Chapter 23
A Geo-Informatics Technique for the Management of Meningitis Epidemic Distributions in Northern Nigeria

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ABSTRACT

This study aims at examining and mapping the spatiotemporal distribution of meningitis epidemic, in relation to climate variability, using GIS and Remote Sensing techniques. Using the northern part of Nigeria as a case study, data on meningitis epidemic were obtained from the archive of National Bureau of Statistics, Nigeria for the periods between 1998 and 2013. The data were updated with collection from Nigeria Demographic and Health Survey (NDHS). Also, Nigerian Ministry of Health has compiled consistent statistics on meningitis incidence for the periods. A meningitis distribution map was derived from an environmentally-driven form of predicted probability of epidemic experience as it is in International Research Institute for Climate and Society (IRI) Database. The results showed that Meningitis Epidemic is very high during months with low rainfall. Thus, seasonality of rainfall and temperature are important determinants of Meningitis Epidemic incidence in the Northern part of Nigeria. Therefore, it can be confirmed, as cited in some literatures, that the distribution of the epidemics has a strong association with the environment, especially climate variability. Although meningitis surveillance systems in Nigeria have improved, they still fall short of the sensitivity required to demonstrate incidence changes in vaccinated and non-vaccinated cohorts and complementary approaches may be needed to demonstrate the impact of the vaccines. There is however, a need for a new technology and innovation like an integrated GIS, and other environmental modeling system, to allow health practitioners as well as policy makers, for better management, productivity and profitability.

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1. INTRODUCTION

The understanding of environmental change impacts on human health has received increasing recognition in recent scientific researches. Risk maps of vector-borne diseases like meningitis in Africa based on environmental data, have received considerable attention in recent years and have become tools with public health potential (Brooker 2002; McMicheal *et al*., 2003; Thomson *et al.* 2006a). There is at present an overabundance of research and policy activity regarding climate-sensitive diseases, particularly meningitis, malaria, dengue, diarrhoeal diseases and under-nutrition, by individual researchers and international research organizations (Lanham, 2014). Typical among the international research organization are the studies by WHO and Intergovernmental Panel on Climate Change (IPCC) which acknowledged the fact that human population health is influenced by "upstream" environmental and social conditions (WHO 1998; Kovats *et al*.2000; IPCC2001). Meningitis Epidemic disease is an infection of the fluid that surrounds a person's brain and spinal cord (the meninges). Meningitis spreads mainly through kisses, sneezes, coughs, and in close living quarters, especially when people share cups, forks, and spoons. Although many bacteria can cause meningitis, most epidemics are due to a small number of meningococcal serogroups, especially groups A, C, X, Y and W135, with more than 90% of these epidemics due to group A *Neisseria meningitides* (Ouedraogo *et al*., 2001; Stephens *et al*., 2007), which usually occurs in a cycle of 10-12 years.

Meningitis epidemic is characterized by a sudden onset of intense headache, fever, nausea, vomiting, photo-phobia and stiff neck, in association with neurological symptoms (lethargy, delirium, coma and convulsions). The WHO (2003a; 2013) recommends that the clinical diagnosis should include an examination for meningeal rigidity, neurological signs, purpura, blood pressure and focal infection. Other potential drivers include the potential impact of dust on preceding viral infection and the fluid dynamics of airborne transmission of the bacteria through dust. Another factor is the impact of high dust levels on human including crowding and reduced ventilation and the climatic variables such as absolute humidity and temperature. Meningitis epidemic in Africa remains an important and unresolved public health problem because it is one of the most feared diseases in Africa due to its rapid onset and high mortality and morbidity rate; those it doesn't kill often suffer brain damage or deafness as a result of the infection of the thin lining that surrounds the brain and spinal cord. Epidemics of meningococcal meningitis affecting West Africa and the Sudan between 1905 and 1908 were amongst the earliest documented in Sub-Saharan Africa (Bulto *et al*., 2006). Subsequently, an epidemic event was reported with increasing frequency throughout the region and increasingly becomes a permanent and severe problem, and has plagued the African continent for over a century creating public health emergencies with considerable morbidity and mortality. The recent outbreak of meningitis in parts of Northern Nigeria did not catch the nation's health authorities unawares. Investigations by Vanguard (2009) showed that preparations were already in place to contain the disease in the nation's "meningitis belt" long before the outbreak.

Moreover, it is observed from literature that many of the previous studies in Nigeria used different techniques, such as parametric and non-parametric tests, for testing the spread of meningitis. To explore the association of the climate with the epidemics, it is desirable to categorize geographical areas within Nigeria that contain the environmental features of the meningitis belt. In this study, meningitis belt is environmentally vulnerable to the epidemic with massive populations at risk. Although epidemics may occur outside of this belt, but they are often less frequent. There is therefore the need for an integrated Geographical Information System (GIS), Remote Sensing Techniques (RST) and Meningitis Early Warning System (MEWS) that offer health practitioners, as well as policy makers, access to informed

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