RESEARCH UPDATE

SITUATION ANALYSIS SIERRA LEONE

The Dynamic Drivers of Disease in Africa Consortium is an ESPA[1]-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 Lassa fever in Sierra Leone.

Photo: Gianni Lo Iacono

AUTHORS

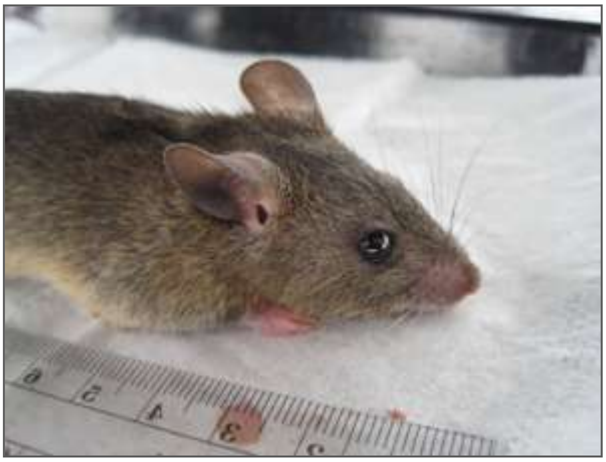
Lina Moses, Tulane University; Alie Kamara, Njala University; Alhaji Brima Gogra, Njala University; Bashiru M. Koroma, Njala University; Thomas R.A. Winnebah, Njala University; Morrison Kenie Lahai, Njala University; Mohamed Jalloh, Njala University; Hannah S. Senesie, Njala University; Melissa Leach, Institute of Development Studies; Catherine Holley, Institute of Development Studies; Gianni Lo Iacono, University of Cambridge; David Redding, University College London.

SEPTEMBER 2013

[1] 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

Lassa fever is an acute, sometimes severe haemorrhagic infection caused by the Lassa virus and transmitted by the multimammate rat, *Mastomys natalensis.* It is endemic in parts of West Africa, including eastern Sierra Leone where the Dynamic Drivers of Disease in Africa Consortium (www.driversofdisease.org) is working. There is little information on the ecology, social distribution and determinants of Lassa virus transmission. Yet the impacts of Lassa fever add significantly to the health burdens, poverty and vulnerabilities faced by people in these regions.



MASTOMYS NATALENSIS *Photo: Lina Moses*

The Drivers of Disease Consortium (www.driversofdisease.org) is using interdisciplinary methods to explore the relationships between land use (mining, subsistence farming and commercial agriculture), rodent numbers and Lassa virus transmission, with the aim of developing practical and sustainable policy intervention strategies for communities affected by rodent-borne disease. The research is being conducted in Kenema District, in the forest zone of eastern Sierra Leone, which has the highest recorded incidence of Lassa fever in the world.

KEY QUESTIONS

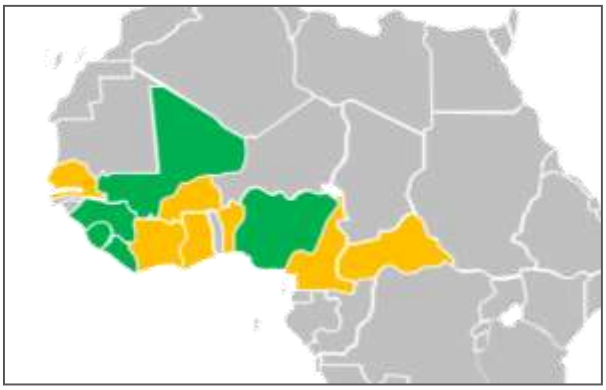
The research is exploring how land-use variation affects rodent abundance and biodiversity, livelihood activities, ecosystem service use, and poverty and access to healthcare facilities, thus affecting transmission of Lassa virus.

