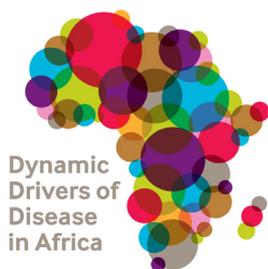




Responding to uncertainty: Bats and the construction of disease risk in Ghana

Linda Waldman, Audrey Gadzekpo and Hayley MacGregor

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Responding to uncertainty: Bats and the construction of disease risk in Ghana

Zoonotic disease has gained international attention since the identification of avian and swine influenza, with academic focus on the modelling of disease emergence, and policy centring on disciplinary approaches of analysis. Recent scholarship has recognised that the conditions which encourage zoonotic diseases are both ecological and socio-political. The challenge lies in the deeply complex causality and high uncertainty in identifying causal links between human, wildlife and livestock diseases.

There is a disjuncture between existing academic knowledge on zoonoses and the role that uncertainty plays in anticipating and preventing future outbreaks of as yet unidentified diseases, and the way that policymakers tend to frame such evidence. This paper examines Ghana policymakers' diverse perspectives on uncertainty related to newly emerging zoonotic diseases through the specific example of fruit bats, showing why it is so difficult to develop appropriate policy for emerging zoonotic disease. These animals have significant potential for zoonotic transmission, as evidenced in the 2014 Ebola outbreak in West Africa. This research predated this outbreak and provides a prescient account of framings of risk, uncertainty and zoonotic disease potential prior to this regional crisis.

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The Dynamic Drivers of Disease in Africa Consortium is a multidisciplinary research programme designed to deliver much-needed, cutting-edge science on the relationships between ecosystems, zoonoses, health and wellbeing with the objective of moving people out of poverty and promoting social justice. It is focusing on four emerging or re-emerging zoonotic diseases in four diverse African ecosystems – henipavirus infection in Ghana, Rift Valley fever in Kenya, Lassa fever in Sierra Leone, and trypanosomiasis in Zambia and Zimbabwe.

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Acronyms

CBPP	Contagious Bovine Pleuro Pneumonia
CBS	Community Based Surveillance
CDC	[United States-based] Centre for Disease Control
CREMA	Community Resource Management Area
EPA	Environmental Protection Agency
GNA	Ghana News Agency
HIV/AIDs	Human Immunodeficiency Virus Infection/Acquired Immune Deficiency Syndrome
KCCR	Kumasi Centre for Collaborative Research in Tropical Research
MERS	Middle East Respiratory Syndrome
NADMO	National Disaster Management Organisation
NAMRU	United States Naval Medical Research Unit
NGO	Non-Governmental Organisation
NPR	National Public Radio
NYD	Not Yet Diagnosed
TAD	Trans-boundary Animal Diseases
UENR	University of Energy and Natural Resources
TB	Tuberculosis
UK	United Kingdom

Introduction

'Bats were the forgotten species. No-one thinks of them as posing a threat to human life'
[Dr Richard Suu-Ire, Ghana Wildlife Veterinary Specialist, 2012].

Significant international attention has been focused on emerging zoonotic disease since the identification of avian influenza in the late 1990s, swine influenza in 2009 (Rubin 2009) and the recent 2014-2015 Ebola outbreak in West Africa, which postdates the research for this work but makes it even more pertinent. International attention on zoonotic disease has been complemented by an academic focus on the modelling of disease emergence, and policy interest in a standardised approach to disease mapping and risk assessment, surveillance systems and regulation. There has been increasing recognition that the conditions which encourage zoonotic diseases, both newly emergent and endemic, are both ecological and socio-political. This calls for novel understandings of social and ecological processes, and attention to the intersections of human and animal health, as articulated in policy terms especially in the One Health Initiative. The One Health initiative is a collaborative, multi-disciplinary approach which seeks an integrated response in order to develop optimal health across human and animal populations as well as the environment, and at local, national and global levels.

The transdisciplinary study of emerging zoonotic diseases is a growing academic field. While such transdisciplinary approaches are desirable, identifying the causal links between human health, wildlife and livestock diseases, environmental change and ecosystem dynamics at different scales remains challenging, as causality is deeply complex and uncertainties high (MEA/WHO 2005; Costello 2009). For instance, in examining animal migration and zoonotic disease risk for humans, Altizer *et al.* (2011) demonstrate how many questions remain unanswered in relation to pathogen emergence, resistance, and pathogen shedding even before the nexus of human behaviour, ecosystem properties and disease risk has been addressed. Dudley (2008) identifies a wide range of uncertainties in relation to avian influenza and public health concerns which include key facts about the ecology and epidemiology of the influenza viruses, the dynamics and mechanisms of transmission, uncertainties around 'spill-over' and 'spill-back', vaccine effectiveness, as well as the risk factors associated with human involvement. As Stirling and Scoones (2009) have pointed out, the reality of so many uncertainties has led to a focus in the literature on 'science-based risk' assessment methods which emphasise 'outcomes' and 'probabilities' to assess 'risk'. As this paper demonstrates through examining the context of Ghana, the reality of uncertainty and the focus on measuring and defining risk of disease emergence, extends beyond the academic sphere to influence the actions of policy makers. At the same time, different actors have different perspectives on uncertainty and opinions as to the degree of risk, and this too shapes the ways in which policy makers respond. In broadening the discussion to incorporate diverse perspectives and to reflect on the policy process, this paper explores a variety of perspectives on, and interpretations of, uncertainty in relation to new emerging zoonotic disease. In so doing, it challenges the notion that scientists and policy makers always identify the same risks in relation to such disease.

The paper examines these questions of uncertainty and the assessment of the risk of zoonotic disease emergence and associated policy responses through the example of fruit bats in Ghana. Fruit bats have been scientifically identified as a reservoir of relevant viruses that make them a potential source of known zoonotic disease as well as new disease emergence (Flanagan *et al.* 2012). Most recently in 2014, subsequent to the research reported in this paper, the link between a bat reservoir and the Ebola outbreak in another part of West Africa has significantly underscored the association of bats with Ebola, a well-known and much-feared zoonotic disease that has established human to human transmission. Prior to this Ebola outbreak, with respect to new emergent zoonotic disease, the significance of bats as a potential reservoir was elevated in academic and international policy circles,

for example by the cases of spillover to humans investigated in Bangladesh, Malaysia, Singapore, India, Cambodia and Australia (Gurley *et al.* 2007; Gurley *et al.* 2007a; Montgomery *et al.* 2008; Reynes *et al.* 2005; Chadha *et al.* 2006; Nahar *et al.* 2010; Luby *et al.* 2009; Young *et al.* 1996; Hooper and Williamson 2000; Barclay and Paton 2000; Field 2009). Over the past few years, bats (along with monkeys) have come to be identified as sentinel and iconic creatures in the search for viruses because they demonstrate 'greatest potential for zoonotic transmission and emergence' (Jones *et al.* 2011; Calisher *et al.* 2006). Across the world, and in many different contexts, bats have thus assumed a new strategic importance in relation to zoonotic disease attention (Wang and Hu 2013; Leroy *et al.* 2005). Global organisations have become interested in bats because of their potential to serve as an example to help understand and control zoonotic disease spillover. Local and national actors, such as in wildlife, veterinary and human health sectors, are potentially interested in bats for other more personal and career-orientated or conservation reasons. The international media has made much of bats and virus hunting (see Cruzan Morton 2013; Leung 2004; Doucleff 2013; Gale 2009). Following the outbreak of the Middle East respiratory syndrome virus (MERS), which infected 96 people and killed 47, Doucleff (2013), for example, produced a series of reports for National Public Radio (NPR) in which she cited scientific research linking bats to coronavirus.

