	0.0	0.0	0.0	1.5
Livestock species moved into Malawi						
Cattle	5.6	0.0	0.0	11.0	2.4	4.8
Goats	26.8	13.2	15.0	28.1	14.3	21.2
Poultry	45.1	71.1	70.0	47.6	81.0	59.4
Pigs	9.9	0.0	6.7	9.8	0.0	6.5
Sheep	1.4	0.0	1.7	0.0	0.0	0.7
Pets	5.6	15.8	6.7	3.7	0.0	5.8
Rabbits	5.6	0.0	0.0	0.0	2.4	1.7

get most of their seed in Malawi although some is imported from Mozambique (Table 5). Farmers in the discussion groups said that they preferred buying cheaper, uncertified (and untreated) cotton seed from Mozambique. Importing uncertified seed may pose a risk to cotton growing from the seed-borne cotton mosaic virus, for example, which we observed in the field.

Thresh and Cooter (2005) claim that cassava mosaic disease (CMV) has been in Malawi since at least 1993. In Machinga farmers complained of their diseased cassava, and we observed that almost all of their plants showed CMV symptoms. In about 2004 or 2005, NGOs gave them improved varieties which may in fact have been infected. Now farmers go to Mozambique to find clean planting material, arguing that they cannot take cuttings from their own field because the sticks are stunted.

In Chikwawa farmers in one focus group remembered that in 1942 the district was attacked by stalk borers which destroyed over 40 % of their maize crop.[4] They added that in 1980, maize streak virus, now endemic, destroyed over half of the maize. It is vectored by a planthopper and is seed-borne. The disease has stayed because people grow off-season maize (*dimba*) with irrigation, so they have maize and planthoppers for most of the year, a common problem as production systems intensify. The Chikwawa farmers also said that in 1985 wireworms affected more than 75 % of their maize crop. Although in subsequent years they had fewer wireworms they remained present. The worms (larvae of the click beetle, *Elateridae* spp.) are cosmopolitan and can be transmitted in vegetable seedlings in soil. Also in 1985 the cowpeas in Chikwawa were attacked by a mosaic virus that continues to reduce the yield of the crop. The farmers called mosaic symptoms *khate*, which means "leprosy" in Chichewa. This is a reference to the symptoms, but is also evidences that local people perceive an analogy between plant and human diseases (see Bentley *et al*. 2009, and Rugalema *et al*. 2009).

New pests may enter the country more than once. The larger grain borer (*Prostephanus truncatus*) appeared in Malawi for the first time in Karonga, across the border from Tanzania, during a maize shortage in 1991 (Munthali 1992, cited in Farrell 2000). According to an extension agent in Machinga, the larger grain borer appeared in Machinga later, in 2002 when there was another maize shortage and much maize was imported from Mozambique. Trucks from Blantyre would buy all the maize that was offloaded from the train from Mozambique without bothering about weevils or borers. The borer flies only short distances and has mainly spread through Africa via the maize trade (Farrell 2000).

Bacterial wilt (*Ralstonia* [*Pseudomonas*] *solanacearum)* is one of the more serious potato diseases worldwide and is transmitted in seed and soil. It is endemic in Malawi and Mozambique. Farmers have no source of fresh, clean seed. They rotate their crops for two or three seasons (over 1–2 years, roughly in line with recommended practice), but without access to clean seed the disease returns. Movement helps to introduce, establish and spread exotic species. As interviews showed, some like the larger grain borer, stalk borers, tuber moth arrived within living memory (Table 6).

In the household survey, 60 % of the people who travel from Malawi (mainly to Mozambique) had brought back

[4] In fact, the species involved (*Chilo partelus*) originated in India and is thought to have been introduced to Mozambique in 1930 (Tembo 2007).

