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In-situ and remote sensing networks for environmental monitoring and global assessment of leptospirosis outbreaks

Andreas N. Skouloudis[a]*, David G. Rickerby[a]

[a]*Institute for Environment and Sustainablity, European Commission, Joint Research Centre, TP263, via Enrico Fermi 2749, Ispra, I-21027, Italy*

Abstract

Leptospirosis is a disease that affects human population and can claim many victims with large outbreaks associated with natural disasters. This work focuses on the technological aspects for inexpensive climate monitoring techniques based on ground and satellite sensors for obtaining information prior to disease outbreaks in under-developed regions and on water-quality sensors that can lead to radical changes in our ability to detect and abate this disease. The remote deployment of such sensors in areas where outbreaks can occur can help in enhancing in real-time the spatial and temporal resolution of information and allows unattended operation that will be particularly useful for monitoring under extreme climate events. Such types of monitoring advancements, when coupled with regular geographical, population and habitat monitoring can assess the hazards and risks to local population prior to a disease outbreak. Then in the eventual aftermath, it can assist in identification of affected geographical locations where abatement solutions will be required, and eventually in the assessment of the effectiveness of control measures. This work explores recent releases of open global observation data and a range of in-situ environmental monitoring tools of increasing complexity for measuring several parameters and for detecting contaminants and pathogens that were previously irresolvable due to the high degree of complexity in the diagnosis of this disease.

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Keywords: Environment and climate monitoring; leptospirosis; remote ground and satellite sensors; warnings amd outbreak assessments

1. Introduction and the nature of the disease

Leptospirosis is a zoonotic disease that became recently a major public health problem and a cause of significant morbidity and mortality among impoverished populations [1]. This disease originates from zoonotic pathogens

* Corresponding author. Tel.: +39-333-5941778; fax +39-0332-785628.
E-mail address: andreas.skouloudis@jrc.ec.europa.eu

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associated with asymptomatic rodent carriers. It has emerged to become a major public health problem in much of the tropical developing world. Although the spirochaetal agent has been discovered one hundred years ago, it still is little understood because it is a complex and dynamic bacterial disease with multiple modes of transmission, numerous hosts, a multitude of pathogenic serovars, various clinical manifestations, and difficulty in laboratory confirmation. Hence, even today it may claim many victims due to its global distribution, its epidemic potential, its presence in domestic animals, small mammals and the natural environment, and its high potential for human mortality, if left untreated.

Leptospirosis is also of particular public health concern due to the influence of certain environmental conditions, which means that climate change impacts affects the nature of the disease and influences the magnitude and severity of outbreaks. The severity of the illness ranges from subclinical infection to a fulminating fatal disease. It is most commonly found in tropical and subtropical locations although incidence is highest in island countries or low-lying countries with frequent flooding. Individuals and geographic regions with limited resources are subject to higher rates of leptospirosis compared to other parts of the world. This is likely correlated with poor housing conditions, housing density, drainage and sewage, and food storage conditions which increase people's proximity to rodents. While Leptospirosis is primarily a disease of poverty, other high risk groups include outdoor recreational users (adventure racers, white water rafters), certain occupational groups (agricultural workers, veterinarians) and survivors of natural disasters (floods, hurricanes). For this purpose several international organizations have worked together since 2010 in a Global Leptospirosis Environmental Action Network (GLEAN) for setting up surveillance, prevention and control demands. This initiative [2] was designed to develop a holistic multidisciplinary approach to leptospirosis problem by bringing together different expertise involved in leptospirosis research. It provides direction and coordination to fill the many gaps in leptospirosis knowledge with the ultimate goal of translating the research findings into operational guidance for communities and countries affected by leptospirosis outbreaks.

Of increasing concern is the worldwide increase in the number of reported incident cases associated with natural disasters and flooding with the most notable outbreaks occurring in: Nicaragua (1995), Peru and Ecuador (1998), Orrissa (1998), Malaysia (2000), Jakarta (2002), India (2000 and 2005), Sri Lanka (2008), and Philippines (2009). Representative publications about such outbreaks are available [3,4]. The latest reported cases from Aug 2014 to Jan 2015 are shown in Fig.1 according to 52 alerts reviewed in Healthmap, the WHO online real-time monitoring of emerging health threats, with 568 alerts from 2007 to 2011 [5].

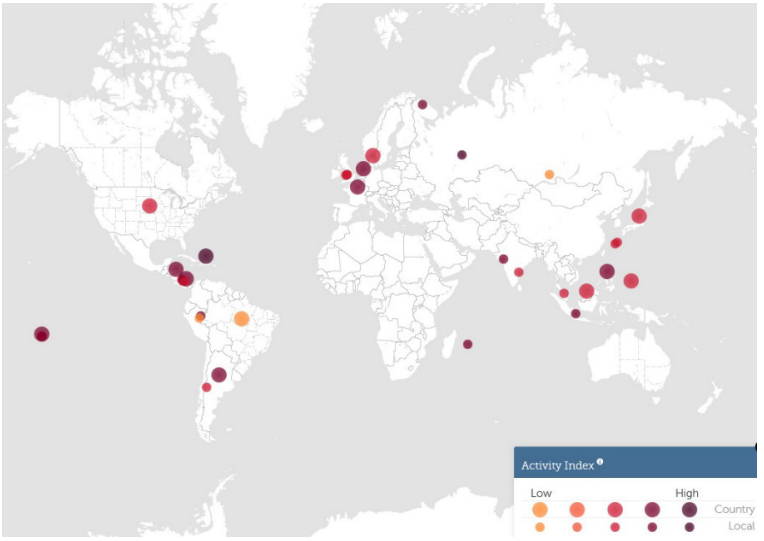

Fig. 1. The Leptospirosis health map dataset for 52 alerts from Aug 2014 to Jan 2015. Several countries are not reporting cases of this disease due absence of diagnostic tools [5].