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A Manager's Guide to Public Health Geomatics

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Submitted to:

Natural Resources Canada
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Submitted by:

AMEC Earth & Environmental
A division of AMEC Americas Limited
300 – 210 Colonnade Road South
Ottawa, Ontario   K2E 7L5

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EXECUTIVE SUMMARY

The idea of 'place' as a central component of public health analysis is not new. Its history dates back to 1854, when Dr. John Snow plotted cholera deaths on a map of the Soho district in London, England. However, while 'place' is a key element in the field of epidemiology amongst other public health practices, the use of analytical tools for 'place'-based (geospatial) information is still nascent and the acceptance of geospatial analysis in operational public health business processes is limited.

For those that have taken steps to implement geomatics[1] programs within their organizations the three most significant challenges they have to deal with are lack of awareness at all levels, issues with data (e.g. sensitivity, availability, quality, currency), and cost. An additional challenge is that many organizations do not have the capacity in terms of trained resources or technology support to efficiently absorb geomatics applications into the organization.

It is recognized throughout the public health geomatics community that in order for geospatial analysis in decision making to move beyond its nascent state there is a need to:

- build awareness of the business benefits within the executive levels of public health organizations;
- provide support to managers in implementing geomatics within their business processes; and
- educate public health practitioners in the use of geospatial information for operational decision making.

GeoConnections sponsored this project as a means to provide interested parties with some direction in addressing these needs and challenges.

GeoConnections was established to foster the creation of the Canadian Geospatial Data Infrastructure (CGDI) to enable online access and sharing of geographic information and services from authoritative and comprehensive sources of Canadian geospatial information to support decision-making. As a programme, GeoConnections selected public health as a priority sector to support due to the significance of health and well being to Canadians, the potential for geomatics to improve the efficiency of public health services and interaction between health jurisdictions across the country, and the spatial components within most health data sets lend themselves to geospatial analysis and as a means of associating with other types of related data.

The objective of this document is to provide readers with an interest in public health geomatics with some insight into how to address these challenges and needs. It is targeted towards mid-level public health managers that need, or wish, to become more familiar with implementing, entrenching, and eventually institutionalizing the use of geomatics

[1] The science and technology of gathering, analyzing, interpreting, distributing and using geospatial data. Geomatics encompasses a broad range of disciplines including surveying, global positioning systems, mapping, remote sensing and cartography. http://www.geoconnections.org/en/resourcetool/glossary;jsessionid=A4128C7656A61A2467BEC3594F8AFE08.ap p1#G

within their organization. Advice is offered in the form of technical and non-technical resources as well as fundamental information technology and information management practices thus aimed at improving the success rate of those interested and/or required to implement geomatics.

Recognizing the breadth of both the audience and subject matter, this document does not seek to provide a prescriptive approach to implementing an operational geomatics program as it would not fit most organizations needs. Rather, the document presents the reader with sufficient knowledge, advice and links to relevant resources to allow them to plan for, develop and implement their own specific geomatics program that meets the business requirements of their organization.

This project has taken advantage of the experiences, systems, knowledge and expertise gleaned from GeoConnections' projects as well as research into the use of geomatics in the public health sector to address the stated needs and challenges. The document covers a large range of topics and provides the following:

- An ***overview of geomatics in the public health sector*** including the relevance of geomatics to public health matters, the current status of public health geomatics use in Canada and abroad, and common challenges encountered when applying geomatics within public health organizations. The objective of this overview is to address the general awareness of what is possible with geomatics in the public health sector, demonstrate that progress is being made, identify where support may be found for advancing geomatics within an organization and indicating basic issues that need to be considered in implementing a geomatics program within an organization;
- Insight into ***application areas and considerations when applying geomatics*** in public health, as well as a ***review of GeoConnections funded projects*** pertaining to the public health sector including lessons learned and their significance. The objective of this review is to assist public health practitioners appreciate the breadth of geospatial applications and analysis techniques that have been developed and provide the reader with links to resources (people and documents) to further expand their geospatial knowledge and develop a network of support; and
- The ***challenges and best practice guidance to institutionalizing geomatics*** in public health organizations. Topics include data requirements, sharing sensitive data, meeting business requirements, development methodologies, the importance of standards, access to support networks and best practices. The objective is to provide managers with guidance and links to resources to assist them in establishing a sustainable geomatics program within their organization.

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1 INTRODUCTION

1.1 Project Overview

Background

The idea of ‘place’ as a central component of public health analysis is not new. Its history dates back to 1854, when Dr. John Snow plotted cholera deaths on a map of the Soho district in London, England (see Figure 1-1).[2]

Although ‘place’ is entrenched in the history of public health and is a key element in the field of epidemiology amongst other public health practices, the use of analytical tools for ‘place’-based information is still nascent.

In recent years a shift has been underway to incorporate and enhance the spatial aspect in public health analyses and evidence-based decision-making. Health analyses reveal more when they include such variables as socio-economic status, age, education, gender, environment, culture and family medical history, all of which are factors that determine Canadians’ health. And, there is a growing appreciation that each of these variables can be studied more fully with respect to “place”. Examples of where “place” can be used within public health practice include:

- program planning and evaluation;
- disease outbreak investigations;
- disease and injury surveillance;
- emergency preparedness;
- resource allocation;
- intervention program implementation; and
- evaluation, public awareness and policy activities.

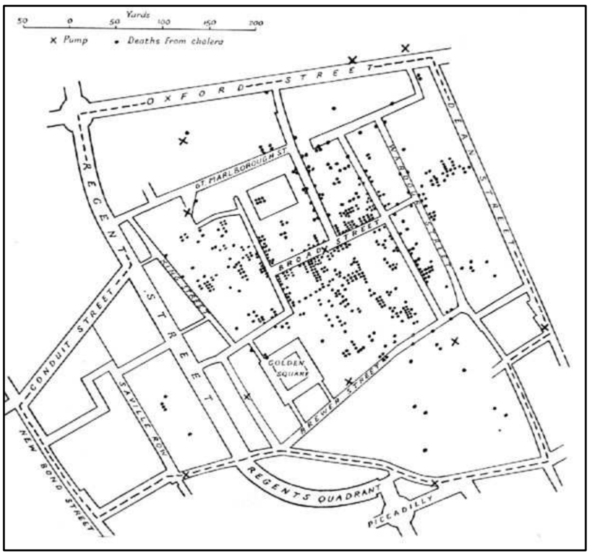

Figure 1-1: Dr. John Snow’s Cholera Map Deaths Near the Broad Street Water Pump

The use of geomatics, specifically Geographic Information Systems (GIS), is increasing within the public health community. Due to the complexity of factors that are significant to health (as listed above) no one designated set of data is adequate for effective analysis. Furthermore, no one method or approach can satisfy the wide-ranging analysis needed in public health practice. This is acknowledged within the community, which is ready to consider and even demand geospatial analytical tools that allow for unique examination of their public health information.