Table 5 Perceived origin of seed or planting material

District	Formal border			Informal border		
	Malawi	Mozambique	Don't know	Malawi	Mozambique	Don't know
Dedza	72.1	19.0	9.0	86.3	10	3.6
Machinga	80.7	16.0	30.4	93.2	3.2	3.7
Mwanza	96.5	0.9	2.7	93.5	5.6	0.9
Chikwawa	96.6	2.6	0.9	99.0	1.2	0
Mulanje	89.2	3.9	7.0	90.3	9.2	0.5

seed and planting materials at least once. People often bring home seeds of crops that are common where they live as gifts for friends and family (Table 7). In each case, the crops that are exported are also the crops that are imported. The trade is local and reciprocal.

Human Movement

Most of the Malawi-Mozambique border is unmarked. As Wittmayer and Büscher (2010) describe for South Africa and Lesotho, the people on either side of the border speak the same language (e.g., Chichewa), belong to the same tribe, and have historical connections. Cross-border marriages are common. Local people don't perceive the border. They say it is "like walking across the street." According to the household survey, the most common reason for Malawians to go to Mozambique was to visit relatives (57 %), followed by trade in livestock and crop products (10 %), seeking wage labor (5 %), holiday or tourism (5 %), trading and business (2 %), seeking health facilities (2 %) and farming (2 %). In Mulanje, where most of the best land is used by the tea plantations, some people migrate to Mozambique to farm. It is the reverse in Mwanza, where Mozambicans farm in Malawi. According to the survey of 87 travelers (at formal and informal border crossings), most said they cross the border often (Table 8) and few travel empty handed (Table 9).

Border authorities only inspect (some of the) seed or planting material, but not cooked food or produce. Uncertified seed is not tested for pathogens. Bulk maize from Mozambique is not returned at the border even if it is badly infested with weevils. In Mulanje (at Muloza border), we observed a 30-tonne truck loaded with maize grain that had weevils crawling all over the truck and the bags. This truck was offloaded into a warehouse 200 hundred meters from the border post in Malawi without any inspection.

Few if any animals enter Malawi at formal borders. Besides hand-carried pets and chickens, the only animals crossing the border formally are dairy cows, breeding stock imported by the Government of Malawi from South Africa, which go directly to quarantine before being distributed.

Table 6 Summary of main arthropod pests (Compiled by study team)

Main disease/pest (Cause and crop)	How the pest can spread via travel
Larger grain borer (LGB) *Prostephanus truncatus* (weevil-like beetles, stored grains, cassava)	Infested sacks, infested grain
Weevils e.g. *Sitophilus* spp. insect pests of stored grain (sorghum, pear millet, maize)	Infested grain, grain transport
Bruchids e.g. *Acanthoscelides obtectus*, *Callosobruchus* spp. (storage pests of beans, cowpeas)	Infested grain, grain transport
Army worms (*Spodoptera exempta*) (caterpillar, cereals)	Infested sugarcane if harvested with shoot on
Stalk borers (*Chilo* sp, *Busseola fusca*, *Sesamia* sp) (caterpillar, cereals)	Infected green maize cobs, sale of green maize from one area to another
Maize earworm (*Helicoverpa* spp.) (caterpillar in field maize)	
Potato tuber moth (*Phthorimaea operculella*) (caterpillar, stored potatoes and field)	Infested planting material
Wire worms (beetle grub, attacks roots of cereals)	Infested implements
Elegant grasshopper (attacks cereals, groundnuts, beans, cassava)	Not related to mobility
White grubs, beetle grubs in roots of maize, beans, groundnuts, cassava	Movement of roots or soil infested with larvae
Beetles (*Ootheca* spp) field pests of beans	Not related to mobility
Red bollworm (*Diparopsis castenea)*, cotton strainers (*Dysdercus* spp), aphids (*Aphis gossypii*), stink bug (*Nezara* spp), cotton jassids (insect pests of field cotton)	Not related to movement
Aphids (*Aphis craccivora*, pest of cabbage and vegetables)	Infected produce
Red spider mite (pest of potatoes and tomatoes)	Wind, irrigation & flood water, insects, farm tools, clothing, footwear, produce, containers & seedlings

Otherwise, all cows, goats, sheep and pigs are herded across the border at informal crossings. The owners do this to avoid paying duty, but also because there are really no facilities for them at the formal borders. A herd of livestock would disrupt vehicle traffic, while the cars and trucks would startle the animals. Since the bird flu scare of 2006, Malawian livestock inspectors have confiscated and destroyed fresh eggs crossing into Malawi, because eggs may have virus in the feces on the egg shells. But these are small imports, the occasional passenger with 30 or 60 eggs.

