Using GIS to Identify Biological Warfare Agents as Threats to Drinking Water Supplies

Primary Author:

Shweta Tope
Graduate Student
Department of Geography & Geology,
Center for Water Resource Studies,
Western Kentucky University

Dr. John All
Assistant Professor
Dept of Geography & Geology
Western Kentucky University

Dr. Andrew Ernest
Director, Center for Water Resource Studies
Western Kentucky University

Karla Andrew
Information Technology Manager
Center for Water Resource Studies
Western Kentucky University

Abstract :

Today, water quality infrastructure of the United States is highly vulnerable to terrorist activity because of critical need of water in every sector. This paper describes the importance of using Integrated-GIS based warning system that monitors drinking water supplies and forecasts unprecedented water borne bioterrorist related events. It aims at automating the detection of anomalies those exceed water quality standards at critical locations in the water distribution system. A rule-based expert system framework will be used to automate the detection process. Set of rules adhering to the water quality standards of Environmental Protection Agency (EPA) and Center for Disease Control (CDC) will be created and any violations will be reported as anomalies. An ArcIMS website will be developed to map the potential drinking water supplies that are under bioterrorist threat. This website will serve as a platform for those users who need to access information independent of the GIS software enabling interactive mapping.

Introduction:

Water is fundamental to human life. Moreover, clean water is the basic need of every household. The looming threat of water contamination at the supply level questions the vulnerability of the existing infrastructure in place at the water utilities. Intentional biological contamination of water is one of the major concerns of water supply utilities all over the United States. A short-term disruption of water supply will significantly impact a community and intentional contamination of the municipal water system as a part of an attack can lead to medical, public health, and economic issues [2]. To say the least, intentional contamination of a water body has the potential to cause mass causalities, threatening the quality of life, human health, and environment. In this paper we identify and determine the characteristics of potential biological warfare agents as threats to drinking water supplies. Examine the public water supplier's source (surface, sub-surface). We use a rule-based expert system framework automating the process of anomaly detection and transportation networks using ArcGIS 9.1 Network Analyst for proximity analysis (scenario based) mapping potential threat localities in the distribution system. In the future, we plan to integrate ArcGIS output coverage with EPANET 2.0 for population risk assessment. Furthermore, an ArcIMS website will be developed to map the potential drinking water supplies under bioterrorist threat. The Website will serve as a platform for those who need to access information (in the event of an attack) independent of GIS software, enabling interactive mapping.

Characteristics of few BW agents as potential threats to drinking water

Agents[1]	Type [5]	CDC Category[4]	Water Threat[5]	Incubation Time (Range)[1][10]	Lethality[6]	Infectious Dose [1]	Water Stability[1]	Chlorine Tolerance (under usual conditions)[1]
Anthrax	Bacteria	A	Yes	1-6 (days)	High	171 spores at 5L/day for 7 days	2 – 40 yrs	Spores are highly resistant
Smallpox	Virus	A	Probible	7-17 [4] (days)	High	10-100 organism per person	Unknown	Unknown
Plague	Bacteria	A	Yes	2-3 (days)	Moderate	70 org at <= 1 org/L at 5L/day for 7 days	16 days in tap water	Unknown

Source: [1] W. D. Burrows and S. E. Renner, Environmental Health Perspectives, Vol (107), Dec, 1999, *Biological Agents as Threats to Potable Water,* [4] Center for

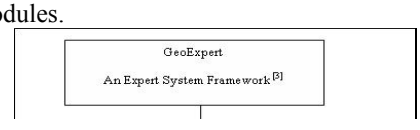
Methodology:

- Identification of biological agents and determine which are viable threats to source water
- Collecting Drinking Water Supply Information
- Using a rule-based expert system framework for anomaly detection in spatial databases [3]
- Calculating the travel time using transportation network routes to predict the possible extent of the attack
- Assessing population under risk by integrating ArcGIS 9.1 Network Analyst with EPANET 2.0
- User Interface: A Web-based system that issues more direct warnings to the public and the utilities

Bioterrorist agents released by Center for Disease Control (CDC)[4]are categorized into: Category A: Highest priority risk agents, which includes organisms that pose utmost threat to national security as they are highly contagious, result in high mortality rates, and have the potential to cause major public health concern. Category B: Second highest priority risk agents include those that are moderately easy to disseminate, result in moderate morbidity and low mortality rates, and require enhanced disease surveillance mechanisms. Category C: Third highest priority risk agents are emerging pathogens that could be engineered for mass dissemination in the future because of their availability, ease of production and dissemination, and the potential for high morbidity and mortality rates. They have the capacity to cause social disruption and public panic. Almost, all of the 18 replicating (infectious) agents and 9 biotoxins known and likely to be used for contamination of water supplies are considered effective via the digestive tract, and some, *Shigella* spp. and *Vibrio cholerae* for example, are registered water-borne threats [1]. In Jerry A. Valcik, P.E., report on *Biological Warfare Agents as Potable Water Threats*, states:

> Most biotoxins [biological agents] would probably be effective threats to drinking water under suitable conditions. For others, however, either there is no known infectious path through ingestion, or the agent cannot survive in water. [5]

to calculate travel time using transportation network and to assess population at risk for bioterrorism response and designing of a customized ArcIMS Web-site as the user interface. We have distinguished each of these functionalities that form the architecture into different modules. In this paper, we cover only the first two modules.



Author Information

Shweta Tope
Graduate Student
Department of Geography & Geology
Center for Water Resource Studies
Western Kentucky University
Bowling Green, KY – 42101
USA
Email: shweta.tope@wku.edu
Phone + (270)-535-7413