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[2] http://en.wikipedia.org/wiki/John_Snow_(physician)

Although there are varying levels of knowledge and expertise in geospatial analysis, most public health practitioners require education on the use of geospatial information for operational decision making. This need for training, outreach and awareness for the public health community was identified through the Canadian Geospatial Data Infrastructure (CGDI) "Survey of Geographic Information Decision-makers – 2006". The study found that the public health community placed a lower priority on geospatial information compared to other GeoConnections' communities, attributing it as simply one of a number of tools necessary for their successful operation. The GeoConnections' Public Health Advisory Committee, established in spring 2006, also identified training, outreach and awareness as key priorities for the program's focus in the public health community.

Objectives

With the goal of addressing the recognized need for training, outreach and awareness, this project includes three high level objectives: to study CGDI-supported public health geomatics projects; to develop a guide to provide good practices, lessons learned and examples that will facilitate user readiness for the CGDI, and to identify, examine and provide baseline information on the use of geomatics and geomatics practices and methodologies in the public health field, with particular emphasis on federal departments and agencies responsible for public health.

Methodology

The focus of the project's research was to:

1. Conduct an environmental scan to determine the general state of geomatics in public health and more specifically identify: the extent of understanding of geomatics within the public health community, the development intentions of various organizations involved with public health and identification of organizations that are leading the field;
2. Assess GeoConnections sponsored projects to determine the range of geomatics activities that are being carried out across the country, identify best practices, identify leading lights in geomatics related to public health; describe methodologies, approaches, issues addressed, lessons learned and project benefits; and
3. Survey the public health geomatics community to identify how geomatics is being used, related issues and best practices.

The approach taken for the environmental scan was to conduct a:

1. Literature review of Canadian and international articles on geomatics and public health; and
2. Survey of members within the public health community.

Over 120 documents were reviewed and incorporated into an annotated bibliography (Appendix C). This review provided useful insight into the identification of issues and questions for further research.

A web-based survey was conducted in which 289 invitations were issued and 68 responses were received. The survey asked questions concerning the level of knowledge and use of geomatics within the organization, how is it used, organizational structure, benefits derived, development methodologies, implementation issues, who are the leading lights, need for collaboration and standards, and issues with knowledge and data sharing. The results of survey may be found in Appendix D.

Over 30 GeoConnections projects were assessed and 14 reviewed in detail. A framework was established to structure the assessment in order to determine level of partnership with multiple stakeholders, expected benefits, approach and methodology, use of standards, national significance of the project, and key results and lessons learned. While reviewing the project documentation specific questions were raised and subsequently addressed in interviews with the project leads.

In total nine national level organizations were assessed through review of documentation and interviews with senior personnel. The objective of the research was to determine their core geomatics expertise and services provided to the public health community.

Finally, a series of workshops and two WebEx presentations were held to present the findings of the research and to obtain stakeholder feedback.

1.2 Document Overview

Purpose

The purpose of this document is to provide a credible resource to those public health practitioners interested in:

- Learning the capacity and potential of various national organizations with respect to geomatics in public health
- Assessing the potential and role of geomatics in their organization;
- Learning through the experiences of others;
- Seeking resources to assist with their planning efforts; and
- Learning of best practices to adopt where applicable.

The document provides the following:

- An ***overview of geomatics in the public health sector*** including the relevance of geomatics to public health matters, the current status of public health geomatics use in Canada and abroad, and common challenges encountered when applying geomatics within public health organizations;
- A ***review of GeoConnections funded projects*** pertaining to the public health sector including lessons learned and their significance;
- Insight into ***application areas and considerations when applying geomatics*** in public health; and
- The ***challenges and best practice guidance to institutionalizing geomatics*** in public health organizations.

Intended Audience

Although most readers with an interest in public health geomatics can expect to obtain some insight from this report, it is targeted towards mid-level public health managers that need, or wish, to become more familiar with implementing, entrenching, and eventually institutionalizing the use of geomatics within their organization.

Structure

This document is organized into five sections. At a high level Sections 2 and 3 present the potential for geomatics in public health and share the current status and challenges most often encountered. Sections 4 and 5 prepare the reader for being successful when deploying geomatics within their organization.

Section 1, *Introduction* (this section), describes the background, objectives and methodology used on the project and the purpose, intended audience and structure of this report.

Section 2, *Public Health Geomatics – An Overview,* provides an overview of geomatics within the Canadian public health community as well as some insight into the international picture. It provides a fundamental understanding of geomatics and the potential for use in public health, a summary of key national organizations with useful data and/or services, a sense of provincial and territorial uptake across Canada, and finally a discussion on some of the foremost challenges and barriers commonly identified with implementing public health geomatics.

Section 3, *GeoConnections Funded Projects,* summarizes projects funded by GeoConnections' within the public health community. This includes a description of several key projects and their significance to public health. These projects can be leveraged for lessons learned, best practice templates and even potential for re-use in the case of geomatics applications.

Section 4, *Applying Geomatics in Public Health,* presents additional insight into the application of geomatics and GIS in public health, the data required and ways in which to discover the required data, and a discussion of the issues and approaches to working with the sensitivity of public health data.

Section 5, *Institutionalizing Geomatics,* proposes the elements required to institutionalize the use of geomatics within public health organizations. Advice is offered in the form of technical and non-technical resources as well as fundamental information technology and information management practices thus aiming to improve the success rate of those interested and/or required to implement geomatics.