Authorities have no equipment to help them inspect goods. They lack computers, scanners and other tools which are common at airports. Pedestrians and cyclists are barely checked, regardless of what they carry, unless border authorities suspect some illegality.

Conclusions

In rural Africa, most people live by farming, fishing, herding livestock or processing and transporting plant and animal products. Some people travel specifically to move plants and animals, while others travel to visit relatives, for example, but the occasion may call for taking a hen as a gift, or returning with some crop seeds to try at home. Whether they cross a border or stay in their own countries, travelers in Africa potentially spread plant, animal, and human diseases, especially since some travel specifically because they are ill.

Before this study, the FAO believed that refugees from the Mozambique civil war were responsible for much of the cross border travel, since they had stayed in Malawi, built homes, put children in school and were now travelling

Table 7 Movement of crops and planting materials between Malawi and Mozambique

Crop	Households carrying crops/planting materials by district (percentage)					
	Dedza	Machinga	Mwanza	Chikwawa	Mulanje	Overall
Maize (out)*	23.5	27.3	34.9	39.1	38.2	31.9
Maize (in)	22.0	21.7	28.2	38.3	38.4	29.2
Net[a]	1.6	5.6	6.7	0.9	−0.2	2.7
Tobacco (out)	1.7	0.9	0.0	0.0	1.5	0.8
Tobacco (in)	1.1	0.0	0.7	0.7	0.0	0.5
Net	0.6	0.9	−0.7	−0.7	1.5	0.2
Groundnuts (out)	15.1	10.9	6.8	6.5	2.9	9.0
Groundnuts (in)	10.4	9.8	7.4	10.1	4.0	8.6
Net	4.7	1.1	−0.6	−3.6	−1.1	0.4
Potatoes (out)	5.9	1.8	1.5	0.0	0.0	2.1
Potatoes (in)	8.2	3.5	3.0	0.0	0.0	3.3
Net	−2.4	−1.7	−1.4	0.0	0.0	−1.2
Cassava (out)	3.4	10.9	8.3	1.1	14.7	7.3
Cassava (in)	3.3	17.5	6.7	0.7	4.8	6.4
Net	0.1	−6.6	1.7	0.4	9.9	0.9
Millet (out)	0.8	2.7	0.0	7.6	1.5	2.3
Millet (in)	3.9	1.4	0.0	5.4	1.6	2.6
Net	−3.0	1.3	0.0	2.2	−0.1	−0.3
Soya-beans (out)	11.8	0.9	0.8	1.1	0.0	3.3
Soya-beans (in)	7.7	0.0	0.0	0.0	0.0	1.9
Net	4.1	0.9	0.8	1.1	0.0	1.4
Cotton (out)	0.0	0.0	0.0	8.7	0.0	1.5
Cotton (in)	0.0	0.0	0.0	5.4	0.0	1.1
Net	0.0	0.0	0.0	3.3	0.0	0.5
Rice (out)	0.0	13.6	0.0	10.3	10.3	4.2
Rice (in)	0.0	9.1	0.0	0.0	3.2	2.3
Net	0.0	4.6	0.0	10.3	7.1	1.9
Beans (out)	22.7	7.3	12.9	5.9	5.9	11.5
Beans (in)	22.5	2.8	9.4	9.4	10.4	11.2
Net	0.2	4.5	3.5	−3.5	−4.5	0.4

Out=percentage of households that carried a crop outside Malawi. *In*=percentage of households that carried a crop into Malawi