Specific questions for the research include:

- What are the main transmission routes for Lassa virus transmission, from rodent to rodent, from rodent to human and from human to human?
- Who is most vulnerable to Lassa fever?
- How does land-use change affect rodent ecology and Lassa fever transmission?
- How does rodent ecology and Lassa fever transmission transform across seasons and with variations in livelihood practices?
- How does climate change relate to changes in rodent numbers and Lassa fever distribution?
- What are the differences between Lassa fever transmission dynamics in urban-edge settings and those in more remote rural areas?
- What local knowledge and cultural understandings surround Lassa fever?

BACKGROUND

Lassa fever is a zoonosis (disease transmitted from animals to people) caused by Lassa virus. Estimates of its incidence vary widely, and range from 100,000 to nearly 13 million infections, and between 5,000 and 67,000 deaths each year across West Africa. Since it was first recognised in a hospital outbreak originating in north-eastern Nigeria in 1969, studies have shown it to be endemic in focal areas of Sierra Leone, Guinea, Liberia and Nigeria, with evidence of Lassa virus in several other countries throughout the West African sub-region.



GEOGRAPHIC DISTRIBUTION OF LASSA VIRUS ACROSS WEST AFRICA. COUNTRIES IN GREEN HAVE DOCUMENTED TRANSMISSION OF LASSA VIRUS IN HUMANS OR RODENTS. COUNTRIES IN YELLOW HAVE EVIDENCE OF LASSA OR LASSA-LIKE VIRUS.

Primary transmission of Lassa virus to humans is through contact with *M. natalensis*, one of the most widespread native rodents in Africa. Secondary (person-to-person) transmission occurs through contact with the body fluids of an infected person. Rodent-to-rodent transmission is responsible for maintenance of Lassa virus as humans are dead-end, incidental hosts.

Lassa fever manifests itself from three to 21 days after exposure to the virus, with gradual onset of fever, headache, malaise and weakness. The lack of distinctive symptoms from other endemic diseases in the region such as malaria and typhoid make clinical diagnosis difficult without laboratory confirmation. Death can occur 10 to 14 days after the onset of symptoms, but evidence suggests that mild or asymptomatic disease also exists. Treatment is with ribavirin, a broad-spectrum antiviral. No vaccine is approved for Lassa fever prevention**.**

KNOWNS AND UNKNOWNS

There has been little research into the disease dynamics of Lassa fever. As Lassa virus is considered to have potential for use in bioterrorism, the majority of research funding has been devoted to addressing this threat as well as related laboratory-based studies. The result is a paucity of evidence on the social and ecological dimensions of virus spillover (in which it is passed to susceptible humans), exposure and maintenance to guide policy on disease prevention and control.

RURAL HOUSES *Photo: Catherine Holley*

Still, there are some significant known features of the virus and its rodent reservoir. Chief among these are that *M. natalensis* is almost always found in association with human habitation or agricultural activities (farmed or fallow fields) and that the traditional construction of homes in West Africa, using natural materials, is associated with increased *M.*

natalensis infestation. It is known that human antibody prevalence for the virus is greater in communities that eat rodents. Also, that the disease is uncommon in urban areas, though more so in urban-edge areas; and a higher incidence of it has been documented in villages where diamond mining activities take place.

The unknowns though remain more numerous and significant. For example, the geographic range of *M. natalensis* in Africa far surpasses the endemic area of Lassa fever and this lack of congruence remains unexplained.

The disease dynamics of Lassa fever interact with a range of local social and ecosystem service processes – these local system contexts and interactions in turn being shaped by wider drivers of change. For some of these there is an evidence base for the Drivers of Disease study to build upon. These include**:**

- **Climate** For example, it is known that *M. natalensis* is a prolific breeder and population explosions can occur when environmental conditions are favourable (i.e. there is increased rainfall).

- **Biodiversity** For example, it is known that Lassa virus spillovers do occur in other rodent species. (Though unknown whether these species play a role as bridge vectors or amplifying hosts, or whether interspecies rodent aggression or resource competition is significant in regulating *M. natalensis*.)