Galaz argues that the interplays between environmental change, ecosystem dynamics and human behaviour and health are particularly difficult to unravel as, 'uncertainties are high and causalities complex' (Galaz 2010: 2). In Ghana this is further complicated by the fact that, whilst organisms with known zoonotic potential have been identified in bats, spillover of disease from bats to humans has until very recently been suspected but unconfirmed. For example, bats sampled in Ghana have been identified as reservoirs of Hendra and nipa viruses (Hayman *et al.* 2008b), which have been linked to new spillover events elsewhere in the world such as in Bangladesh (Luby *et al.* 2009), albeit without human to human transmission being established to a significant level. However there has not been confirmation of spillover to humans in Ghana of these particular viruses. The risk of spillover and the identification of viruses in bats as a source of new emerging zoonotic disease is not widely known beyond specialist research circles. At the time of research, bats in Ghana were known within these same specialist circles to be reservoirs for Ebola, which does have established human to human transmission. However, at that time, this knowledge was not widely known or disseminated in Ghana.

Fruit bats in Ghana constitute an interesting case study to consider how socio-ecological issues get framed and understood, in a context where generalised disease risk from emerging infections is not strongly established and where, although there is potential for infection, no large-scale definitive outbreaks have occurred in humans. In addition, there is lack of clarity over the potential pathways of transmission routes from bats to humans. The specialist research activity into bats and zoonotic disease in Ghana and the perpetuation of many questions and uncertainties has resulted in a situation in which, as explored in this case study, risk is assessed differently by different actors within the policy sphere. This in turn, has implications for resources and the degree of planning for and the extent of zoonotic disease surveillance. We argue that these unknowns and uncertainties create a disjuncture between scientific research that aims to identify emerging infections, and the reality of policy makers' knowledge and awareness of risk and the extent to which they think it important to orientate human and veterinary public health surveillance systems towards emerging, as opposed to known and identified, zoonotic diseases. Moreover, the paper goes on to explore policy makers' difficulties and anxieties around communicating uncertainty about risk to a wide population and the role of the media in relation to this. The paper interrogates the diverse kinds of evidence required by policy makers in different sectors, and how the focus on evidence leads them to frame zoonotic disease in different ways. The emphasis on evidence leads, in turn, to processes which crowd out a focus on emerging zoonotic diseases in favour of endemic disease; in which zoonotic disease transfer from livestock is given priority over that of wildlife; and in which other forms of wildlife (birds for example) have received attention while bats – despite their international attraction as viral hosts – have until very recently remained neglected. The paper demonstrates how risk is appreciated differently, and how

these different appreciations or framings filter through to policy. Focusing on multiple framings and on the contexts in which knowledge is assessed, it further explains some of the reasons why policy responses are not always as expected.

Whilst the focus of the research reported in this paper was specifically on framings of the risk of newly emergent zoonotic disease in Ghana, it was very evident that knowledge of well-known diseases, such as Ebola, and endemic zoonoses, such as rabies, interacted with perceptions about potential new infections to shape understandings of risk of emergence and spillover. Since the Ebola outbreaks in 2014, the knowledge that bats are reservoirs of this disease has been catapulted into media and public imagination. This research however predated these very recent events elsewhere in West Africa and thus provides a prescient account of perceptions of risk and flows of knowledge prior to this regional crisis, showing policy responses in a context of uncertainty and in the absence of such a noteworthy and deadly outbreak. For Nipah and Hendra, the other, newly emergent zoonotic diseases discussed in our research, Ghana has not experienced epidemic spread; and as a result uncertainty, even regarding spillover to humans, remains a key feature. The extent to which recent events in the West African region will affect policy discourse, risk assessments and surveillance responses for emerging zoonotic diseases as well as for subsequent Ebola epidemics, remains to be seen.

Method

Through an exploration of academic research, policy processes, media reports and health surveillance priorities, this paper examines the impact of scientific research and knowledge about emerging zoonotic disease in relation to bats in Ghana. Qualitative research was undertaken in Accra, Ghana during May 2012 and October 2012 when there was no definitive research evidence of disease spillover from bats to humans, although international researchers had alerted Ghanaian Government officials that this possibility existed. Twenty six open-ended interviews were conducted with key policy makers with an interest in zoonotic disease outbreaks, such as veterinary and human public health officials and a representative from the national disaster response agency; academics involved in bat research, public health, and disease surveillance; doctors and a veterinarian employed by the Ghana military; and state wildlife officials and conservationists in the state and NGO sectors. These interviews explored understandings, awareness and actions relating to bats and disease risk in Ghana, as well as assessing awareness of scientific research on bats in Ghana. Questions were open-ended and a discussion of disease risk from specific organisms was not pursued unless an interviewee expressed a knowledge of scientific findings. Where applicable, questions were posed about policy developments and factors that could catalyse new policies, as well as existing priorities in zoonotic disease policy and the extent of surveillance measures in the human and veterinary health sectors. Interviews lasted on average one hour. In keeping with ethical approval received from the Noguchi Institute of Public Health, these informants have been anonymised and positions and institutional affiliations are not specifically given. Several individuals interviewed had more than one institutional affiliation, such as with the veterinary as well as wildlife services. A few of the doctors worked clinically whilst those involved in policy or public health did not.

In addition, a search of the media was undertaken in 2012 to determine the sources of information on bats and zoonotic disease as well as how risk and uncertainty were being framed. Thus, where Ghanaian officials have made public statements about zoonotic disease which are readily available and/or disseminated in national media, these individuals have been named.

