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# RESEARCH UPDATE

## SITUATION ANALYSIS

### GHANA

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The Dynamic Drivers of Disease in Africa Consortium is an ESPA<sup>1</sup>-funded 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. This document offers a research update on the Consortium case study exploring the drivers of henipavirus in Ghana.



*Photo: Gianni Lo Iacono*

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SEPTEMBER 2013

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<sup>1</sup> Ecosystem Services for Poverty Alleviation (ESPA) is a seven-year, £40.5m interdisciplinary research programme funded by the UK's Department for International Development (DFID), Natural Environment Research Council (NERC) and Economic and Social Research Council (ESRC), as part of the UK's Living with Environmental Change partnership.

## INTRODUCTION

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Henipaviruses include Hendra and Nipah virus which cause encephalitic disease in people, with death rates of around 75 per cent. The viruses' natural reservoir hosts are pteropid fruit bats (flying



STRAW-COLOURED FRUIT BAT *Photo: Marcel Holyoak*

foxes). The closely-related straw-coloured fruit bat (*Eidolon helvum*) is widespread and abundant in mainland Africa, and henipaviruses are known to be maintained within this species. Evidence of henipaviruses in Ghana's human population has not been established, but there has been no surveillance for it and human-bat interactions are common.

The [Dynamic Drivers of Disease in Africa Consortium](http://www.driversofdisease.org) ([www.driversofdisease.org](http://www.driversofdisease.org)) is using interdisciplinary methods to investigate whether spillover dynamics and virus

transmission differ between urban and rural sites in Ghana due to changes in biodiversity and land use. It is exploring whether spillover to people is occurring, if there are high-risk groups for exposure, and the poverty impacts of henipavirus infection. By capturing the drivers and determinants of contact and risk of spillover, researchers aim to inform risk mitigation measures across Africa.

## KEY QUESTIONS

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The research is investigating the hypothesis that disease regulation as an ecosystem service is affected by changes in biodiversity, climate and land use, with differential impacts on people's health and wellbeing.

Questions for the research include:

- How do different contexts of rural/urban livelihoods, poverty and ecology shape people's interactions with bats and bat ecology?
- In what ways do these different factors shape the drivers and dynamics of henipavirus infection within the bat population?
- Do these result in different likelihoods of spillover and who is most at risk?
- Are there high-risk groups for henipavirus exposure based on people's use of ecosystem services, as differentiated by factors such as gender, age, social status and wealth?
- Is spillover of henipavirus occurring? If so, how do spillover dynamics and henipavirus transmission differ between urban and rural sites, and why, taking into account changes in biodiversity and land use.
- Have land-use changes pushed bats to feed in urban and orchard areas, where contact rates and risk of human exposure are higher?

## BACKGROUND

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Bats are recognised reservoir hosts of increasing numbers of fatal and incurable viral zoonotic diseases. As such, they provide an interesting model to examine the modes of virus spillover and the risks to human health from wildlife zoonoses. Bats have adapted to living in urban areas, while simultaneously retaining large, remote, rural populations, so they also serve as an excellent model to investigate how ecosystem change may impact on these risks.

There are several species of fruit bats in Ghana. Drivers of Disease will focus on two relatively common species, *Eidolon helvum* and *Epomophorus gambianus*, which have been reported to harbour zoonotic pathogens. Colonies have been found scattered throughout the country but a recent analysis suggests that they are most likely to be present in the forest/cropland mosaics in the south-west. Currently, a large colony lives in the centre of Accra, with the population fluctuating seasonally between 250,000 and up to one million bats. The size of this colony highly increases the likelihood of exposure of people to bats. Furthermore, land-use changes have pushed bats to feed in urban and orchard areas, where contact rates and risks of human exposure are higher.

Hendra virus spills over into people via infected horses, as documented in Australia. Nipah can spill over via infected pigs, as occurred in Malaysia and Singapore in 1998/9; or directly from bats into people, as occurs on an almost annual basis in Bangladesh, with palm wine drinking a recognised risk factor. In India and Bangladesh, human-to-human transmission of the virus, with fatal consequences, has been documented.

## KNOWN AND UNKNOWN

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There has been little research into the disease dynamics of henipaviruses. However, it is known that zoonotic pathogens can be transmitted from bats to people through animal bites; contact with or



STREET FOOD IN GHANA Photo: Gianni Lo Iacono

consumption of blood, faeces, urine or other animal body fluids; eating contaminated animal products; aerosol; insect vectors; intermediate host species and other forms of animal-human contact. Bushmeat is a common source of human-animal contact (for example, hunting, processing of bushmeat carcasses, bushmeat handling in the market trade) and poses a risk for disease spillover from many animal species.

A known route of transmission of Nipah virus is through consumption of unfermented palm sap that has been contaminated by bats urinating in or drinking from sap collection pots. However, this has not been proven to be an issue in Ghana. *E. helvum* in Ghana urinate and defecate heavily upon return to their city roosts in the early mornings. Food vendors commonly sell food in open containers beneath the bats, and domestic animals graze underneath bats both roosting and feeding in trees. The interaction of domestic animals and people with bat colonies and patients from hospitals with large local populations is currently being studied.

Unknown factors for drivers of bat-borne zoonotic spillover include contact rates between bats and people; transmission rates of bat-borne pathogens to people; levels of current human infections of bat-borne pathogens; impact of bat-pathogen dynamics and bat-human dynamics on transmission rates; and infection rates in domestic animals of bat-borne pathogens.

