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Review:

Web GIS and Public Health

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Abstract:
Both government and private sector organizations are seeking ways to maintain and improve the health of the public in the world to control the costs at the same time. For this aim internet and use of georeferenced public health information for Geographic Information System application is an important and exciting development for the nation's Department of Health and Human Services and other health agencies. Technological progress towards public health geospatial data integration, analysis, and visualization of space-time events using the Web portends eventual robust use of Geographic Information System by public health and other sectors of the economy. Increasing Web resources from distributed spatial data portals and global geospatial libraries, and a growing suite of Web integration tools, will provide new opportunities to advance disease surveillance, control and prevention, and insure public access and community empowerment in public health decision making.
Key Words: Web GIS; Internet; Public Health; Management

Introduction:
Both government and private sector organizations are seeking ways to maintain and improve the health of the public in the world to control the costs at the same time. While people have grown increasingly concerned with the cost of acute and chronic care, insufficient attention has been given to the role that public health data could have on strategies to reduce the burden of disease. Hence a need arose for an easy way to query, organize, combine, overlay, and plot health data. We describe such a system that is accessed over the World Wide Web.

Geographic Information System deployment through the Internet is a relatively new technological development. The remarkable increase in use of the Internet is creating new standards, and challenges, for the efficient use of Web-based geospatial applications.(1) Challenges include spatial scale, size of data files, data compression and transmission, and other conditions for the extensive use of Geographic Information System functionality. For public health applications, geospatial databases created for the Web will have the added requirements to meet confidentiality safeguards to insure the anonymity of the individual from disclosure.(2,3) Geographic Information System and Web technologies offer emerging opportunities to analyze complex geospatial data, solve problems, and present data in a graphical format that public health decision makers and the public can easily see and understand. (4)

Web GIS in health science:
The Internet is becoming the most efficient means available for electronic communication of information and data (5) and the technology is evolving rapidly. Accommodation of geospatial data is no exception, even though constraints persist on bandwidth, transmission speed and integration.(6) The Internet can now provide timely access to geospatial information. It's estimated that at least 80-90 percent of all government databases contain georeferenced information (7) meaning data can be tied to a specific location or place such as area code, latitude and longitude, street address, and many other Census and political boundaries. This suggests the Internet will, in fact, revolutionize our perception and use of geographic and georeferenced information.

Mobilization of public health:
There are several tasks required in order to reach the goal of comprehensive Internet geospatial readiness in public health. Perhaps the starting point is to empower all public state and local health departments (LHDs) with basic geospatial technology, tools and expertise. Insuring that state and LHDs have, or have access to, the needed technology and training is a key investment for developing the nation's public health geospatial infrastructure--from the bottom up. Health database holdings containing geographic or spatially referenced information then become essential infrastructure content, standardized for Web interoperability, and cost-effectively shared.

Public health is beginning to engage geospatial infrastructure-building tasks. Geocoding is one of the most essential (8, 9) and the translation of address information into corresponding latitudes and longitudes in health databases is a national public health goal.(10,11)

Confidentiality of public health geospatial data:
For public health, a key constraint to the release of geospatial data on the Web has been data confidentiality and the protection from any unauthorized disclosure, through location, of an individual's identity. All health agencies, including the Federal government (12), are highly sensitive to any possible public release of data containing geographic identifiers that could lead to the identification of an individual, without some protective and thorough prerelease screening of the data.

Preparing and sharing data for Geographic Information System mapping creates an additional level of complexity to these concerns. Geographic Information System tools easily can layer, parse and spatially reduce geospatial information from an unlimited number of databases and potentially uncover unique geographic locations on a map. Usual approaches to safeguard data against disclosure include temporal or spatial aggregation, smoothing, and other masking techniques. (13)

However, new cautions for public health researchers must be exercised as in the case of using geocoded records with Zip Codes. ZIP Codes and newly created Census Zip Code Tabulation Areas (ZCTAs) sharing the same 5-digit code may not necessarily cover identical areas. The potential for spatiotemporal mismatches and privacy disclosures stemming from the replacement of Zip Codes with ZCTAs in the 2000 census will require thorough examination and new confidentiality guidelines for data release and GIS analysis.(14-18)This information can be displayed with Geographic Information System static proximity maps and posted on the Internet (Figure 1).(19)