Context: Bats and Ghana

Ghana is populated by several species of bat and this includes both fruit-eating and insect-eating bats. The migratory straw-coloured fruit bat (*Eidolon helvum*) roosts in extremely large colonies which can comprise several million inhabitants in both urban and rural areas (Hayman *et al.* 2010). There are several well-known, sizeable Eidolon bat colonies in Ghana which are frequently cited as eco-tourist sites. These include a large roost at Buoyem, BrongAhafo Region, Shai Hills in the Greater Accra Region, Wli Falls in the Volta Region and at 37 Military Hospital in the capital, Accra. The roost at 37 Military Hospital is particularly well-known, and for various reasons, contentious. It is situated in the gardens of one of Ghana's most important hospitals, in the centre of the city and at an intersection of several major transit routes. There is an urban legend that the bats accompanied their chief, who came to the hospital seeking treatment. The chief died and the bats have stayed, waiting for their chief. There are many other beliefs associated with bats amongst the various ethnic groups in Ghana. Bats are variously associated with sacredness, burial and chiefly authority, with evil and witchcraft, or with providing protection and wellbeing (Ismael 2005). At a more mundane level, the bats are considered a nuisance, noisy, polluting and smelly. At the same time they are a source of food, particularly for the Kwahu of the Eastern Region, and as a form of bushmeat, are a delicacy. There is also a belief that eating bats can provide immunity to disease. In contrast they are commonly linked to rabies and in a few cases to ringworm.

Over the past few years, there has been increasing interest from scientists in bats as an object of scientific research, focusing specifically on bat virology and ecology. With the presence of several collaborative research teams involving United Kingdom (UK), German and Ghanaian research partnerships, there has been a substantial number of academic publications linking bats to disease in Ghana (for example, Epstein *et al.* 2008; Hayman *et al.* 2008a; Hayman *et al.* 2008b; Drexler *et al.* 2012; Canuti *et al.* 2011; Annan *et al.* 2013). In addition to the long-established links between bats and rabies, bats in Ghana have been associated with the Lagos Bat Virus (Hayman *et al.* 2008a), Hendra, Nipah¹ (Hayman *et al.* 2008a; Hayman *et al.* 2010) and, more recently, Ebola (Hayman *et al.* 2008a; Hayman *et al.* 2012). As one Ghanaian official commented:

Increasingly everyone is a little worried because of interacting with us, trying to find out in the lectures we give. They ask more and more if these bats don't pose a health risk. As we begin to dig deeper people ask, why are you looking, why are you taking blood?

¹Hendra and Nipah cause severe encephalitis in humans. The disease begins as a mild fever, headaches and muscular pain before progressing rapidly to coma and death over a period of 10 days. The ratio of cases to fatality is 40–76 per cent (Montgomery *et al.* 2008). The viruses can be transmitted directly to humans through direct contact with bat urine, saliva and guano.

Framings of zoonotic disease risk: the perspectives of key actors

Zoonotic disease from wildlife pose particular challenges when examining the relationship between emerging disease, risk and policy, because it cuts across issues of conservation, veterinary services and public health, each of which has sectoral and disciplinary boundaries, responsibilities and priorities. Personnel in each of these sectors have been trained in particular ways, with specific interests and roles. For example, all the veterinary scientists interviewed knew of the potential for bats to carry rabies. As one explained, 'as a veterinary student at vet school, the first problem is rabies. Every vet student knows this'. For medical doctors, however, bats were simply never an issue. 'At medical school I was not really told anything [about bats], maybe in connection with rabies but the more important was dogs.' Rabies itself is predominantly seen as an animal disease, to the extent that one military veterinarian reported that sometimes when a dog with suspected rabies bites a human in Ghana, both the victim and the dog are brought to the vet for treatment.

Such sectoral approaches are of limited value when dealing with emerging zoonotic disease as the situation is highly complicated, involving social, ecological and technological systems as well as, 'the messy political complexities of disease-risk governance' (Stirling and Scoones 2009). This research took place in the midst of a muddled, contingent process of natural science research, knowledge generation and policy response in Ghana. As teams of scientists in both Kumasi and Accra searched for new viruses in bats, seeking permission from, and feeding back information to, influential officials in government ministries and departments, new knowledge came to be acquired by a select circle of scientists and government officials. In exploring the different ways in which Ghanaian public officials interpreted the knowledge of potential spillover, especially of Hendra and Nipah viruses from bats to humans, we focused on the diverse framings of disease risk that informed how they evaluated the situation, drawing on existing and emerging knowledge and evidence. For the most part, officials regarded the knowledge of the risk of potential spillover of Hendra or Nipah as relatively benign. This was, in part, because of the lack of evidence of human suffering and because of the lack of exposure to any outbreaks. However, in early 2010, increasing evidence became available to researchers that bats can harbour the Ebola virus (Hayman *et al.* 2010). Ebola, not in the category of a potential new emergent disease, was much more familiar to Ghana's public officials who all knew of past outbreaks with human to human transmission in African countries such as Uganda and Congo. The knowledge that bats harboured Ebola viruses, the cause of a known and deadly human disease, albeit zoonotic, was seen by these natural scientists as potentially explosive and was carefully disseminated to relevant public officials during the course of this research. It was therefore not widely known at the time of our interviews. We were cautious not to prompt informants while seeking to understand how knowledge of bats and potential spillover is inserted into, and related to, veterinary, wildlife and health sectoral and disciplinary boundaries, responsibilities and priorities to shape particular framings of the problem.

In this paper, 'framings' refers to the ways in which scientific topics are delineated and interpreted, which influences policy processes. Framings are often implicit – shaped through cultural contingencies, life experiences, intellectual paradigms, political agendas, policies and scientific knowledge – and operate to limit possible approaches and solutions to a problem. In contrast, an explicit exploration of framings opens up the possibility of assessing multiple perspectives (Leach *et al.* 2005). Moreover, framings are often influenced by power. Official framings of risk tend to exaggerate the formulaic, scientific calculation of likelihoods and outcomes, while downplaying situations where knowledge about outcomes and likelihood are not as clearly defined (Stirling 2009). Thus, conditions of uncertainty are effectively excluded from governance and policy. However, as this paper demonstrates, when knowledge of potential zoonotic disease emergence is itself in the early stages, conditions are dynamic, complex and uncertain (Scoones *et al.* 2007; Leach *et al.* 2010). In such a context, examining framing factors is particularly useful, because they have, 'profound implications for

notions of what constitutes the best strategy in the governance of infectious diseases' and for shaping policy (Stirling and Scoones 2009).

The scene for examining policy responses and the scope for a One Health approach to emerging zoonotic disease in Ghana was first set in the late 1980s and early 1990s in Accra, a time when bats around 37 Military Hospital attracted lots of policy and media attention. The Military, concerned about the polluting, noisy and smelly presence of the bats, decided to remove them. Their military approach, namely shooting the bats, failed dismally. At the time, the military did not consult with other government services or agencies in deciding on this course of action. The Department of Wildlife Services was initially not involved, and, as a result, 'raised hell'. Veterinary Services were also not involved, despite being, at that time, located in close proximity to the 37 Military Hospital. In addition, conservationists working in NGOs such as the Wildlife Society were also excluded, and also opposed to the Military's actions. After considerable upheaval, and serious discussion, collaboration between the Ghana Armed Forces, Veterinary and Wildlife services was established and this continues to this day. The bats have remained at 37 Military Hospital and new approaches, including the coppicing of trees, have been adopted to try and limit the size of the bat colony. As a result, the Military now acts as a guardian of the bats at 37 Military Hospital. While the military briefly mentioned, in its rationale for removing the bats, the possibility that bats might harbour diseases, these early framings did not consider bats as a noteworthy source of risk for zoonotic disease. This assumption, that bats pose a negligible risk, was still prominent at the time of this research for many policy makers and scientific actors who are excluded from an inner circle of actors who are in close contact or collaborating within research teams investigating disease spillover from bats in Ghana. The latter had thus been made aware that Ghana's bats might harbour Ebola viruses.