- **Land Use** Disease emergence with all the haemorrhagic fevers identified in the past 60 years has been associated with human impact on the landscape (anthropogenic change).

Other drivers of disease remain largely uncharted territory. The effects of spatial and seasonal variations in rodent habitat and Lassa fever transmission in the shifting farm-fallow-upland-swamp sites of village landscapes remain unknown. Gender, age and social relations have important impacts on livelihood opportunities and poverty in rural areas and on the ways people move throughout the landscape in accessing resources and ecosystem services. This raises important questions surrounding different social and demographic groups' exposure to the Lassa virus. There are also questions to be asked in respect of different people's understandings and behaviours in relation to the disease.

Further complexity is added as Sierra Leone's environment undergoes larger-scale changes, shaped by factors such as climate change, rapid urbanisation and major transformations of land use associated with recent large-scale commercial land deals to grow crops for export and biofuels.

CASE STUDY METHODOLOGY

The Drivers of Disease Consortium is investigating the research questions using an interdisciplinary integration of social, participatory, ecological, epidemiological and environmental methods and modelling. Fieldwork is organised from Kenema Government Hospital, where 500-1,000 suspected cases of Lassa fever are typically seen each year, and a research and training field station is maintained by the Ministry of Health and Sanitation in collaboration with Tulane University and other partners.

Four communities in Kenema District with recorded Lassa incidence have been selected for the study. Each displays potentially important variants of ecosystem and land-use features as outlined in the table below, enabling contrasts to be explored.

Village	Mining	Fallow system	Crops	Community type
Majihun (Kenema District)	Yes	Short and long	Rice/mixed	Rural
Lambayama (Kenema suburb)	No	Short	Rice	Urban edge
Lalehun Kovoma (Kailahun District)	Yes	Long	Upland mixed	Rural
Largo Section in Segbwema (Kailahun District)	No	Short	Rice/cassava	Urban edge

CHARACTERISTICS OF FOUR COMMUNITIES TO BE STUDIED

Ecological, environmental, disease-focused and social science field activities are being conducted by interdisciplinary teams working in each of the four communities at a series of seasonal time points over a two-year period, starting in July 2013. The time points capture key moments in annual cycles of climate/rainfall, farming and land use, and hence possible variations in Lassa transmission dynamics.

Field activities include vegetation and land-use mapping, air-temperature and humidity recording, rodent trapping and sampling, human disease sampling, and interviews and focus group discussions. A range of participatory methods and modelling exercises are being used to explore the complex relations that link different people's livelihoods, their use of landscapes and ecosystem services, their contact with rodents and potential exposure to Lassa fever transmission risks, and poverty and wellbeing. Process-based modelling is addressing disease-ecosystem dynamics and Lassa fever transmission, while pattern-based modelling is addressing the factors driving Lassa fever dynamics and distribution at wider scales.

PARTICIPATORY MAPPING *Photo: Catherine Holley*

PATHWAYS TO IMPACT

Drivers of Disease researchers are developing and maintaining close contact and dialogue with government and other stakeholders involved with health, environment and development in Sierra Leone. In this way, it is anticipated that the research findings will contribute to policy and practice, as well as to scientific knowledge.

New understandings of how people are exposed to Lassa virus and its rodent reservoir will, the team hopes, highlight new opportunities to develop interventions decreasing people's risks of infection – in particular low-cost, locally-appropriate interventions which can realistically be taken up by people in the very poor settings where Lassa fever is endemic. Greater appreciation of the environmental, social and economic drivers of Lassa fever should also open up new opportunities for joined-up thinking and policy across local, national and international agencies and sectors – and so real action towards a vitally-needed One Health (www.onehealthinitiative.com) approach, which values human health, animal health and the environment, in order to address this devastating disease.

FURTHER INFORMATION

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

Website www.driversofdisease.org

Email contact@driversofdisease.org

Twitter @DDDAC_org

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.