[a]If the net percent of households is positive, it means more households carry that crop out of Malawi, if it is negative; more of that crop is carried into Malawi than out of Malawi

Table 8 How often people travel

Responses to "How often do you come here in a year?"	Frequency and percentage
Once	5 (5.7 %)
Two or three times	6 (6.9 %)
Four to eight times	4 (4.6 %)
Once a month (12 to 15 times)	6 (6.9 %)
Once a fortnight (20 to 24 times)	8 (9.2 %)
Between 25 and 39 times a year	6 (6.9 %)
Every week (between 40 and 52 times a year)	10 (11.5 %)
Almost twice a week (between 53 and 104 times a year)	13 (14.9 %)
More than twice a week (between105 and 280 times a year)	12 (13.8 %)
Almost daily (between 300 and 365 times a year)	16 (18.4 %)
No response	1 (1.1 %)
	87

From survey of 87 travelers

frequently across the border to farm in Mozambique. Malawian officials were unsure how many Mozambicans had settled permanently in Malawi, but the numbers (Table 1) suggest that there was no great surge of population in the Southern Region (which hosted most of the Mozambican refugees). The Malawians and Mozambicans along the border have a great affinity for each other. They have relatives across the border and speak the same local languages (e.g., Yao or Chichewa) and so different national languages (English vs. Portuguese) are rarely a communication barrier. In most places the border is merely an imaginary line, with brisk travel back and forth. Formal border posts are only active at major highways.

We began with a bias that cross border travel threatened the health of people, crops and livestock. In some instances this may be true, but travel is also the lifeblood of a healthy economy. And travel *within* a country is qualitatively similar and has the same potential for spreading disease. Travel affects plant, animal and human diseases in different ways. While humans, crops and livestock all suffer from fungal, bacterial and viral diseases, crops are more vulnerable to new health problems (possibly because there are more species of crops than of livestock) and are by far more likely to be attacked by insects and other arthropod pests. It is mainly the crops which are victims of new insect pests (e.g. stemborer, wireworm, cassava mosaic, larger grain borer) which cross the border and then stay in Malawi. Crop pests and disease have emerged frequently in the study area.

While there is a net movement of foodstuffs from Mozambique to Malawi, there is also movement the other way, to Mozambique from Malawi. Yet there is little evidence for what economists call "comparative advantage."

Table 9 What travelers said they were carrying at the time of the interview

Item carried	Frequency	Item carried	Frequency
Plants	34 (39.1 %)	Animals & plants	8 (10.3 %)
Maize	7 (8.0 %)	Chickens & potatoes	1 (1.1 %)
Cotton	3 (3.4 %)	Chickens & groundnuts	1
Hominy (*mphale*)	2 (2.3 %)	Maize & fish	1
Cassava	2 (2.3 %)	Maize, sweet potato, chickens, bananas sugarcane, cabbage, cassava & rice	1
Tomatoes	1 (1.1 %)	Sweet potato, maize & doves	1
Cabbage	1	Fish & cabbage	1
Groundnuts	1	Fish, tomatoes, rice & maize flour	1
Tobacco	1	Maize flour, tomatoes, meat, tangerines	1
Tangerines	1	*Khobwe*, chickens, groundnuts & maize	1
Pumpkin seed	1	Animals only	7 (8.0 %)
Maize seed	1	Chickens	4 (4.6 %)
Maize & sorghum	1	Fish	1 (1.1 %)
Maize, sunflower, pigeon peas, beans	1	Pig	1
Maize & sweet potato	1	Chickens & goats	1
Groundnuts & pigeon peas	1	Manufactured items & plants	7 (8.0 %)
Cotton & maize	1	Maize & a bicycle	1 (1.1 %)
Cabbage & tomatoes	1	Apples & blankets	1
Cassava & tangerines	1	Clothes, oranges, groceries	1
Tomatoes, pumpkin seed & leafy vegetables	1	Mattresses, tobacco sugarcane, blankets & oranges	1
Cabbage, tomatoes, onion	1	Leafy vegetables & mattresses	1
Potatoes & cabbage	1	Maize flour & bicycle	1
Potatoes	1	Electronics, sweet potato, banana, oranges	1
Sorghum & maize	1	Manufactures & animals	3 (3.4 %)
Tangerines	1	Chickens & a sound box	1 (1.1 %)
Manufactures only	10 (11.5 %)	Chickens & clothes	1
Clothes	1 (1.1 %)	Bicycle & fish	1
Bicycle	1	Manufactures, plants & animals	1
Fertilizer	1	Maize, fish, hoe & a mattress	1
Distilled alcohol	1	Processed food, salt, meds etc.	6 (6.9 %)
Money & a bicycle	1	Guns, water, bread	1 (1.1 %)
Money & clothes	1	Hoe (a tool, for work)	1
Clothes & mattresses	1	Salt	1
Motorcycle & books	1	Biscuits, medical stores	1
Bicycle & clothes	1	Eggs, salt, matches	1