For this reason, of not being closely involved in research, biologists working at the University of Ghana did not associate bats with any serious disease threat during interviews. They emphasised the difficulty of maintaining a conservation agenda, given the Government's tendency to prioritise humans' needs over conservation in a context where there was very little enforcement of rules and regulations. They also stressed the failure of policies to address complex realities. Thus, while forests are ostensibly preserved, people continue to hunt in the forests resulting in an 'empty forest syndrome' in which there is forest canopy but no animals. 'People are protecting a forest which is not there, it looks like savannah' (Interviewee). In particular, they identified poverty as a major cause for the declining ecosystem. Poverty-induced migration meant that people lived in areas where they had no obligations to respect traditional laws or cultural values, and no long term commitment to the land or natural resources. In contrast, those who have not migrated see themselves as having ancestral ownership over the land and therefore being able to dictate the terms of usage. These biologists reported communities having very negative reactions to wildlife officials and to conservation as they perceived conservation activities to undermine their opportunities to exploit the land and resources. Wildlife officials have apparently been ambushed and killed, and this, coupled with the lack of resources, means that 'there are no guards in the forest when you go there, but loads of people hunting' (Interviewee).

Ghana Wildlife Services is also concerned about the bats in Accra, which they see as a species requiring conservation. For Wildlife Services, bats are framed, not as a nuisance nor as a disease risk, but as providing critical ecosystem services. Their vital role in seed dispersal (bats were described as planting neem trees throughout Accra), the usefulness of these trees as firewood, and the ecological importance of bats was pointed out, 'every creature [has] positives and negatives, we need to balance these. [There is] no perfect creature. We would not have fruit without bats' (Interviewee).

As biologists, they did not support any suggestion of eradication of bats and, as suggested in the above quotation, emphasised the need to 'live with' bats. Officials in Wildlife Services were concerned about the reduction in bat numbers, caused by hunting bats for food, and the associated drop in fruit

production. This position is widely known as a result of the campaign against the bat shootings at 37 Military Hospital. As one doctor from the hospital commented, 'wildlife is preventing the shooting. They say we are infringing the bats' rights. We are destroying the ecosystem. They have right to live'.

The emerging news that bats also harboured Ebola viruses renewed Wildlife officials' attention to the need to manage the interface between wildlife and humans. In particular, those who were aware of the Ebola threat indicated that they had begun to think about how to manage tourist sites close to bat roosts, such as at Buoyem, and to finding ways of informing, but not frightening, the people most exposed.

At the time of the research, Ghanaian conservation NGOs were also interested in bats, not least because 2011–2012 was declared the International Year of the Bat by the United Nations. Working with Bat Conservation International, bat conservation and celebration was promoted both internationally and in Ghana. Conservationists' framings echoed those of Wildlife Services, emphasising bats' role in ecosystem services, their seed dispersal and pollination roles and the ways in which community livelihoods were tied up with bats. The Conservation Alliance in Ghana also emphasised bats as an endangered species, frequently hunted for the bush meat trade as the availability of other wild animals has decreased. However these conservationists were also much more aware of the scientific literature documenting bats as a source of Nipah and Hendra spillover in Asia, and of bats' harbouring Ebola in Africa. In contrast to Wildlife Services, they saw bats as a 'big threat to public health in Ghana', and as one in which potential spillover was shaped not only by the lack of medical evidence of disease contagion, but also by the continued destruction of bat habitats and their growing presence in urban areas. For these reasons, bats were framed by conservationists as endangered species requiring conservation action. From the perspective of conservation NGOs, the Ghanaian Government was not serious enough about bats and their potential for spillover, 'the time has come for the Government to take serious steps to bat conservation which should be on the agenda'.²

The Government agencies, Veterinary Services and Wildlife Services, are in some respects closely aligned, with shared responsibilities around Accra Zoo and with some staff seconded from Veterinary Services to Wildlife Services. The framings of representatives of these two government departments are therefore closely aligned, with vets stressing that all wild animals have the potential to serve as a reservoir of viruses and disease, but that a stable relationship exists between host and virus unless disturbed by environmental stress. Veterinary Services was particularly interested in zoonotic disease from livestock and domestic dogs.³ Officials here argued that its biggest threats, in terms of zoonotic disease, are endemic diseases (rabies, trypanosomiasis) as well as rinderpest,⁴ and avian flu, followed by concerns about African swine fever. Also of strategic importance for Veterinary Services are zoonotic diseases affecting cattle and horses because of their economic impacts (such as Contagious Bovine Pleuro Pneumonia (CBPP)). Senior personnel within Veterinary Services were very aware of the possibility of zoonotic disease spillover. They stressed the potential for wildlife to act as a source of zoonotic disease emergence. For instance, Dr Akunzule, the Principal Veterinary Officer of the Ministry

² This lack of official concern with bats as requiring conservation and protection was reflected in interviews with the Environmental Protection Agency (EPA), which is the public body charged with protecting Ghana's environment. The EPA provides permits to prune trees in urban areas, and oversees the Ramsar sites (wetlands of international importance) in Ghana, but has no special procedure to deal with bats in the course of its environmental protection agenda.

³ Although Ghana Veterinary Services used to co-ordinate free annual rabies vaccinations for dogs, this policy has now been amended to recover costs and is now, as a result of a World Bank proposal in the early 1990s, commercialised. As a result, many people no longer bother to vaccinate their dogs.

⁴ Although Ghana has been declared rinderpest free, work is still underway to determine whether animals still act as hosts for these.

of Food and Agriculture, was quoted in the media as pointing to an, 'unprecedented worldwide impact of emerging and re-emerging zoonotic and other Trans-boundary Animal Diseases (TADs)'.⁵ However, the veterinary scientists interviewed posited that humans had to find ways to live in harmony with animals and that bats did not pose a special threat. This resonated with Wildlife officials who similarly framed the issue in terms of a balance between humans and animals. Veterinary framings acknowledged the importance of bats' ecological role, but in contrast to Wildlife framings, prioritised human health. 'My concern is health protection first [...] veterinary medicine is preventative human medicine' (Interviewee). Nonetheless, most veterinarians interviewed, in both the military and Veterinary Services, were not concerned about spillover from bats to humans despite awareness of the recent research on Nipah and Hendra. 'I won't be scared of the bats unless something new comes up' (Interviewee). As one Government vet commented,

These endemic diseases [...] are very serious animal diseases that attract their attention so before they can appreciate it [the importance of spillover from bats], you really have to have evidence that the disease is killing either animals or humans. It is difficult to direct attention away from what they know is a threat.

