PH02
Satellite Remote Sensing In Water and Health Surveillance System

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***Abstract*— Satellite remote sensing is an evolving technology with the potential for contributing to studies of global environmental change. Moreover, new sensors are bringing new opportunities to the researchers and scientists widening the area of studies. Latest computing power tools, spatial modelling capabilities, GIS and GPS technologies could expand the research into water and health surveillance system. There is a good potential for developing an early warning systems based on satellite remote sensing data and environmental drivers. A paradigm of future water and health surveillance system is approached developing a complex mathematical model from the satellite imagery and environmental information. The system could support the water and health professionals in advance minimising the possible outbreaks.**

INTRODUCTION

Satellite remote sensing technique is being used by the scientists and researchers at several temporal and spatial scales since 1972, contributing to diverse studies of environment. With the better spatial and spectral resolutions, more frequent coverage, and increased availability of the range of new sensors, satellite technology is creating new opportunities to the researchers and scientists widening the area of studies [1].

It is evidenced that infectious diseases are linked to environmental changes. An extensive number of researches have confirmed over the last few decades that there is a strong relationship between environment and disease [2-8]. Satellite remote sensing has the capabilities of detecting such environmental changes, which could play critical role to predict possible outbreaks. This paper discusses the enormous possibilities of this frontier technology into water and health surveillance system.

SATELLITE REMOTE SENSING IN WATER AND HEALTH RESEARCH

Researchers have been trying to find a relationship between water parameters and health outcomes by satellite imagery techniques for a long time. The pioneer of such study is CHAART remote sensing of cholera outbreaks project, conducted at the NASA Ames Research Centre in collaboration with University of Maryland. In this study, [9] used the satellite data for the Bay of Bengal to measure the timing and spread of cholera in Bangladesh over a 4 years period. They discovered that both sea surface temperature and sea surface height in the Bay of Bengal are linked with the cholera outbreaks. Based on their interesting results, they hypothesized that the increasing of the sea surface temperature affects the growth of phytoplankton concentrations and that sea surface height indicates the tidal incursion of plankton-laden water inland.

Reference [10] measured the spatiotemporal associations between cholera incidence and environmental variables derived from satellite imagery with in situ time series data in Bangladesh and Vietnam. Ordered probit models and probit models were used to examine the associations. They scrutinized that increases in ocean chlorophyll concentration are influential to the magnitude of cholera increment in Bangladesh. Sea surface temperature was observed as correlated factor in Vietnam. Erstwhile research supports the findings, concurring that sea surface temperature smooth the progress of phytoplankton growth, thus persuades the subsequent multiplication of copepods [7].

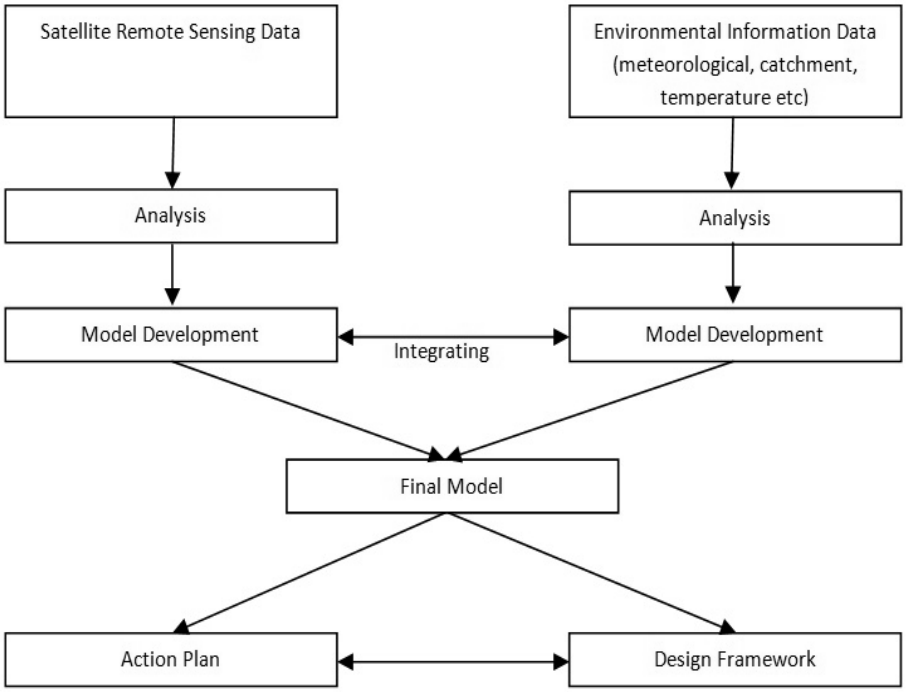
Further study conducted by [11] concluded that ocean and climate patterns analyzed from the earth observation data are useful predictors of cholera epidemics. Satellite sensors were used in the study measuring chlorophyll a concentration, sea surface temperature and rainfall. From the analysis, a statistically considerable association between the time series for cholera in India and chlorophyll and rainfall differences was resolved.