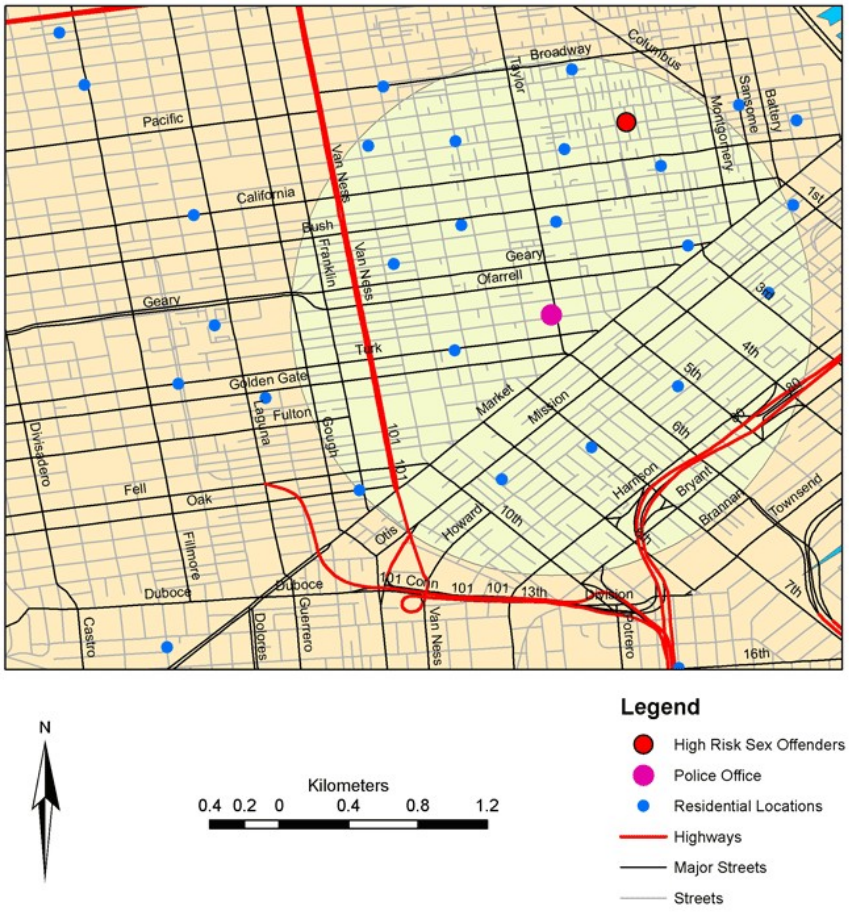

Figure 1: The circle is ½ Kilometers radius around Police Office in Prospero, CA. It contains residential locations (blue dot locations) and one "high risk" (red dot) sex offenders. "Megan's Law" permits the release of this geocoded information to the Internet. (Source: Prospero Police Department, Megan's Law web site http://www.ci.Prospero.ca.nr/fpd/meganlaw/index.html)

Public health geospatial data on the internet:

The availability of public health geospatial data on the Web is growing. Most of these databases are available as either static or dynamic mapping products. The online cancer incidence maps of New York State Cancer Surveillance Improvement or hypertension incidence maps of Esfahan City, Iran Initiative provide one of the more detailed static Web GIS displays of geographic area and disease outcome. These maps compare individual zip Codes with expected cancer incidence.(20) Where downloadable, static display data from a source geospatial database could be prepared for use in a Geographic Information System.

In contrast to static presentations, geospatial maps become dynamic when users are allowed to access, or interact with, the database from their own computer.(21-24) Users can customize maps and tables and interactively query the database to search for features based partly on their own criteria. These allow for a wider, but predetermined, selection of parameters and tools for geospatial analysis.