This lack of concern is replicated in the routine surveillance of animal diseases provided by the Ministry of Agriculture. As one animal husbandry specialist explained, diseases from wildlife are not a significant concern to the Ministry, bats are considered only a very minor rabies risk.

Human public health priorities in Ghana were reported to relate to Cholera, HIV/AIDs, Meningitis, hepatitis, TB and Malaria. A focus on these priorities appear for the most part to crowd out an interdisciplinary approach to zoonotic disease control. As stated by one medical official 'zoonotic infections, we leave that to veterinarians'. Nonetheless, human public health officials in both 37 Military Hospital and Ghana Public Health Services recognised zoonotic disease as a potential area of concern, not least because of the possibility of it resulting in epidemics. 'Zoonosis is becoming increasingly more important in the world, you always wonder what the next infection will be, where the next outbreak will come from' (Interviewee). The framing of public health officials is focused exclusively on human health as the most important variable, as articulated by one very senior health official in the Military, 'human health should triumph in the preservation of bats versus humans'. The primary public health zoonotic concerns were reported at the time of research to be known zoonotic infections such as influenzas, HIV/Malaria and Lassa fever (purportedly brought back by peace-keeping soldiers in Sierra Leone). There was strong awareness, amongst health officials in both Ghana Health Services and the Military, of the potential for soldiers to bring disease into the country. They reported that before going on peace-keeping missions, soldiers receive lectures about the potential of disease spread and, upon their return, they are medically examined. The military respondents claimed that procedures are 'very strict' about ensuring soldiers are aware of these risks when travelling abroad, and that their medical surveillance of soldiers has been tightened in recent years. It is haemorrhagic fevers that generate the most fear. Veterinarians are involved in the preparations for soldiers travelling abroad, particularly in terms of giving lectures on zoonosis and, in recent years, soldiers are cautioned that bats – which might be hunted for bushmeat – carry a disease risk.

The knowledge that bats may carry the Ebola virus had brought renewed public health attention to the risk of emerging zoonotic diseases amongst those in the loop of the new research findings. Unlike Hendra and Nipah, Ebola did raise considerable concern. 'We are', as one medical official stated (in hindsight, prophetically), 'sitting on a time bomb'. Nonetheless, as public health officials relayed to us in interviews in 2012, as there was still no evidence at that time of bats transmitting Ebola to humans, it was difficult to take action. The lack of certainty as they saw it – about exactly which diseases were

⁵<http://www.ghanaweb.com/GhanaHomePage/health/artikel.php?ID=162784>, accessed 23 May 2013

involved, as well as the extent to which spillover of new infections was likely and would involve ongoing human to human disease transfer – made this a nebulous area for concrete public health precautionary responses, in the view of Government public health officials.

This new research has also led to increased collaboration of Public Health officials with Wildlife Services and with the Noguchi Institute for Medical Research, which is a semi-autonomous institute of the University of Ghana. Although respondents from Ghana Public Health reported that they wished to undertake human studies to ascertain if bat-borne diseases have infected humans, Ghana Health Services has very little capacity in the microbiology required and limited equipment to undertake such studies. The Ghana Ministry of Health could turn to the United States-based Centres for Disease Control (CDC) which operates a small office within Ghana for additional support but it had not done so.⁶ CDC was thus providing only ‘small and fragmented’ support to Ghana’s national health management information system (CDC 2011: 3). There is nonetheless research collaboration between the Noguchi Memorial Institute for Medical Research, the CDC and the United States Naval Medical Research Unit (NAMRU). Although not focused on bats, Hendra, Nipah or Ebola, NAMRU and CDC have helped Noguchi set up a sentinel system for Avian Influenza and provided funding for establishing laboratory capacity for testing influenza. They are working with Ghana Health Services and continue to support the system.

As the following quote by a member of the Ghana Health Service indicates, the onus has been on Wildlife and Veterinary Services to do surveillance and to track the levels of disease within bats, in the light of the emerging research findings:

Now we take zoonotic disease more onboard [...] We have not seen the Ebola virus and we are hoping that it’s not there. If we do find it, we will try to find the source. Our veterinarians follow the virus reservoirs in animals, monitoring rabies and anthrax. We are however on our toes now for the Ebola virus – the study has put us on our toes and since every animal is a carrier of disease we are watchful. We are watching cows and dogs, although the animal side belongs to the vets, cows and dogs are on our radar, we are now aware.

There was thus a growing awareness of the potential for zoonotic disease transmission from bats, even though there was disagreement on the seriousness of this threat and on the nature of evidence required prior to effecting policy. Select people within Ghana, particularly within scientific and government circles, were aware of this. Yet, media dissemination and public knowledge of bats and zoonotic disease in Ghana has been more constrained.

⁶ CDC’s collaboration with the Ministry of Health is HIV-related, building capacity and strengthening laboratory systems. CDC’s support is primarily laboratory-orientated, including helping with ‘the development of the national laboratory strategic plan, laboratory policy and procedures, laboratory information systems and quality management system’ (CDC 2011: 2). CDC also works with Ghana to develop HIV/AIDS-related surveillance systems and improve national HIV-related health services.

Public awareness of zoonotic disease risk: the media in Ghana

Various policy actors in Ghana view the media as an important source of public information and awareness on zoonotic disease and some have appeared in media reports as expert sources, especially on rabies, avian flu and swine flu. But they have tended to adopt a more cautionary approach in providing the media with information on bats and disease primarily because they lack confidence in the media's ability to treat the subject competently.

Interviews with most policy actors betrayed a fear there will be moral panics if media coverage on bats and disease risk is 'mishandled'. Some recalled with dissatisfaction media reportage on the outbreak of avian influenza. 'People got into a panic, there were exaggerations about side effects; the media went on overdrive', said one health official. Another health official, who said he acted as an expert source for the media, complained that some reports on avian flu were simply inaccurate, and provided the public with wrong information regarding how it could be contracted. Such experiences have influenced the kind of information public officials provide on bats. As a consequence, media reports have tended to focus on the importance of bat conservation and on getting the public to accept putting up with their nuisance value.

On the few occasions when public health officials have tried to engage the media on the risk of disease posed by bats to humans, the media have failed to pick up on the information. One official who mentioned to journalists bats were carriers of Rabies, Nipah and Hendra said that they failed to put that information in the public domain. Another official explained also that when in 2008 journalists came to a national stakeholders' workshop at which the link between bats and Nipah disease was discussed, there were no published reports because journalists 'did not consider it big news'. More recently in July 2012, no journalists were invited to a workshop involving health service officials at which research findings on Ebola in bats in Ghana were shared, although, according to a researcher there was some media information on bats as possible sources of disease predicated on findings by other researchers.⁷

Content analyses of the Ghanaian media confirm the dearth of information on bats and zoonotic diseases. A scan of key news sources, such as the Ghana News Agency (GNA) and the Daily Graphic,⁸ indicates that stories published on bats rarely make reference to the threat of zoonotic diseases, while stories on zoonotic diseases refer to such threats as rabies from dogs and avian flu, but not threats from bats.

