Chapter 59
Interactive Visualizations as "Decision Support Tools" in Developing Nations:
The Case of Vector-Borne Diseases

Oluwakemi Ola
Western University, Canada & Babcock University, Nigeria

Olga Buchel
Counting Opinions (SQUIRE) Ltd., Canada

Kamran Sedig
Western University, Canada

ABSTRACT

The impact of vector-borne diseases on developing nations is significant. Currently, the uncertainty of disease dynamics, volatility of human-environment interactions, and competing objectives coupled with the nature of applicable data present obstacles to stakeholders charged with developing preventive, control, and treatment measures. As a result, notwithstanding numerous measures, vector-borne diseases persist and impede the growth of developing nations. Therefore, computational tools that can address these obstacles and serve as decision support tools to stakeholders are much needed. This chapter is meant to draw attention to interactive visualization tools that allow stakeholders to control the flow of information, manipulate visual representations, and perform analytical tasks. Through a discussion of the vector-borne disease situation and interactive visualization tools, the case for integrating these tools into public health practice in developing nations is made.

INTRODUCTION

Vector-borne diseases (VBDs), such as malaria, dengue fever, and chagas, result in over 750 thousand deaths annually and cause a significant fraction of the global infectious disease burden (World Health Organization, 2012a). Developing nations bear the brunt of this burden. For instance, 90% of all the deaths from malaria, the most deadly VBD, occur in Sub-Saharan African countries (World Health

DOI: 10.4018/978-1-4666-9845-1.ch059

Organization, 2012c) and 75% of the global population exposed to dengue fever, the fastest growing VBD, are in Southeast Asian countries (World Health Organization, 2012b). In addition to the significant morbidity and mortality, VBDs place an economic strain on nations. From the direct costs of treatment and prevention to the indirect cost of lost productivity, VBDs significantly impede the development and economic growth of developing countries (World Health Organization, 2012a). In full awareness of the consequences of VBDs, public health (PH) stakeholders[1] have implemented various preventive, control, and treatment measures. Some of these measures include the genetic modification of vector populations, the use of insecticide-treated bed nets, indoor residual spraying, and rapid diagnostic tests (Kramer et al., 2009; World Health Organization, 2012a). While some of these measures have proven beneficial for instance, global reduction of malaria mortality by 26% between 2000 and 2010 (World Health Organization, 2012c) there is still much more that can and should be done.

To plan and implement the aforementioned measures, PH stakeholders must make sense of epidemiological and entomological data, analyze the local determinants of the disease, compare possible vector-control methods, predict morbidity levels so as to ensure sufficient supply of treatment measures, and perform various other decision-making tasks. While engaged in these tasks, PH stakeholders interact with data[2]. This data has high volume, has an extensive variety, and, in some situations, has low veracity (Eisen & Eisen, 2011; Setel et al., 2007; World Health Organization, 2012a). These factors all contribute to the complex situation in which PH stakeholders operate in order to address VBDs. In addition to the challenges data presents, the multivariate nature of VBD poses additional obstacles to PH stakeholders. These challenges include understanding the complicated dynamics, interdependencies, and uncertainties that arise from various control strategies over time, the impact of human-environment interaction on vector populations, and the difficult-to-balance trade-offs between competing health, social, and environmental objectives (Kramer et al., 2009). As with all infectious diseases, time plays a crucial role, as the early detection of VBD outbreaks is essential to their control. When dealing with VBDs, the stakes are high, the challenges are immense, and a timely response is paramount. Therefore, computational tools that support the decision-making tasks of PH stakeholders are much needed. Fortunately, technological advances can dramatically change our capacity to predict, prevent, and control VBDs.

Interactive visualization tools (henceforth simply referred to as visualization tools without the adjective 'interactive') are a group of computational tools that has gained prominence in several disciplines over the last 20 years. These tools use interactive visual representations to convey information and support decision-making tasks by allowing users to control the flow of information, to customize visual representations, and, in certain cases, to perform a myriad of analytical tasks (Parsons & Sedig, 2014; Spence, 2007). Visual representations encode abstract or concrete information (e.g., geographic, scientific, or health data) in a visual form, and can be static or interactive in nature. From the time John Snow used a map to reason about a cholera outbreak in 1850 (Snow, 1855) to the use of atlases to make sense of the endemicity of malaria in Africa in recent times (Le Sueur et al., 1997), static visual representations have been used by PH stakeholders. Though useful, static representations do not effectively support decision-making tasks in which stakeholders engage. Visualization tools, on the other hand, employ the use of interactive visual representations and as a result are better equipped to support the decision-making tasks of stakeholders.

Since VBD decision-making requires PH stakeholders to reason with heterogeneous data, visualization tools can play an important role. The effective and efficient use of data determines the extent to which PH stakeholders can sufficiently address VBDs (O'Carroll, 2003; Reeder, Revere, Hills, Baseman, &