Interoperability:

Today, the promise of interoperability whereby geospatial data distributed anywhere on the Web can be searched, located, retrieved and compiled, either by a Web GIS service provider or at an individual's desktop, is becoming reality. This is a signi-

ficant accomplishment given the long-standing lack of industry consensus about hardware platforms, operating systems, network protocols and programming languages in support of Web GIS use.(25) In fact, specifications are now being developed to accommodate these operational differences and allow Web GIS clients and desktop users to fully integrate Web accessible geospatial data resources.

The effort to "geoenable" the Web is being led by the Open Geographic Information System Consortium (OGC). The development of common ground for integrated geospatial mapping applications (26) depends on interface specifications designed to enable Geographic Information System interoperability of geospatial information regardless of operational differences in the vendor environment. Geography Markup Language (GML) is the base language developed by OGC, and GML is becoming the world standard for eXtensible Markup Language (XML) encoding of geographic features and geoprocessing service requests.(27,28) OGC standards for interoperability will advance Web-based use of geospatial data.

The availability of public health geospatial data, in a robust Geographic Information System functional Web environment, is in a nascent state. By comparison in USA and UK, many non-public health agencies have an extensive Web GIS presence with digital geospatial data. Many of these agencies, including EPA, USGS, FEMA, Bureau of Land Management in UK (BLM), U.S. Forest Service (USFS), National Oceanic and Atmospheric Administration in USA (NOAA), National Aeronautics and Space Administration (NASA), Department of Transportation in USA (DOT) and Census Bureau have long-established geospatial products and inventories related to georeferenced themes, as part of their institutional mission.

Web GIS functionality:

The Intranet is helping many of these agencies to develop enterprise Geographic Information System activities. The Intranet provides advantages for secure sharing and analysis of restricted geospatial information within respective agencies. These activities may provide operational models for public health where scarce Geographic Information System resources can be similarly leveraged. Enterprise Geographic Information System may become a workable strategy, as evidenced in a variety of non-public health settings, to unify Geographic Information System services for state.

For example, in the case of the District of Columbia in USA (DC), the DC GIS Atlas initiative was designed for employees at all levels of District government to have an Intranet access point to standardized, updated Geographic Information System data, eliminating the need to search disparate resources for critical information.(29) The atlas consists of a collection of thematic mapping modules (e.g., public safety, transportation, socioeconomic, environmental, and others) that can pull information from a central Geographic Information System server as well as from the databases of all district agencies, depending on what kind of queries employee request. The atlas now offers over 130 map layers for the "average" district employee and another 16 layers (available via a password-protected emergency management module) for authorized personnel. Several more layers are under development.

A point-notification tool exists that allows DC Atlas users to encircle/polygon areas of interest and receive all address/owner information for these areas from the district's tax and revenue database. This enables users to easily generate mailing lists and a variety of other notification services. Another powerful tool is a reporting capability that allows users to compile all available information for a particular area (point or polygon) as well as link to the various agency Intranet sites from which the information originated. And, a mapping tool allows users to plot data from any district database and perform "on-the-fly" geocoding.(30)

Part of the DC Atlas will become Internet-enabled sometime this year to provide full customer service with access to citizens. This extension to the Internet will comprise a more limited selection of data layers from the centralized Geographic Information System database but help serve routine citizen needs concerning public health, maintenance, city services.

Conclusions:

Web GIS will generate new opportunities to advance the mission of disease surveillance, understanding and prevention, and the well being of the nation. The overriding process to document, make accessible and share geospatial information and data, in a Web-enabled environment, is perhaps the key condition of Geographic Information System Department.

In order to build the foundation, every public health department and agency needs to inventory its respective geospatial data holdings and, using the appropriate identifying metadata, render these discoverable through the Internet. Geospatial Web-searchable metadata will help public health agencies to communicate and make known their geospatial resources to internal and external users. Secure Intranet and Internet data sharing solutions, that uphold all database safeguards of an individual's anonymity and confidentiality, can be adapted to public health.

All public health agencies must become Web enabled and have access to basic geospatial tools and training in order for public health to ultimately become an integral part of Geographic Information System Department. Investment in, and by, province and local health departments through partnerships and other cost-effective data sharing mechanisms is crucial to this process. Building a comprehensive and responsive geospatial Web-enabled public health infrastructure is clearly an exciting, and achievable, challenge for Iran's public health.

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