2 PUBLIC HEALTH GEOMATICS – AN OVERVIEW

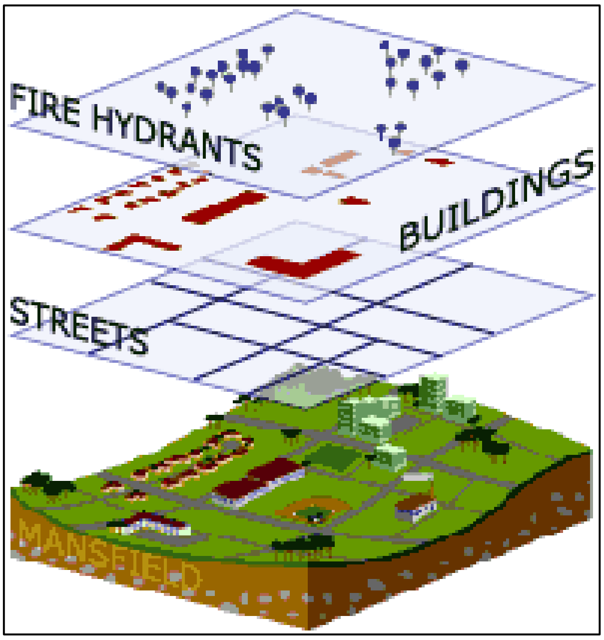
This section focuses on the state of geomatics within the Canadian public health community as well as some insight into the international picture. It provides the reader with: an overview of geomatics and GIS and the potential for use within public health; the status of key organizations involved; a sense of accomplishments; as well as some of the challenges and barriers commonly identified.

2.1 Introducing Geomatics

According to Natural Resources Canada (NRCan), the definition of Geomatics is "...the science and technology of gathering, analyzing, interpreting, distributing and using geographic information. Geomatics combines the underlying disciplines and technologies of surveying, digital mapping, remote sensing, geographic information systems (GIS) and the Global Positioning System (GPS) to create a detailed but understandable picture of the physical world and our place in it.

Originally used in Canada, because it is similar in French and English, the term geomatics has been adopted by the International Standards Organization (ISO)... and many other international authorities, although some (especially in the United States) have shown a preference for the term *geospatial technology*." [3]

Figure 2-1: Spatial data layers enable comparison of unrelated entities



GIS captures, stores, analyzes, manages, and presents data in a geographic perspective. Simply stated, GIS conceptually extends traditional databases to include location (i.e. spatial) data. Moreover, most modern GIS include a wide variety of software tools to display, analyze and manipulate the data to achieve the desired results. Conceptually this is similar to the way a database analyst would process traditional tables of data to derive the desired information.

Excluding some theoretical physics hypotheses, ***every physical thing exists at a given location at a given time***. Therefore it is up to the GIS user to determine at what level of resolution or map scale that spatial data is relevant and thus required. This is usually determined by the needs of the business problem. For instance, given a need to produce a map of

[3] http://en.wikipedia.org/wiki/Geomatics

election results, jurisdictional boundaries linked to election results would be required. However, given a need to automatically determine the name and location of the polling station at which each voter should cast their ballot, at a minimum, the location of each voter's home address would be required. With this resolution of spatial data, various predefined spatial analyses can be performed to either determine the closest polling station to each voter (assuming polling stations are known and are fixed) or determine the best location for polling stations given the distribution of voters on the map (aka spatial distribution) and a fixed number of polling station resources.

In most GIS software, spatial data is organized into layers as in Figure 2-1 above[4]. Just as two tables can be compared or "joined" together based on a common data column, ***layers of data can be integrated using spatial data as a common reference framework***. Layers of unrelated data can be visualized and digitally analyzed for spatial correlation using geography as the common denominator. This process of ***overlaying layers of spatial data to potentially reveal otherwise non-discernable relationships is fundamental to the power and potential of GIS***. Moreover, being able to resolve questions that are either non-spatial in nature (e.g. all voters over the age of 65), of a spatial nature (e.g. all jurisdictions neighbouring jurisdiction 'abc'), or both (e.g. jurisdictions within a 75 kms of a nuclear or coal burning power facility and the environmentally focused party secured less than 10% of vote) is core to GIS capability.

Like most software available today, ease of use and integration with the internet are predominant themes in their incentive to broaden their user base. No where could this be more evident in the GIS industry than with Google's Google Maps (maps.google.com) and Google Earth (earth.google.com) and Microsoft's Bing Maps (www.bing.com/maps). These internet mapping tools from IT industry leaders introduced mainstream users to digital spatial data and certain spatial analyses (e.g. 'shortest path' along a road network) through an intuitive web based interface never before experienced except by those in the GIS industry. These and many other web based mapping portals have made great strides in raising awareness of the potential for GIS to support every day decisions.

However, while serving a specific purpose well, these popular internet based tools are constrained in their scope and flexibility of analytical capabilities, as are most applications serving a wide user base, and thus the requirement for analytical GIS functionality is still very much necessary. GIS packages come with a rich suite of analytical tools and sophistication that enable the trained user to resolve and research ad-hoc problems that may or may not yet have been considered through a geographic lens. However, just as a tradesman is armed with his training, toolbox and experience, so to do GIS analysts require an investment in specific training to enable them to achieve the greatest benefit to the organization(s) they support.

2.2 Relevance to Public Health

GIS enhances the interpretation and understanding of population and public health information and thereby adds significant precision to the information required for decisions concerning planning and delivery of policies and programs. GIS adds a powerful graphical and analytical dimension by bringing together the fundamental epidemiological triad of

[4] http://www.mansfield-tx.gov/departments/gis/images/learn.gif

person, time, and the often-neglected place. The analysis and mapping of data can be used in the public health domain to answer several complex questions such as:

- Where is a disease spreading over time?
- Where are vulnerable populations located?
- Are there correlations of disease with the physical environment or socio-economic characteristics?
- What is the best location for a new health facility?
- Where should ambulance stations be located to meet the minimum response times required for service delivery thereby maximizing resources?
- How will locating a hospital at location (X, Y) impact neighbouring hospital demand?
- What impacts will municipality planning have on public health service in the next 5 years?; and
- How effective have public health policies been in progressing towards goals, objectives and targets?

The survey results (see Figure 2-2) below clearly corroborate the perceived potential for the use of geomatics in many areas of population and public health.

Effective decision-making in population and public health is critically important in servicing the health of Canadians and ensuring the sustainability of health care in Canada. Over the medium term it is highly unlikely that more resources will be devoted to public health, hence the need to be more efficient and effective at managing resources. The achievement of this state will benefit greatly from having, even as demand rises, access to the right information, interpreting it intelligently and using it in informed decision-making.

Spatial data analysis and presentation can contribute greatly towards this goal. In recent years, the use of GIS by public health professionals has expanded rapidly, driven by the growing realization that:

1. The majority of health data have a spatial component;
2. Graphical representations, particularly maps, are extremely informative to various aspects of public health; and
3. There is value in associating health data with other data (e.g. census data, environmental data, etc).