Table 9 (continued)

Item carried	Frequency	Item carried	Frequency
Polythene plastic	1	Pearl millet, salt, sugar	1
Nothing (or blank)	8 (9.2 %)	Only money	2 (2.3 %)
		Total	87

The same species are traded in both directions, suggesting generalist agrarian economies based on mixed farming.

The most serious animal diseases, such as African swine fever, foot and mouth, diarrhea, Newcastle disease etc., have reservoirs within Malawi (often in wildlife) and need holistic management (e.g., vaccinations and reduced contact with wild animals) to improve animal health. Travel per se is not a great source of animal diseases. Most of our respondents said they had never had an animal become sick after crossing the border. Most of the animals that did get sick were probably just tired, hungry and thirsty from being herded a long distance.

Of the major human diseases, malaria is from Africa (Joy *et al*. 2003), cholera was introduced from Asia (Gaffga *et al*. 2007) and AIDS jumped from other non-human primates (Woolhouse *et al*. 2005), yet their origin is now a moot point. They are all present in Malawi now. All three diseases can be managed by public health initiatives (e.g., mosquito control, clean water, latrines, and readily available condoms and medications). Travel per se is not the problem. Local people do not perceive travel as inordinately risky, and this is probably realistic.

Since some people travel to seek medical attention, simply improving hospitals and clinics on both sides of the border would ease their suffering, including those that have infectious diseases. Some public health problems are underprioritized. Although public health action in Malawi is focused on AIDS, many people also die from drinking filthy water. There are two chickens for every Malawian, and every year most of these birds die from Newcastle disease (personal communication, Dr. Ben Chimera, veterinarian and head of the livestock department at the Ministry of Agriculture and Food Security). Maize is ruined by weevils and other small beetles before people can eat it. Potato growers have no source of seed which is free from bacterial wilt, and cassava viruses are still spreading from garden to garden. All of these problems harm Malawian's health and literally eat up the food supply, but they receive little attention from the public sector.

There will be fewer pests and diseases to transmit if the people, crops and animals of Malawi are healthy to begin with. This involves: basic healthcare for everyone, clean drinking water in every village, vaccinations for livestock (including poultry) and basic veterinarian healthcare, plant health care, cleaner planting materials, less movement of infected materials, appropriate technology for managing pests and diseases and practical information for rural people on plant, animal and human health.

Local people have a fairly rational view of the causes of disease. An awareness campaign urging people not to carry diseased animals or plants might help reduce the spread of disease. Less movement of chickens would help lower the incidence of Newcastle disease. It would be useful to warn people that the planting material of vegetatively-reproduced crops (like cassava and potato) frequently carry plant diseases, but that diseases are also spread by true seed (e.g., cotton) and food for grain (e.g., weevils in maize). Rather than restricting border traffic, it would probably be more useful for African governments to monitor plant, human and animal diseases more closely and to share information with each other on emerging health problems so countries have time to prepare for new diseases before they arrive.

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