In general media stories were generated mostly from press releases or local and international meetings, conferences, symposiums, and other speech events, at which the threat of emerging zoonotic diseases (avian flu, swine fever, etc.) were mentioned. We found information on zoonotic diseases in stories on rabies, such as a recent story on death from rabies of five children who had reported to a regional hospital within a six month period.⁹ We also found a few opinion pieces on the subject, although there appears to be very little reporting emerging out of enterprise journalism, that

⁷There are various research initiatives on bats in Ghana, including one by the Kumasi Centre for Collaborative Research in Tropical Research (KCCR) and the Ulm University in Germany; and another on henipa viruses in bats by Andrew Cunningham, a wildlife epidemiologist at the Institute of Zoology in London and James Wood, a veterinary researcher at the University of Cambridge.

⁸We largely examined stories from the Ghana News Agency (GNA) and the Daily Graphic as these sources are among the most widely circulated and read in Ghana and can arguably be considered elite news sources, in that they potentially influence how other media report stories.

⁹ GNA, 18 October 2012

is where journalists, through their own initiative and based on developed news sources, produce stories on zoonotic diseases.

Societal actors, predominantly wildlife officials, veterinarians, public health officials and academics, especially scientists engaged in zoonotic or conservation research, have been the primary sources through whom information on zoonotic diseases have been conveyed to the Ghanaian public. Still, few media articles quote these sources as associating bats with zoonotic infectious diseases. The exceptions were an online radio article on the relationship between bats and humans which quoted a researcher working on a collaborative project between the Kumasi Centre for Collaborative Research in Tropical Research (KCCR) at the Kwame Nkrumah University of Science and Technology and the Ulm University,¹⁰ and an article in which Richard Suu-Ire, a veterinarian with the Wildlife Life Division of the Ghana Forestry Commission revealed that antibodies to the Ebola virus had been detected in bats. Suu-Ire was speaking at a lecture during an Ecotourism Week celebration at the University of Energy and Natural Resources (UENR) in April 2013.

¹⁰ myjoyonline, 20 August 2010 (Ghanaian internet news media outlet)

Media Framing of Bats and Zoonotic Disease

Typically media reports on bats are framed within narratives of conservation where bats are perceived as being threatened by human actions. Several such stories form coverage on the standoff between bats and the military in the late 1980s/1990s where part of the solution to the bats and the associated problems at the 37 Military Hospital has been to shoot them. The conservationists frame bats as important for ecological balance and as eco-tourism attractions.

Stories on zoonotic diseases, in contrast, contain narratives on human public health and veterinary concerns with some making reference to officials warning of the threat of zoonotic diseases from domestic animals (chickens, dogs, cattle) and increasingly from wildlife. One article reports a Ghana veterinary expert as identifying the wildlife sector as a 'major factor in the outbreak of emerging zoonoses', and stating that '71 per cent of zoonotic diseases were of wildlife origin', so there was a need to educate tourists and train professionals regarding them.¹¹ Another by the president of the Ghana Veterinary Medical Association noted there were 'over 134 zoonotic diseases of viral, bacterial, fungal, parasitic or rickettsial origin which can be transmitted from animals to man'.¹² Included in the list were 'rabies, anthrax, brucellosis, tuberculosis clostridial diseases like tetanus, ringworm, Echinococcosis, Fish tapeworm, Pork Tapeworm, Salmonellosis and Highly Pathogenic Avian Influenza virus (HPAI)'. Obvious omissions were emerging threats from bats such as Hendra, Nipah and Ebola viruses.

An online radio article reporting the views of a local researcher on a project between the Kumasi Centre for Collaborative Research in Tropical Research (KCCR) at the Kwame Nkrumah University of Science and Technology and the Ulm University in Germany was one of few media reports found on the risk of animal-human spillover of diseases from viruses carried by bats.¹³ The researcher was quoted as stating:

It has become important for us to study the bat because if these bats are known to harbour these viruses and human beings interact with these bats, definitely there might be some transmission from these organisms to the humans and therefore there is the need to look at the extent of this interaction, the levels of occurrence of these viruses in the animals, so as to determine whether transmission do actually occur and whether some of the diseases that are found in humans, being caused by viruses, are actually coming from transmissions that are coming between bats and humans (ibid).

A passing reference to disease-carrying bats was made in another report sourced from the KCCR, although the dominant media frame was conservationist. A third story linking bats with disease emerged from lectures marking Ecotourism Week celebrations where bats were identified as carriers of Ebola virus antibodies. Like the Farm Radio story, the framing was conservationist and curiously reported Suu-lre downplaying the risk; arguing that though bats had antibodies to Ebola virus, their presence in the environment did not pose a risk to human health.¹⁴

Clearly the evidence from local media and official sources of information (health and wildlife officials and other policy actors) would suggest little interest in creating public awareness on emerging threats of diseases from bats. The only meaningful media analysis on the subject of bats and zoonotic disease

¹¹ Ghana News Agency (GNA) 25 April 2008

¹² Daily Graphic 8 May 2009

¹³ Myjoyonline 20 August 2010 (see above)

¹⁴ GNA 19 April 2013

risk was found on the Ghanaian online site Ghanaweb, which occasionally aggregates news on research findings from international scientific journals such as Nature.¹⁵

While the media has focused on bats and conservation, in effect downplaying the role of bats in zoonotic disease and the potential of spillover, and while the public remains largely ignorant of the links between bats and disease, Ghana's policy actors remain concerned about zoonotic diseases and are starting to implement policy to address this.

¹⁵ Ghanaweb, General News of Monday, 3 October 2011

Policy responses associated with Bats and zoonotic disease emergence

As a result of all the scientific attention to zoonotic disease emergence and to bats and the sharing of this information with key actors, there has been some proactive policy development in relation to bats in Ghana. Policy has focused on ensuring the protection of bats as a keystone species, despite the potential disease risk. The Wildlife Regulation Act of 1963 is being revised to ensure that bats are listed as a scheduled species. This will allow Wildlife Services to prosecute people for illegal hunting as well as ensuring that Protected Area Managers pay greater attention to bats as a species. Alongside this, Wildlife Services has been working to create greater community responsibility towards bats. In 2011, the Government of Ghana was seeking, through the passing of a new bill, to provide a legal framework for Community Resource Management Areas (CREMAs), in which responsibility for natural resource management and its sustainable use is devolved to communities (Agidee 2011).