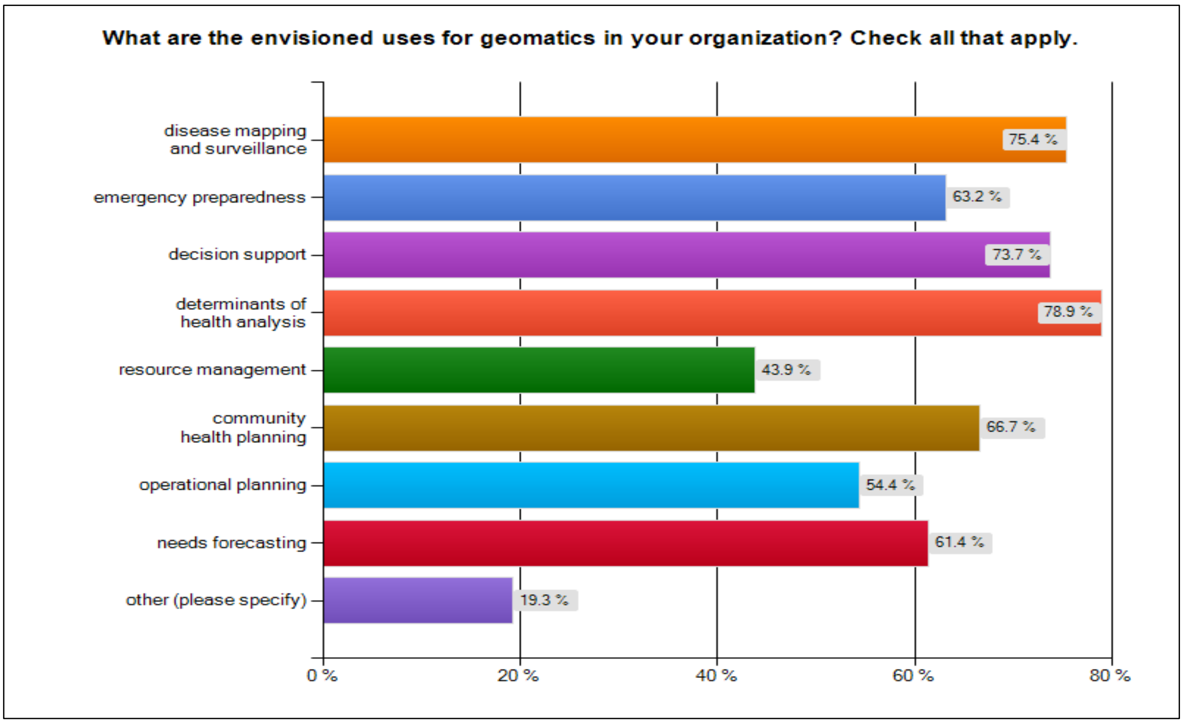


Figure 2-2: Survey Result – Envisioned Uses for Geomatics

2.3 A Canadian Perspective

The University of New Brunswick's Department of Geodesy and Geomatics Engineering stated [5]: "Although researchers have recognized the importance of incorporating place into analyses of health outcomes in Canada, the models have not explicitly incorporated geographic location. … models did not allow for the possibility of spatial auto-correlation, nor provide a means to portray the findings graphically. … During the past ten years, Statistics Canada has been successful in developing a unified and coherent system of social statistics, aimed at providing a framework for the study of causes, effects and outcomes, and the roles and possible impacts of policies. This system is based on a suite of large national studies pertaining to children's education and health, the transition of youth from school to the labour market, youth and adult literacy, and population health. These studies could employ spatial analyses, but to date any attempt to do so has been limited to comparing provinces, or, in some cases, cities or Federal Electoral Districts. … confidentiality, which has been one barrier in conducting localized spatial analysis. A lack of appropriate software, and a belief that the data are too thinly sampled to accomplish localized analyses, are also important barriers."

Development has accelerated in this field since 2004 due, in large part, to support from the Government of Canada through GeoConnections. Yet to date, development has been piecemeal and is far from being comprehensive and widely adopted. Activity has varied

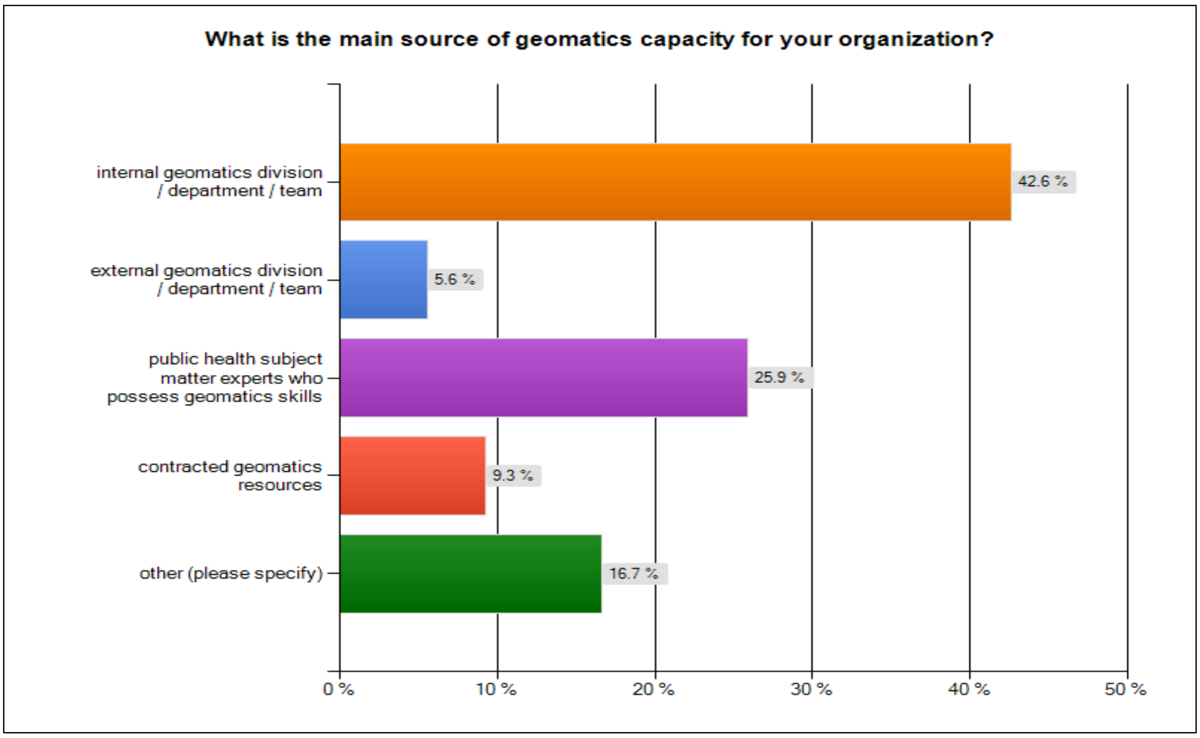
[5] Spatial Variation in Health and Human Development, the GEOIDE Network, Network of Centres of Excellence, February 14, 2004

across the country, with relatively more going on in British Columbia and Ontario and relatively less in the territories, the Prairie Provinces and the Atlantic Provinces.