Unknown factors relating to fruit bats and their role as a source of human disease include:

- The characterisation of the unknown henipavirus found in *E. helvum*, including its ability to infect people and cause disease.
- The dynamics of zoonotic infections within the different species, including the impact of a seasonal birth pulse, providing naive hosts in the population and annual and seasonal migrations altering contact points and contact rates, and population structures.
- The nature and number of interactions between bats and people.
- The perceptions of bats as sources of disease and therefore the attitudes and behaviours of people towards bats.

*E. helvum* and the henipaviruses that infect them are found across sub-Saharan Africa as far south as Malawi, Zambia and probably Mozambique. The situation is unclear and needs further detailed study. People live and interact in different ways with colonies of bats, framed by local ecological differences and cultural practices.

There is little perception of disease risk from contact with bats among local people. Any risk perception is found among non-bat eaters. Bat meat is believed by those who eat it to be lean and healthy. These people believe the only risk to lie in being bitten by a bat. In terms of the study, unknown factors include impacts of the various hunting methods on risk of pathogen transmission; sustainability of current off-take rates; variation of hunting and consumption throughout the whole of the country; clarification of impacts of tribe and home-region on bat hunting, selling and consumption; confirmation of the numbers of bats hunted and sold; observations of bat hunting, preparing and consumption practices and potential health risks; impact of the hunting season on disease risk; and firmer understandings of the economic and social drivers of bat bushmeat.

## CASE STUDY METHODOLOGY

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Researchers are working in three sites in Ghana:

- The 37 Military Hospital in Accra.
- Ve-Golokuati in the Volta Region.
- The Tano Sacred Grove in Tanoboase near Techiman.

The fieldwork is building on extensive data on bat ecology and population dynamics and viral infections of bats, as well as serological and other studies of henipavirus initiated in people.



TANO SACRED GROVE

Photo: Gianni Lo Iacono

There are three main areas of study:

**1 Social Science** Participatory modelling, involving the use of participatory research techniques and ethnographic methods, is providing the core of the social science research in the Consortium. Participatory methods are valuable in two distinct ways: generation of participatory models and participatory research and modelling as a source of inputs to the process- and pattern-based modelling efforts being undertaken in other parts of the study. Methods include reconnaissance visits, participatory approaches, and individual, semi-structured interviews/surveys.

Researchers are using participatory modelling to test, verify, challenge, compare or critique existing views of disease epidemiology and ecology. This is being accomplished by comparing process- and pattern-based modelling assumptions and outcomes with the participatory work, and sharing other models with villagers and generating critical discussion around them.



PARTICIPATORY MODELLING *Photo: Catherine Holley*

**2 Natural Science** Viral dynamics within bat populations are being compared between the urban and two rural sites. Bats in both kinds of roost are having their movements identified in radio transmitter studies. While there is some evidence of henipavirus spillover to domestic animals in Accra, no such studies have yet been conducted around Tano or Ve-Golokuati. Researchers are extending local spillover studies to consider the differential spillover risks associated with hunting (men) versus butchering (men and women) and with livestock keeping, where there may also be a sex bias. Researchers are also investigating whether palm wine consumption is an infection risk.

The study is conducting parallel investigations in all study sites, exploring further the interactions between bats and people, as well as epidemiological studies. This includes regular bat surveying and human, bat and domestic-animal sampling.

Beyond the three study sites researchers are mapping bat species occurrence Ghana-wide to research the possibility and extent of potential spread of any bat-transmitted diseases and its importance in terms of the population that could be at risk.

**3 Modelling** Taking a broad, multidisciplinary and holistic approach, the study is developing detailed, dynamic process-based models of henipavirus transmission, encompassing ecological, socio-economic and epidemiological processes to compare the risks of virus spillover between a densely populated urban setting and remote rural sites. A key objective of this is to understand the role of ecological and anthropological drivers in the individual and population-level mechanisms of transmission among bats and spillover events to people and domestic animals

In addition to its usefulness as a research technique in its own right, participatory modelling will be used to ensure that the other modelling approaches use frameworks appropriate for the diseases and ecological settings.

## PATHWAYS TO IMPACT

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Many questions still remain about henipaviruses. The Drivers of Disease project is contributing to existing knowledge, but as well as exploring the 'whys' and 'how manys' behind henipavirus transmission a major objective of researchers is to assess local situations and propose appropriate mitigating measures if found necessary. To this end, researchers are making contact and entering into dialogue with a wide range of stakeholders in health, environment and development, at the local, national and international levels, in order to inform policy and practice. The discussions taking place, it is hoped, will lead to greater joined-up action across government departments and other relevant agencies, so that effective [One Health](http://www.onehealthinitiative.com) (www.onehealthinitiative.com) policies can be pursued which will achieve optimal health for animals, people and the environment. The research findings will also prove relevant to understanding similar contexts elsewhere.

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### **FURTHER INFORMATION**

*For more information on the work of the Dynamic Drivers of Disease in Africa Consortium:*

*Website [www.driversofdisease.org](http://www.driversofdisease.org)*

*Email [contact@driversofdisease.org](mailto:contact@driversofdisease.org)*

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Produced by the 'Dynamic Drivers of Disease in Africa Consortium', NERC project no. NE-J00 1570-1, funded with support from the Ecosystem Services for Poverty Alleviation Programme (ESPA). The ESPA programme is funded by the Department for International Development (DFID), the Economic and Social Research Council (ESRC) and the Natural Environment Research Council (NERC), as part of the UK's Living with Environmental Change Programme (LWEC). The views expressed here are those of the authors and do not necessarily represent those of the funders, the ESPA Programme, the ESPA Directorate, or LWEC.