The presence of avian flu in Ghana's wild birds and poultry led to the establishment of a National Task Force for Avian Influenza in 2006 (GNA 2006). This was the first instance of a multi-stakeholder Ministerial Group and it created a framework which allowed a multi-sectoral approach, pushing for greater collaboration between the Military, Wildlife Services, Veterinary Services and Public Health. This kind of initiative is in line with the agenda of global agencies for a 'One Health' Approach, discussed in the introduction. These Departments and Ministries came together to undertake a series of table-top exercises in pandemic disaster training. In addition, a government agency, the National Disaster Management Organisation (NADMO), was created as a coordinating body for national disasters in general, and zoonotic outbreaks were placed within this remit. This has worked to create greater alliances between departments in Ghana, to develop training in disaster management and, with greater knowledge of different roles and responsibility, has had the effect of reducing Government agencies' competition for funding. For example, according to interviewees, as a result of participating in NADMO, public health officials have a greater appreciation that effective management of rabies cannot be limited to human exposure and treatment. Medical personnel have since advocated for greater resource allocations to Veterinary Services to ensure a more multi-disciplinary approach to rabies prevention. They also valued the new relationships that have been built between individuals in different government agencies and departments: 'We are changing our perception of disease control, not only solving issues at a departmental level but the one health approach and bringing in other partners' (Interviewee). NADMO was seen as the solution should a disaster, such as a disease outbreak, occur. NADMO provides the muscle to mobilise for education, financial support and material supplies and has the legal mandate to deal with disasters. NADMO staff were however, at the time of interviews, unaware of bats as a potential source of zoonotic disease or spillover. According to one NADMO member, bats are a threat to public health only in terms of the way in which these animals are clustered around a hospital. Their droppings can be a source of contagion, but for known endemic diseases such as anthrax. At the time of this research there had been no discussion with NADMO that these animals are potentially a source of disease. However, from a NADMO perspective, it was not the bats *per se* which mattered in terms of a risk profile. Their concern focused rather on the proximity of bats to medical experts who might be exposed, the community of patients, doctors and residents at the hospital. As a respondent put it, 'if people at 37 were at threat then the whole population would be at threat'. There would be no hospital staff, equipment, skills and, if 37 Military Hospital was the epicentre of an outbreak and it would need to be cordoned off. This would in turn limit access to medical staff, equipment and would in effect result in a far greater threat.

Academics at the Ghana University School of Public Health have also been seeking to develop a multi-sectoral One Health strategy for emerging zoonotic disease. They too were highly aware of zoonotic disease in general and of the potential for a mass outbreak. As one senior member of staff explained,

'the problem is that we are susceptible, there are huge peri-urban groups, one drop of infection and there will be disease'. These academics were aware that wildlife poses a threat as a disease reservoir and that there may be spillover from bats, yet at the same time pointed out that this was not a priority. Indeed, they added it was unlikely to be a priority unless or until 'it explodes' and receives emergency international support. Nonetheless, it was the awareness of new zoonotic disease emergence that led the School of Public Health to create, in 2007, a one-year course in Field Epidemiology which brings together medical doctors, veterinarians and lab scientists. The aim is to train field epidemiologists who can spot problems, investigate and actively respond. As such, students undertake field studies, engage in public health practice and are linked in to national policy. They are also expected to participate in the service of any outbreak that occurs in the course of their studies, working under the co-ordination of NADMO and with classes suspended to facilitate this.

In addition, as suggested above, research collaboration between the Noguchi Memorial Institute for Medical Research, the CDC and NAMRU has helped Noguchi set up a sentinel system for Avian influenza and provided funding for the establishment of laboratory capacity for testing influenza, although not focused at the time of this research on Hendra, Nipah or Ebola. This system is set up to identify unusual cases in human health. Noguchi in particular focuses on disease surveillance and laboratory capacity for parasitology, bacteriology and virology coupled with epidemiology expertise.

Intersectoral challenges and uncertainty: a One Health approach?

Many of Ghana's public officials in health, veterinary and wildlife services were aware of the need to develop an interdisciplinary and collaborative approach, not only for emerging zoonotic diseases, but also for well-established priorities such as TB. In relation to bats and emerging disease, meetings were held with key actors as scientific findings emerged and information was disseminated. Yet, different actors' interpretations of the data were shaped by their framings and this, and this created bottlenecks which limited a One Health approach.

Wildlife Society officials stressed that more research was necessary to investigate further the possible links between bats and disease, to establish the level of risk and to understand why bats might harbour the disease but not die from it. In keeping with their training as biologists, Wildlife Services officials were keen to look for positives and questioned whether better understandings of bat immunity might offer solutions for human exposure. They cautioned that, 'it has not yet been established that they [bats] can transmit the disease. It is possible to harbour the disease, which is species specific, so there is no risk to humans'. Wildlife was particularly concerned about positive results and how it would handle a situation in which bats were strongly associated with disease. It feared that scientific research on emerging zoonosis would create a backlash and result in people shooting their animals. Their solution is to find ways for communities and bats to live together. One way of achieving such a balance is through community engagement with natural resource management such as the Boabeng-Fiema (Saj *et al.* 2006). In this instance, they argue, poaching, conflict and forest degradation have decreased while species diversity has increased.

In contrast to the views of Wildlife Services which emphasised the unknowns associated with bats as a viral host, human public health perspectives emphasise the need for more evidence and scientific proof, particularly of the risk to humans, such as serological evidence of infection:

'We still need evidence but in such interaction where people come close to any species especially now the bats, we face a considerable risk. It is worth looking at and closely monitoring, as we never know when it will spill out and it could come from the bats'.

'I don't know that bats can transfer airborne disease. We don't have signs and haven't done any research to prove [risk]... It is good to leave the bats, there is no harm, apart from their droppings because as I'm talking now, there's no scientific proof. If there is a disease they can transmit, in an air-borne way, we don't know unless we do some research'.

(Public health interviewees)

Because of the lack of evidence of human infection from bats at the time of this research, public health officials emphasised the need for Veterinary and Wildlife Services to monitor the prevalence of antibodies in the bat population to achieve a more detailed picture of the infection dynamics in the animals. One senior health representative was reported to have said, 'this is your problem, you handle it'. People working in the Department of Public Health were, as one informant described it, 'very neutral' and 'not keen to take it on'. The public health framing, which emphasised that there was as yet, no firm scientific evidence of spillover of disease from bats to human and of substantial risk to humans, was echoed in the framings of veterinary specialists.

Most reports from the researchers are just precautionary, they haven't put their hands on anything firm. We don't have to cause panic and can just say that bats, like any other animal, could be dangerous. Until we get evidence... .

(Interviewee)

Veterinarians recognised this need for proof of evidence before being able to move forward with their research on bats and on understanding the conditions which may generate spillover. 'For us to receive attention, we really have to prove that Ebola is killing people. Politicians will only release funds when humans die' (Interviewee).