Although the public health community is beginning to gain awareness of geospatial applications and adopt them, knowledge of geospatial analysis is still not widespread. As a result the full potential of geomatics has not been reached, with current geomatics techniques limited primarily to static mapping for report purposes. On the other hand, just as satellites and the Internet led to an explosion of information, these technologies are making it possible to acquire high-quality epidemiological information with a precision and speed that could not have been imagined a decade ago.

While some organizations have extensive experience (usually 10-12 years) in using public health geomatics, others have little or no awareness of their benefits and this is reflected in the organization's capacity and structure. For some organizations surveyed, the geomatics capacity of the organization resides with a very limited number of public health subject matter experts who possess geomatics skills, while more advanced organizations rely on internal geomatics teams that generally collaborate with public health experts (see Figure 2-3). Others partner with public and private organizations with such capabilities.

Figure 2-3: Survey Result – Main Sources for Geomatics Capacity



2.3.1 Supporting Organizations and Agencies

Several institutions in Canada have a role with respect to the use of geomatics in public health. This section discusses the role of geomatics in relation to public health within several national as well as provincial and territorial organizations.

Institutional Hierarchy

Health is primarily a provincial/territorial responsibility. Canada's public health system, however, is comprised of a network of agencies from the community, regional and provincial/territorial levels up to the federal government. Integrating and coordinating mechanisms serve to ensure that these agencies function to a large extent as a system aimed at protecting the health of Canadians. From a public health perspective overall leadership is provided by the Public Health Agency of Canada. However, there are several supporting agencies at the national level. Understanding their geomatics role is important for others to determine support options.

2.3.1.1 National

This section reviews the following national organizations:

1. Public Health Agency of Canada (PHAC);
2. Health Canada;
3. Statistics Canada;
4. Natural Resources Canada (NRCan) - GeoConnections
5. Pan-Canadian Public Health Network;
6. Canadian Institute for Health Information (CIHI);
7. Canadian Institute of Population and Public Health (CIHR);
8. Canada Health Infoway; and
9. Canadian Public Health Association (CPHA).

1. Public Health Agency of Canada (PHAC) [6]

Role and Structure

PHAC was created in 2004 in response to growing concerns about the capacity of Canada's public health system to anticipate and respond effectively to public health threats. PHAC's creation was the result of wide consultation with the provinces, territories, stakeholders and Canadians. The role of the Public Health Agency of Canada is to:

- Promote health;
- Prevent and control chronic diseases and injuries;

[6] http://www.phac-aspc.gc.ca

- Prevent and control infectious diseases;
- Prepare for and respond to public health emergencies; and
- Strengthen public health capacity in a manner consistent with a shared understanding of the determinants of health and of the common factors that maintain health or lead to disease and injury.

This agency of the Government of Canada reports to the Minister of Health through the Chief Public Health Officer.

PHAC is comprised of three branches: Health Promotion and Chronic Disease Prevention; Planning and Public Health Integration; and Infectious Disease and Emergency Preparedness.

Geomatics and Capacity

Within the PHAC, geomatics is seen as a tool. Geomatics development began over 12 years ago with a major initiative 10 years ago. Promoting the use of geomatics in public health projects within the organization is ongoing.

The main geomatics development activities are addressing in-house needs, including surveillance tools, data dissemination tools, and web forums to support the collaboration with the provinces and territories.

There are many geomatics applications within the Agency that are used in consultation and collaboration with provinces and territories on outbreak management, health promotion, emergency management, etc. Surveillance is the main line of business where geomatics is used, but there are also some examples of analytical and decision making applications. The Public Health Map Generator is an example of a spatial epidemiological tool.

Geomatics is used to support the Agency in its role to coordinate surveillance with the provinces and territories. Geomatics provides them with an effective visualization tool for presentations, and to support disease tracking and analysis. In the past, effort was made to promote geomatics at the local public health level, but that program is currently on hold due to budget constraints. In addition to national support and collaboration, PHAC undertakes research relevant to Canadian public health GIS and fosters links to the international public health GIS community.

The Agency has a geomatics team in the Planning and Public Health Integration Branch that are seen as leaders in the field of geomatics within the Agency and the public health domain in general. There are also scattered pockets elsewhere in the organization that make use of geomatics although it is not their core expertise.

To increase the GIS capacity of The Office of Public Health Practice within the Planning and Public Health Integration Branch provides GIS services tailored to the needs of public health professionals to increase their capacity. They work with Canadian public health professionals at federal, provincial/territorial, regional, and local levels, as well as non-government organizations (NGOs) and academic research groups. To support the spatial information needs of evidence-based public health planning and research in areas such as chronic and infectious disease prevention and control, health promotion, surveillance, emergency preparedness and response, and pandemic outbreaks they offer:

- No cost access to selected data;
- Intuitive and easy to use spatial analysis and presentation tools;
- Support and training for users; and
- Partnership and collaboration.

2. Health Canada [7]

Role and Structure

Health Canada's goal is for Canada to be among the countries with the healthiest people in the world. To achieve this goal, Health Canada:

- Relies on high-quality scientific research as the basis for its work;
- Conducts ongoing consultations with Canadians to determine how to best meet their long-term health care needs;
- Communicates information about disease prevention to protect Canadians from avoidable risks; and
- Encourages Canadians to take an active role in their health, such as increasing their level of physical activity and eating well.

Health Canada believes that prevention and health promotion can hold health care costs down and improve quality of life in the long term.

This federal department reports to the Minister of Health.

Several branches of Health Canada play a role in public health. They include First Nations and Inuit Health, Healthy Environments and Consumer Safety, Healthy Products and Food, Regions and Programs and the Pest Management Regulatory Agency.

