IDENTIFICATION OF GLOBAL WATER AND CLIMATE INDICATORS TOWARDS AN AFFORDABLE SATELLITE-BASED EARLY WARNING SYSTEM FOR DIARRHEAL DISEASE OUTBREAKS

A post-doctoral position is available beginning from September 2014 for research at the intersection of hydrologic modeling and prediction and mitigation of vulnerability to diarrheal disease. The position will be guided by a cross disciplinary team of experts on global hydro-climatology and global health at the University of Washington (UW). UW offers a unique training ground for training cuts across water and health by taking advantage of the world-class expertise of the Global Health Department (http://www.globalhealth.washington.edu) along with expertise in hydrology and water resources within UW's Department of Civil and Environmental Engineering (http://www.ce.washington.edu/research/water/). Ample opportunities for direct interaction with potential stakeholders in developing countries exist through the Institute of Water Modeling (IWM-Bangladesh), International Centre for Diarrheal Disease Research, Bangladesh (ICDDR,B) and the International Center for Integrated Mountain Development (ICIMOD-Nepal). In addition, the successful applicant will be exposed to unique insights on long-standing engagements with government and semi-government agencies of South Asia for capacity building and operational satellite-based early-warning systems. Under multi-disciplinary guidance, the post-doctoral researcher will explore the development of a predictive modeling platform that will link freshwater availability to a series of relevant public health metrics on diarrhea. Due to the multifactorial complexity of diarrhea, evaluation of the potential impact of fresh water availability along a continuum of health outcomes is critical, from gross measures of health (e.g.: under-5 mortality, stunting) to pathogen-specific risk (e.g.: incidence of *cholera* or *enteropathogenic E. coli*) that can help us better understand the linkage between health and water and eventually translate that to a decision-making tool.

The successful applicant is expected to be conversant in data-base management, programming/script-writing to handle global-scale satellite and modeled datasets, mathematical modeling and geo-spatial analysis. Although a background in public health is not required, familiarity with global health issues, concepts and approaches, and a demonstrated desire to make an impact through cross-disciplinary research and education will be considered in evaluation of applications. For further information, interested applicants are requested to first read the remainder of the announcement below and then contact Dr. Faisal Hossain at fhossain@uw.edu (http://WWW.SASWE.NET) as needed.

MOTIVATION

According to the World Health Organization (WHO), diarrhea is a water-related disease that is responsible for the largest fraction of infant mortality in the developing world. The compounding factors that increase diarrheal risk are malnutrition, lack of access to clean water (due to overcrowding, poor sanitation or drought) and increased contamination of water during floods. Vulnerability to malnutrition can also increase when droughts or floods result in reduced crop yields and an increase in food prices.
There are clear hydro-climatic controls of diarrheal risk in the developing world that have been demonstrated in recent research. For example, an explanation of the dual peak of cholera incidences in the Ganges Delta can be found in the seasonal variability of freshwater that modulates the water salinity

and consequently the abundance of *vibrio cholera*. While the hydro-climatic controls are obvious, little work has been done to explore the global space-time variability and availability (fluxes and volumes) of freshwater in coordination with public health experts to search for clues that can lead to a pragmatic and affordable approach for early warning of outbreaks on a global scale. We are now poised to have global satellite missions dedicated for freshwater monitoring (precipitation, surface water and soil wetness) in manner that may allow us to better answer a question that has been fundamentally elusive using ground based approaches in the developing world – *"how much water do (will) we have, where and when?"* The anticipated freshwater-related data from satellites is expected to be freely available in near-real-time and in a virtually 'on-demand' fashion by the next decade (2020). Technological innovations are already beginning to address the question of making the plethora of satellite-based freshwater information available to ordinary people in the developing world in a manner that actually empowers an individual to improve the quality of life (see "LIQUID EARTH" at http://climate.cae.tntech.edu for more information).

However, a pure hydro-climatic approach of comparing freshwater distribution against diarrheal incidence is unlikely to yield a robust design of the early warning system of global utility. This is because of non-hydro-climatic controls on diarrhea that are related to demography, sanitation and public health policy (WASH), health and socio-economic conditions, and nutritional background. Thus, the design of satellite-based early warning system that actually works in practice necessitates working very closely with public health experts (such as at UW's Global Health) who have devoted their lives to understanding vulnerability to diarrheal disease in the developing world.

OBJECTIVE

The primary objective of this project is to compare the global space-time variability of freshwater fluxes, that is available from a combination of satellite-based monitoring and predictive modeling, with the global space-time variability of the non-hydroclimatic controls of diarrhea and search for clues towards a satellite-based early warning system. The non-hydroclimatic controls will span, at a minimum, sanitation and socio-economic conditions, nutritional background, demographic characteristics as well as the specific diarrhea-causing agent (e.g. rotavirus, enterpathogenic. E Coli, shigella, v. cholera). In the first round of investigations, the global variability of runoff, soil temperature, stream flow, soil wetness will be matched in a data-based exercise with global variability of diarrheal incidences, clustering further the analysis, according to Koppen climate, elevation (terrain steepness), population density (crowding in slums) and season (round 2). The pairs of parameters that yield significant correlation will then be explored for a cause-effect explanation by seeking guidance from the public health experts and will broken down further according to the specific diarrhea-causing agent (round 3).

The fourth round of investigation will involve developing mathematical models (most likely non-linear or regression-based) for predicting diarrheal outbreaks (or risk) as a function of key freshwater variables derived from satellite observables and predictive modeling and other non-hydroclimatic parameters. A simpler version of the proposed approach has already been found feasible for malaria early warning. We believe that direct collaboration with public health experts on diarrhea, in our case, should yield

significantly more promising results than the state-of-the-art where there is currently no early warning and affordable scheme for predicting diarrheal outbreaks.

The final round (#5) of investigation will involve calibration and validation of the predictive models over regions of South and Southeast Asia where there exist continuously monitored sites for diarrheal incidences. The table below breaks down the schedule of work that is planned during every 4 month period beginning from Sept 2014.

TASKS (Round)	**Sept-Dec 2014**	**Jan- April 2015**	**May-Aug 2015**	**Sept-Dec 2015**	**Jan-April 2016**	**May-Aug 2016**
Round 1- Exploring data-based correlations between freshwater and diarrhea	XX	XX	XX			
Round 2 – Exploring cause-effect (climatic and land controls)		XX	XX	XX		
Round 3- Exploring cause-effect (public health controls)		XX	XX	XX	XX	
Round 4 – Predictive Model development				XX	XX	
Round 5 – Model Calibration and Validation for early-warning					XX	XX