PARADIGM OF FUTURE WATER AND HEALTH SURVEILLANCE SYSTEM

A warning system giving the information of likely occurring outbreaks is important to public health experts in taking action as possible remedies. Such warning system can only be introduced by predictive modeling, with integrating satellite and local environmental data. Currently, with the satellite technologies, sea surface temperature, sea surface height, chlorophyll and a variety of vegetation indices and soil indices can be measured, in addition to many other physical, chemical and biological parameters [12]. A complex mathematical model can be developed from these satellite remote sensing data, together with the environmental information data (e.g. meteorological, catchment temperature data etc). Based on the final model, possible actions can be taken along with designing an effective framework to support the water and health professionals in advance minimizing the possible outbreaks. Figure 2 shows a possible paradigm of water and health surveillance system.

DISCUSSION

Predictive modeling from satellite and environmental data has a great promise for developing an effective water and health surveillance system. However, satellite technology is



still a subject of ongoing research and far more information is needed to develop such scheme. Furthermore, inadequate temporal resolutions of the current satellite sensors are an impediment of the paradigm. Cost and technical expertise is another obstacle restricting the use of technology within the research community as a whole. Yet, developing such system is very much essential for a better decision and policy management.

REFERENCES

[1] L. R. Beck, *et al.*, "Remote sensing and human health: New sensors and new opportunities," *Emerging Infectious Diseases*, vol. 6, pp. 217-227, May-Jun 2000

[2] G. Nichols, *et al.*, "Rainfall and outbreaks of drinking water related disease and in England and Wales," *Journal of Water and Health*, vol. 7, pp. 1-8, Mar 2009

[3] F. C. Curriero, *et al.*, "The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994," *American Journal of Public Health*, vol. 91, pp. 1194-1199, Aug 2001

[4] S. Paz, *et al.*, "Climate change and the emergence of Vibrio vulnificus disease in Israel," *Environmental Research*, vol. 103, pp. 390-396, Mar 2007

[5] Auld, *et al.*, "Heavy rainfall and waterborne disease outbreaks: The Walkerton example," *Journal of Toxicology and Environmental Health-Part a-Current Issues*, vol. 67, pp. 1879-1887, Oct-Nov 2004

[6] Hashizume, *et al.*, "Association between climate variability and hospital visits for non-cholera diarrhoea in Bangladesh: effects and vulnerable groups," *International Journal of Epidemiology*, vol. 36, pp. 1030-1037, Oct 2007 T. Kiorboe and T. G. Nielsen, "Regulation of zooplankton biomass and production in a temperate, coastal ecosystem .1. Copepods," *Limnology and Oceanography*, vol. 39, pp. 493-507, May 1994

[7] G. Wilkes, *et al.*, "Seasonal relationships among indicator bacteria, pathogenic bacteria, Cryptosporidium oocysts, Giardia cysts, and hydrological indices for surface waters within an agricultural landscape," *Water Research*, vol. 43, pp. 2209-2223, May 2009

[8] B. Lobitz, *et al.*, "Climate and infectious disease: Use of remote sensing for detection of Vibrio cholerae by indirect measurement," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 97, pp. 1438-1443, Feb 2000

[9] M. Emch, *et al.*, "Local environmental predictors of cholera in Bangladesh and Vietnam," *American Journal of Tropical Medicine and Hygiene*, vol. 78, pp. 823-832, May 2008

[10] G. C. de Magny, *et al.*, "Environmental signatures associated with cholera epidemics," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 105, pp. 17676-17681, Nov 2008

[11] T. E. Ford, *et al.*, "Using Satellite Images of Environmental Changes to Predict Infectious Disease Outbreaks," *Emerging Infectious Diseases*, vol. 15, pp. 1341-1346, Sep 2009