Geomatics and Capacity

Dedicated geomatics expertise within Health Canada is neither centralized nor coordinated through any internal group within the department. As with many public health organizations, the geomatics capacity within Health Canada tends to be dispersed throughout the organization.

The number of individuals with geomatics skills is limited. Only a handful of individuals with geomatics expertise were identified according to their job title. These individuals were located in the First Nations and Inuit Health group within the Alberta Region as well as the Nuclear Emergency Preparedness and Response Division of the Healthy Environments and Consumer Safety Branch.

[7] http://www.hc-sc.gc.ca/index-eng.php

3. Statistics Canada [8]

Role and Structure

As Canada's central statistical agency, Statistics Canada is legislated under the Statistics Act to "collect, compile, analyse, abstract and publish statistical information relating to the commercial, industrial, financial, social, economic and general activities and conditions of the people of Canada."

Statistics Canada has two main objectives:

1. To provide statistical information and analysis about Canada's economic and social structure to:
    - Support development and evaluation of public policies and programs; and
    - Improve public and private decision-making for the benefit of all Canadians.
2. To promote sound statistical standards and practices by:
    - Using common concepts and classifications to provide better quality data;
    - Working with the provinces and territories to achieve greater efficiency in data collection and less duplication;
    - Reducing the burden on respondents through greater use of data sharing agreements; and
    - Improving statistical methods and systems through joint research studies and projects.

This agency of the Government of Canada reports to the Minister of Industry through the Chief Statistician of Canada and is one of 12 federal departments and agencies that make up the Industry portfolio.

Geomatics and Capacity

There are two groups within Statistics Canada relevant to a discussion on public health geomatics use and capacity: Health Statistics Division and Health Analysis Division. A third relevant group is the Geography Division which provides geomatics support to various business lines within Statistics Canada.

The Health Statistics Division provides statistics on a variety of subjects of interest to public health including population and demographics, health, environment, education, income, families, seniors and the environment. In the health field relevant subjects include:

- Diseases and health conditions;
- Factors influencing health;

[8] http://www.statcan.gc.ca

- Injuries;
- Measures of health; and
- Prevention and detection of diseases.

Health Statistics Division conducts a number of health related surveys. For instance, the Canadian Community Health Survey is a national health survey that asks Canadians about their health and well-being, the factors that affect their health and their use of health care services. Results of this survey are used for policy-making and program development that affect Canadian communities.

The National Population Health Survey (NPHS) is a longitudinal survey that collects information from a sample of people who lived in Canada when the survey was launched in 1994/95. Its goal is to collect information on their health status and the factors that can have an influence on health. Health indicator information is also collected for Health Canada.

Tabular information from these surveys is linked to census boundary geography which enables spatial analyses to be performed in concert with the health data. This is done by using methodology developed internally which links postal codes to census geographies (Postal Code Conversion File plus – PCCF+) as they change over time. This allows for the long term consistent spatial representation of data.

The Health Analysis Division develops maps as inputs to reports and studies that are created for clients. Geomatics is used to display results in more interesting and creative ways. For instance, the Division uses geomatics in the geospatial analysis of cancer registries, mortality files, and characteristics of small geographies, areas of concentrations, social determinants of health, census and socio-economic status influences. In some cases geospatial methods are used to proxy what is otherwise not available. For instance, air pollution data is added to other cohort data to determine the potential contribution of air pollution on health in partnership with Health Canada. The result of their work is published as reports, papers and journals for clients using maps to illustrate the findings. Geomatics techniques pioneered in their work have been adopted by other departments and agencies to make additional data available and to support their own analysis.

The Geography Division, which is primarily responsible for creating and maintaining the geographic administrative boundaries used to support the national census. Moreover, the Geography Division of Statistics Canada and the Electoral Geography Division of Elections Canada work collaboratively to maintain a national digital spatial road network which includes address data.

The Geography division is significant not only to the support the geomatics requirements internal to Statistics Canada (e.g. Health Statistics Division) but it also provides the foundation geography for conducting geospatial analyses using socio-economic and health statistics linked to census geographies such as Census SubDivisions (CSD's) and Dissemination Areas (DA's).

In addition, Statistics Canada provides easy access to a variety of maps and geographic products including:

- Interactive Maps showing various places and locations, census and non-census boundaries, patterns, and distribution based on interaction with the user and the map.
- Thematic maps by subject – e.g. population distribution and earnings of Canadians, for selected geographic areas.
- Reference maps by geographic area: view the boundaries of geographic areas, such as provinces, cities, health regions, or watersheds.

4. Natural Resources Canada (NRCan) – GeoConnections [9]

Role and Structure

In 2000, GeoConnections was established to foster the creation of the Canadian Geospatial Data Infrastructure (CGDI) to enable online access and sharing of geographic information and services.

The vision for the CGDI was updated by GeoConnections' in 2005 to enable access to the authoritative and comprehensive sources of Canadian geospatial information to support decision-making.

GeoConnections Division is located within the Mapping Information Branch of the Earth Sciences Sector of Natural Resources Canada. Oversight for the public health GeoConnections activity has been provided by the Public Health Advisory Committee. It is comprised of GeoConnections staff and representatives of PHAC, CIHI, a university research institute, regional delivery organizations and provincial departments of health.

Geomatics and Capacity

GeoConnections helps decision-makers use online location-based (or "geospatial") information, such as maps and satellite images, to tackle some of Canada's most pressing challenges. The program focuses on working with partners in public health, public safety and security, the environment and sustainable development, Aboriginal matters, and geomatics technology development. By helping make location-based data and technologies accessible and useful to decision-makers, GeoConnections is contributing in numerous ways to a better quality of life for Canadians.

GeoConnections is working to ensure that decision-makers in key areas benefit from the Canadian Geospatial Data Infrastructure (CGDI), a one-stop searchable portal for a wealth of location-based information. They are accomplishing this objective by co-funding projects that encourage key decision-making audiences in public health to work with the Canadian geomatics sector in developing technologies and data sets that meet their specific needs.

[9] http://www.geoconnections.org, http://geodiscover.cgdi.ca/

Public health was selected as a priority for GeoConnections due to the significance of health and well being to Canadians, the potential to improve the efficiency of interaction between health jurisdictions across the country and the spatial component of most health data and an appreciation for associating it with other types of related data.[10]

5. Pan-Canadian Public Health Network [11]

Role and Structure

The (Pan-Canadian) Public Health Network (PHN) was established by Canada's Federal, Provincial and Territorial Health Ministers in 2005, creating a new way for governments and experts to work together to improve public health in Canada. The PHN is co-chaired by Dr. Perry Kendall (Chief Medical Officer of British Columbia) as the provincial/territorial co-chair, and Dr. David Butler-Jones (Chief Public Health Officer for Canada) as federal co-chair. The Public Health Network takes a collaborative approach to public health that is not only critical during public health emergencies – but also in assisting Canada in gaining a strong handle on serious public health issues, such as obesity and chronic disease.

