Assessing Socioeconomic Factors Underlying Ebola Infection

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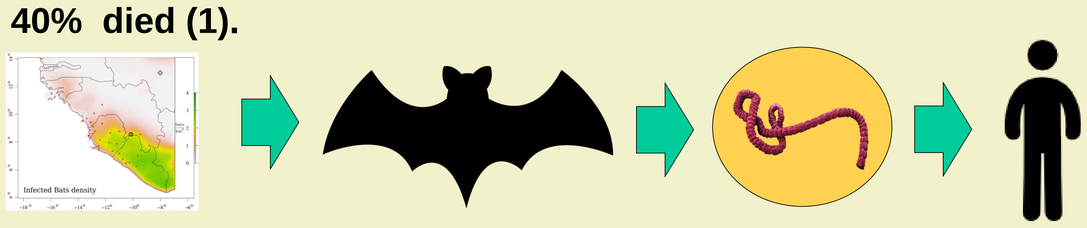
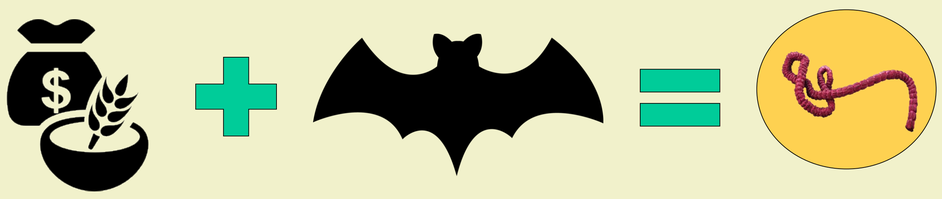
ABSTRACT: Zoonotic diseases are spread across continents by non-human animal carriers which are infected by pathogens and subsequently infect humans. In the case of Ebolavirus, evidence supports that the main animal carrier is fruit bats. In the 2014-2016 outbreak, the virus travelled upwards of 3000 miles. Not only is the virus lethal in humans (over 11,000 casualties in 2014 outbreak), but its spread could become a global epidemic. This project focuses precisely on the transition of Ebola-Virus from animal vectors to human carriers (i.e., "spillover"). Using readily available data over the African continent (e.g., demographics, urbanicity) we are trying to identify the probability of spillover for each region. We conducted a survey in Sierra Leone in which a set of questions focused on behaviors that put an individual at risk of exposure to Ebola-Virus and another set addressed sociodemographic characteristics and other quantities which are routinely collected for each region in the country. The survey data was processed to identify key variables that are best predictors of risky behavior and to establish a data-driven model that predicts risky behavior statistics for other regions and future times. This model will be combined with previously developed models assessing the density of Ebola infected bats over space and time in Africa, to compute the overall risk of a spillover to humans. Knowing when and where spillover is more likely to occur would allow for effective deployment of resources (e.g., drug supplies) and otherwise preventative measures.

Problem

Between 2014 and 2016, approximately 30,000 people were infected with Ebola in West Africa of which approximately 40% died (1).



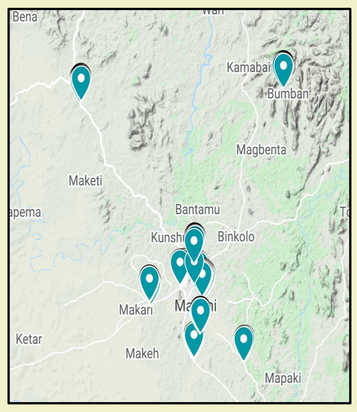
Dr. Buceta & Dr. Bocchini successfully predicted the Spatio-temporal location of Ebola infected bats throughout West Africa using a SIR model in 2017.



This revealed the possibility of modelling the probability of an infected bat transmitting the disease to humans in a similar way, using sociodemographic characteristics.

Data Collection

A survey was developed to collect measurable quantities and risky behaviors which increase the likelihood of spillover.



To identify a correlation on an individual level, the survey was categorized into **5 sections**:

1. **Sociodemographic Characteristics**
2. **Household Characteristics**
3. **Risky Behaviors**
4. **Environmental Characteristics**
5. **Ebola Perception**

Conducted **284 interviews** in the specified locations above Sierra Leone in Summer 2019.

Analysis & Results

The qualitative survey answers were converted into **binary variables** for questions with multiple answers and **dummy variables** for categorical data so it could be processed. Questions in sections 1, 2, and 4 served primarily as inputs and questions in section 3 served primarily as outputs. A risk index for each respondent is generated as a linear combination of the R variables corresponding to the output answers.

$$\frac{\sum_{n=1}^{R} \gamma_n * \omega_n}{\sum_{n=1}^{R} \gamma_n}$$

RStudio software is used to try and identify a linear regression between the respondent's inputs and their risk index, including second degree numerical parameters and cross terms. Currently all questions are weighed equally. The adjusted R is –1, indicating that it is accurate although the number of parameters is close to the number of data points. The goal is to minimize the number of parameters in the model and conduct testing.

Next Steps

This model will predict future outbreaks by utilizing publicly available demographic data. Allowing organizations and governments to allocate West Africa's limited resources to the areas of greatest risk.

Specifically, allocating the limited number of Ebola vaccines **(REGN-EB3 and MAb114)** to at-risk areas. As well as shape preventive policies, and improve education surrounding Ebola.

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