Thus, while researchers were emphasising the importance of bats as a reservoir for zoonotic disease and the potential for spillover, these messages were refracted through different sectoral and scientific framings in the policy world. Wildlife officials were worried about causing panic and emphasised the importance of living with bats. Health officials emphasised that it was a wildlife and veterinary problem while veterinary officials were frustrated by the need for evidence of human disease in order to attract political attention and resources. To date, however, there is an impasse between veterinarian concern and medical evidence. In addition, the known existing zoonotic diseases such as Ebola generate more interest than the risk of diseases hitherto not known in Ghana, such as from Henipa viruses. One expert summed up the problem as follows.

The Government is paying attention to zoonotic diseases. They do because that's one of our main concerns. CDC asked if they need assistance and the vets said no. They said they know what they need to do, what they need is resources. The agencies mandated to deal with zoonotic infections know what they are doing. [...] Veterinarians and doctors all work together, at the national level, all sit on the same committee, do research to find out what's happening and it works. It is not about vets establishing a threat level in animals, rather any unusual cases of disease in humans are supposed to be investigated. The catch is we do not have specific systems in place [to diagnose particular zoonotic infections] e.g. Lassa, Ebola, etc.

This summary of the issues indicates that there is also a high level of uncertainty regarding the ability of the existing public health system to detect and diagnose cases of both known, endemic zoonotic disease as well as occurrences of suspicious infectious disease symptoms that might herald an outbreak of a new condition (see, for example, Jephcott 2013). If one considers rural Ghana, where people's livelihoods ensure that they come in close proximity to a range of wildlife including bats, the public sector health system is already under considerable strain with respect to accurate diagnosis of known diseases, zoonotic or otherwise. Infrastructural, human resource and other material constraints, such as shortages of diagnostic test kits and reagents, mean that many illnesses are likely to be treated based upon a clinical assessment of the syndrome. Febrile illnesses in such contexts are more often than not treated as malaria, even in the absence of laboratory confirmation, so that it is hard to assess the extent of misdiagnosis. A prominent public health academic interviewed spoke of the reality of diseases being labelled as 'Not Yet Diagnosed'. This NYD acronym in some cases remained on the death of a patient in the absence of resources to pursue a more definitive investigation. Diagnostic practices and constraints make it unlikely that pyrexia of unknown origin would be thought of as potentially also indicative of new emerging disease, and in rural areas people cannot always reach public sector biomedical facilities to seek diagnosis or care (Jephcott 2013). Whilst the reported use of the NYD category at least acknowledges the constraints to achieving certainty, discussions with public health academics suggested that the existing surveillance system is seldom going to flag up potentially unknown diseases. Public health officials have also relied on Community Based Surveillance volunteers to assist in surveillance for emerging zoonotic diseases.¹⁶ There are some very positive incidences of these CBS volunteers identifying well-known disease outbreaks and travelling considerable distance on foot or bicycle to report them. In addition, specific programmes have tackled the surveillance of

¹⁶ Ghana also recruits and trains Community Based Surveillance (CBS) volunteers. In 2006, the Ghana Health Service reported that the Disease Surveillance Dept had trained almost 18500 CBS volunteers from over 25,000 villages (Ghana Health Service 2006). During interviews, representatives of the Public Health Division of the Ghana Health Service, claimed that every community had at least one CBS volunteer and that, in 2013, there were 27,000 such volunteers operating across Ghana.

zoonotic diseases well known to Ghana (CDC 2003). However, such an extension of reach is unlikely to be effective in relation to new or emerging diseases until much closer attention is paid to improving the system of health care in general in rural areas. This is significant given that regional initiatives such as the Integrated Disease Surveillance and Response Strategy (designed by the WHO and CDC) relies on early detection of disease at facility level.

Conclusion

As brought home by the recent 2014-2015 Ebola crisis in West Africa, bats around the world, are seen as significant animals in relation to zoonotic disease spillover and in the search for new viruses (Jones *et al.* 2011; Calisher 2006; Wang and Hu 2013; Leroy *et al.* 2005). Prior to the Ebola outbreak and when this research was undertaken, the international media had used headlines such as 'The Virus Hunter' or 'Virus Hunters Find Ebola, Marburg Source in Fruit Bat' (Cruzan Morton 2013; Gale 2009), while Ghana's media remained largely ill-informed and silent on the significance of bats for zoonotic disease spillover. This was, in part, a reflection of the sectoral divisions within Government and of the different framings these actors have of disease and disease risk to humans. It was, however, also a reflection of the considerable uncertainties that Ghana's policy actors were grappling with and of the difficulties of making key decisions in such a context. Recent events in West Africa related to the Ebola outbreak are likely to have radically altered the local media attention, and are also likely to shift policy responses with respect to zoonotic disease. With the link between Ebola and bats firmly established, some of the conservation concerns expressed by interviewees for this research in 2012 now ring loudly.

This paper has explored the range of framings associated with the issue of zoonotic disease in Ghana and the different understandings of a series of key actors in the wildlife, veterinary and public health services, particularly with respect to understandings of the level of disease risk. Across institutional and disciplinary affiliations, concerns foreground human health, livestock health, or wildlife preservation respectively. We have demonstrated that in Ghana an appreciation of the risk of endemic or emerging zoonotic disease from bats in 2012 was largely confined to a core group of academically-oriented actors who are linked into the network of foreign researchers interested in this topic. Indeed, this recent bat-related research seems to a large extent to have catalysed awareness of the more complex dimensions of the assessment of disease risk from bats. In this regard, policy makers spoke of requiring more certain evidence before they would be willing or able to take action with regards to responding to any disease risk to humans or livestock from bats. A politics of precaution operated around this uncertainty regarding the extent of risk. In a context of uncertainty, certain trade-offs are evident that make the control of knowledge a sensitive issue. For example, the discovery of antibodies to Ebola virus in bats in Ghana generated tensions between the preservation of human health and wildlife, which militated against immediate and full public transparency about the issue. The degree of uncertainty regarding the extent of the implications of the research findings makes the politics of knowledge and response even more complex to navigate.

The case of bats in Ghana thus raises important questions about how policy is made around disease threats when the extent of the risk is not yet known. However, at the same time, the different sectoral gazes and framings create impasses that make it hard to link and assess evidence across the disciplinary divides. This reality also facilitates a situation where no one sector takes full responsibility so that unknowns continue to hover uneasily in the space of current policy. Furthermore, the existing regional surveillance systems suggested by the WHO and other international players presuppose a particular set of conditions on the ground that rarely exist in a stretched public health system, where resource constraints of various kinds make facility-based detection of new infectious diseases unlikely. This research suggests that intersectoral collaboration on policy and the strengthening of surveillance systems for emerging infectious disease, such as those from bats, is still limited. It is likely that the devastating Ebola outbreak in West Africa will affect zoonotic disease policy in Ghana and also inform the mechanism for coordinated international response to confirmed outbreaks with epidemic human-to-human spread. Whether a politics of precaution will continue to operate for unconfirmed emergent zoonotic disease and whether surveillance for such occurrences will receive greater attention, remains to be seen.

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