The mandate of the Network is multi-faceted, ranging from facilitating the sharing of information among all jurisdictions in Canada, to working with and providing policy and technical advice to Deputy Ministers of Health on public health matters, to supporting the public health challenges jurisdictions may face during emergencies and/or crises.

A key to the Network's effectiveness lies in its connectedness. The Network is led by a 17 member Council with representatives from each province and territory; as well as the federal government. Various Task Groups provide assistance – as needed – by studying and developing recommendations on specific issues of interest to the Network. Academics, scientists, public servants and members of non-governmental organizations form six Expert Groups in the areas of: communicable disease control, emergency preparedness and response, Canadian public health laboratories, surveillance and information, chronic disease and injury prevention and control, and health promotion. These Expert Groups advise and guide on concrete work that needs to be done, and are supported, as needed, by Issue Groups.

Geomatics and Capacity

The geomatics capacity of the network lies within the members of the network.

The key expert group related to geomatics is the Surveillance and Information Expert Group (SIEG) co-chaired by Dr. Greg Taylor of PHAC. This group has a focus on emergency preparedness and response as well as communicable disease control.

The expertise that the Network brings to the table is in:

- Establishing policy;

[10] Public Health Program, Nina Wesch, Program Advisor, December 7, 2006
[11] http://www.phn-rsp.ca

- Disseminating information; and
- Directing research.

6. *Canadian Institute for Health Information (CIHI)* [12]

Role and Structure

The Canadian Institute for Health Information (CIHI) is an independent, not-for-profit organization that provides essential data and analysis on Canada's health system and the health of Canadians.

CIHI's 15-member Board of Directors is proportionally constituted to create a balance among health sectors and regions of Canada. It links federal, provincial and territorial governments with non-governmental health-related groups.

The Board provides strategic guidance to CIHI and the Health Statistics Division of Statistics Canada, as well as advice to the Conference of Deputy Ministers of Health and the Chief Statistician of Canada on health information matters.

CIHI tracks data in many areas, using information supplied by hospitals, regional health authorities, medical practitioners and governments.

CIHI's data and reports focus on:

- Health care services;
- Health spending;
- Health human resources; and
- Population health.

CIHI also identifies and promotes national health indicators—measures such as life expectancy or what we spend on health per capita—that are used to compare health status and health-system performance and characteristics. To make sure these measurements are comparable and meet the same quality requirements, CIHI coordinates national health information standards.

Geomatics and Capacity

At CIHI, geomatics has been in use for over 10 years primarily in producing maps for reports. Nevertheless, geomatics does not have a particularly high profile within the organization.

CIHI has two areas where public health geomatics is most evident: the Canadian Population Health Initiative (CPHI); and the Health Indicators Department.

[12] http://www.cihi.ca

Within the CPHI group geomatics knowledge is basic with the focus on thematic mapping rather than on spatial analysis or geoprocessing. The CPHI provides reports but they do not generate digital map products for distribution.

The Health Indicators project was created jointly with Statistics Canada to create a system with the capacity to co-ordinate data sources, set common definitions in public health and to make it available to the public, as well as planners and decision makers. Within the Health Indicators Department there are a few analysts who use GIS. They produce information at three levels: national, provincial and regional. Results and trends over time are mapped using geomatics but again no digital map products are provided.

Each year, CIHI generates maps showing health indicators and results are featured on the map. Travel conditions and analyses of urban vs. rural determinants are also performed using geomatics. As with Statistics Canada, CIHI recognizes the potential to provide maps through web based services but no steps have been taken in this direction at the time of this report.

7. Institute of Population and Public Health (CIHR) [13]

Role and Structure

The Canadian Institute of Health Research (CIHR) is the Government of Canada's agency responsible for funding health research in Canada. CIHR was created in 2000 under the authority of the CIHR Act and reports to Parliament through the Minister of Health.

CIHR was created to transform health research in Canada by:

- Funding more research on targeted priority areas;
- Building research capacity in under-developed areas such as population health and health services research;
- Training the next generation of health researchers; and
- Focusing on knowledge translation, so that the results of research are transformed into policies, practices, procedures, products and services.

CIHR consists of 13 "virtual" institutes, a structure that is unique in the world. These innovative institutes bring together all partners in the research process - the people who fund research, those who carry it out and those who use its results - to share ideas and focus on what Canadians need: good health and the means to prevent disease and fight it when it happens. Each institute supports a broad spectrum of research in its topic areas and, in consultation with its stakeholders, sets priorities for research.

CIHR’s Institute of Population and Public Health (IPPH) supports research into the complex interactions (biological, social, cultural, environmental) which determine the health of individuals, communities, and global populations; and into the application of that knowledge to improve the health of both populations and individuals.

[13] http://www.cihr-irsc.gc.ca

Geomatics and Capacity

While the IPPH itself is not a geomatics user, the researchers it funds are using geomatics methodologies to analyze data and to present their findings. As with many other agencies the geomatics outputs tend to be maps within reports.

8. Canada Health Infoway [14]

Role and Structure

Canada Health Infoway is a federally-funded, independent, not-for-profit organization equally accountable to its Members – Canada's 14 federal, provincial and territorial governments represented by their Deputy Ministers of Health.

In 2004, the Government of Canada granted Canada Health Infoway the mandate to work with provinces and territories to develop a communicable disease surveillance system for all jurisdictions to use. The result will be Panorama, a software application that is expected to be in place across the country by 2011.

Geomatics and Capacity

Infoway has designed the system in a modular fashion with the provinces implementing the modules that meet their priorities.

The Spatial Locator Registry module is designed to provide the underlying geospatial linkages that tie all data in the system together. Unfortunately at this point in time none of the provinces have implemented this module. A Panorama-based project in BC and the Yukon adds family health, environmental health and health resources components to the basic Panorama scope. Spatial data play an important role in this project.

9. Canadian Public Health Association (CPHA) [15]

Role and Structure

The CPHA is a national, independent, not-for-profit, voluntary association representing public health practitioners in Canada with links to the international public health community.

