Chapter 8
A Multicriteria Spatiotemporal System for Influenza Epidemic Surveillance

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ABSTRACT

Influenza has been a growing concern for the public health decision makers/policy makers. Indeed, they are in need of a real geo-making tool for monitoring and surveillance. The chapter aims to introduce a novel spatiotemporal decision system based on multicriteria ranking method, information geographic system (GIS), and SEIRSW system for public health. The later was designed, implemented, and validated in previous research for influenza risk assessment. The authors highlight the use of PROMETHEE II ranking method of multi-criteria decision analysis in GIS that incorporates various factors to monitor and identify potential high-risk areas of seasonal influenza and disease mapping. Factors related to the risk of seasonal influenza are obtained from simulation system and constitute the input values of PROMETHEE II ranking method for the 26 communes of the city of Oran, Algeria. The proposed system has demonstrated analytical capabilities in targeting high-risk spots and influenza surveillance monitoring system and it can help public health policy makers prioritize in their response goals and evaluate control strategies.

INTRODUCTION

Infectious diseases are a major concern in public health, each year they are responsible for mortality and significant morbidity. Indeed, the purpose of epidemiologic surveillance is to set up methodological tools and software to define an informational environment for collect and organize data. Analysis tools are necessary to treat these data and build relevant, reliable and accurate information for the surveil-

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lance, monitoring, and prevention. Currently, there are many approaches and tools to achieve veritable epidemiological surveillance (Stilianakis & Weber, 2008). However, each one has its advantages and disadvantages.

Mathematical and simulation models are increasingly used to study the transmission of infectious diseases to predict how they might spread in a human population in the event of an epidemic (pandemic), to evaluate different intervention strategies and to help public health decision makers with disease outbreak control and management (younsi et al, 2015b). Model can be used to represent the different state of patients in the course of the illness (S: susceptible, E: exposed, I: infective, R: removed, etc.). In this study, we used the Susceptible, Exposed, Infected, Removed (SEIR) model within SW to explore the dynamics of flu epidemic. The transmission of epidemic occurs through person to person contact, and contact between susceptible and/or infected individuals takes the form of a network. Because SEIR model cannot model this, it must be integrated with a social network model, to understand the spread of the epidemic. Moreover, the structural properties (e.g., density, diameter, clustering coefficient, etc.) of networks play an important role in affecting diffusion behavior. In previous study, we have developed SEIRSW simulation model based on Geographic Information System (GIS). The SEIRSW-GIS was implemented and validated in (Younsi et al, 2015b).

The aim of epidemiological surveillance system based on decision making concept is to bring support to epidemiologists in their monitoring task by providing appropriates indicators and helpful recommendations for making the decision. However, the traditional decision support systems are limited to simple spatiotemporal analysis of surveillance data and a visual detection of epidemic outbreaks on a geographical map. Moreover, they don't provide ways to understand and predict the dynamics of diseases spread in human populations.

The SEIRSW-GIS system generate simulation data and it cannot ranking the areas from the high level risk to low level risk, nor to identify the main factors promoting the disease spread. To fill this knowledge gap, we propose the integration of Multicriteria analysis method in SEIRSW-GIS system to monitor and identify potential high-risk areas of flu and disease mapping. To achieve this goal, we highlight the use of Preference Ranking Organization METHod for Enrichment of Evaluations (PROMETHEE II) method. Multicriteria analysis is performed on the influenza epidemic to examine the main factors influencing flu incidence number, and therefore to predict and track influenza epidemic.

The originality of our paper is to develop a new extension of spatiotemporal decision support system (SEIRSW-GIS: Susceptible- Exposed- Infected- and Removed within Small World Network using Geographic Information System). The latter is based on the development of PROMETHEE II method and its integration within a hybrid simulator (SEIRSW-GIS). The aim of the paper in one hand, to discuss SEIRSW-GIS simulation system in order to understand how epidemic spreads in human population by the coupling of the compartment epidemic model (SEIR) and the social network (SW) model. On the other hand, to assure the integration of Multicritteria analysis using PROMETHEE II in SEIRSW-GIS model in order to show the contribution of the latter in the monitoring and surveillance of influenza epidemic spread in an area, to provide a decision tool for responsible of the infection control program, to better identify risk areas and to develop methodologies to improve the relevance of information for decision making public health.

The remainder of this paper is organized as follows: Section 2, briefly overviews related work in the literature that is similar in spirit to our system. In Section 3, we describe our proposed decision-making system. We present SEIRSW-GIS model and we develop the Multicriteria ranking method (PROMETHEE