CPHA's mission is to constitute a special national resource in Canada that advocates for the improvement and maintenance of personal and community health according to the public health principles of disease prevention, health promotion and protection and healthy public policy.

In September 2007 CPHA hosted the first public health geomatics conference in Canada – GIS in Public Health. This was done in collaboration with:

- Public Health Agency of Canada (PHAC); and

[14] http://www.infoway-inforoute.ca
[15] http://www.cpha.ca

- NRCan's GeoConnections

Geomatics and Capacity

CPHA is neither a user nor provider of geomatics applications or data. However, the organization is aware of the growing interest in geomatics and is keen to support its adoption within the public health practice.

2.3.1.2 Provincial / Territorial

All provinces and territories have departments or agencies reporting to Ministers of Health that operate systems for identifying and dealing with public health risks. Characteristically, they are responsible for:

- Health Promotion;
- Monitoring and surveillance;
- Population health assessment;
- Prevention and protection; and
- A delivery system with a network of public health services.

Most jurisdictions situate responsibilities for public health within Departments of Health that are responsible for a broad range of publicly funded health services. However, five provinces have more public health specific organizations. Nova Scotia has a separate Department of Health Promotion and Prevention, while Quebec, Ontario, Alberta and British Columbia have standalone agencies, institutes or centres that are responsible to their respective Minister of Health.

Many provinces have public organizations that are charged with providing information gathering, dissemination, analysis and research support to the health system. The bulk of these organizations are university-based. However, the provinces of Quebec, Ontario and British Columbia have established agencies responsible to their respective Ministers of Health that play leadership roles in population health monitoring and advice to the public health community. Many of these are involved with public health geomatics.

While the introduction of geomatics into operational processes is increasing it is largely confined to Quebec, Ontario and British Columbia. However, even those provinces are far from achieving maturity in the field. This unbalanced development is demonstrated by the uptake of GeoConnections project funding, response to the survey conducted during this project and participation in the regional and web based workshops.

Over one-half (19) of the GeoConnections projects funded were in Ontario: six (16%) were in British Columbia, four (11%) took place in the Prairie Provinces, three (8%) were in the Atlantic Provinces, an only one (3%) was in Quebec. Three projects (8%) were undertaken by Health Canada including PHAC.

The following provides an overview of some of the geomatics activities being undertaken in the provinces and identifies different organizations that could be tapped for their knowledge and experience.

Atlantic Provinces

Newfoundland has its Statistics Agency's Community Accounts, the Centre for Health Information[16], Memorial University's Health Research Unit[17] and the Centre for Applied Health Research.[18] Other agencies of note in the Atlantic Provinces are Community Counts housed within the Nova Scotia Department of Finance; Geo NOVA[19] ; and The Canadian Research Institute for Social Policy[20] based at the University of New Brunswick.

The Newfoundland and Labrador Statistics Agency initiated Community Accounts in 2005. Through a single portal any user may access a wide variety of community, regional and provincial data and thematic maps at no cost. Information can be retrieved according to 400 communities, 80 census consolidated subdivisions, Health Authorities' boundaries and the province. Eastern Health collaborated with the NL Centre for Health Information and Memorial University on a GIS strategic planning project funded by GeoConnections. Senior Management from Eastern Health is supportive of the initiatives identified in this process, nevertheless ongoing financial challenges and competing priorities will remain an obstacle to further development.

In 2005 the Nova Scotia Department of Finance developed Community Counts based on Newfoundland and Labrador's Community Accounts and GeoNOVA provides geomatics support to public agencies. However, our research uncovered no other evidence of public health geomatics activity in Nova Scotia.

The only public health geomatics related activity in New Brunswick has been lead by the NB Lung Association. The organization was a beneficiary of GeoConnections funding for two projects.

Quebec

Quebec's Institut national de santé publique (INSPQ)[21] is an expertise and reference centre in public health. It supports the Ministre de la santé et services sociaux du Québec, regional public health authorities and health and social services institutions in carrying out their public health responsibilities. In Quebec universities there is IRIS-Quebec[22] a consortium of several universities, the Clinical and Health Informatics Research Group[23] at McGill University as well as health research units at both Laval University[24] and University of Sherbrooke[25]. These Quebec universities are associated with other Canadian universities and research organizations in the GEOmatics for Informed Decisions Network (GEOIDE)[26].

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[16] http://www.nlchi.nf.ca
[17] http://www.med.mun.ca/HRU/home.aspx
[18] http://www.nlcahr.mun.ca
[19] http://www.gov.ns.ca/geonova/home
[20] http://www.unb.ca/crisp
[21] http://www.inspq.qc.ca/english/about/default.asp
[22] http://www.iris-quebec.ca
[23] http://www.mcgill.ca//mchi
[24] http://www2.ulaval.ca/la-recherche.html
[25] http://www.usherbrooke.ca/recherche
[26] http://www.geoide.ulaval.ca

Quebec has made recent yet substantial progress in public health geomatics. GeoConnections has funded five public health projects in Quebec. The Institut national de santé publique du Québec (INSPQ) is leading activities in Quebec with the support of several universities through IRIS-Quebec.

Ontario

Ontario's Agency for Health Protection and Promotion (OAHPP) [27] serves as a hub, linking researchers, practitioners and front-line health care workers to the best scientific intelligence from around the world. It provides specialized scientific and technical advice and on-the-ground support to front-line health care workers, public health units and government. The OAHPP brings academic, clinical, public health and government experts together to focus on the areas of infectious disease, infection control and prevention, health promotion, chronic disease and injury prevention and environmental health.

Ontario is rich with organizations involved in health services research. There is the Institute for Clinical Evaluative Sciences (ICES)[28] and its network of associates in universities and health sciences centers across Canada. The McLaughlin Centre for Population Health Risk Assessment [29] is located at the University of Ottawa.

Geomatics is evident in Ontario at all levels of the public health community. Government leadership comes from the Ministry of Health and Long Term Care (MOHLTC) and the OAHPP. The MOHLTC is in the process of finalizing a business plan for health geomatics. Other development has taken place within local public health units, Cancer Care Ontario, ICES, the University of Ottawa, University of Toronto, a hospital-based research institute and the Social Planning Council of Ottawa.

Prairie Provinces

In Alberta there is a new province-wide delivery agency, Alberta Health Services, which is developing a health GIS framework under the guidance of a multi-disciplinary advisory council. In partnership with Alberta Health Services, the University of Calgary hosts the Calgary Institute for Population and Public Health [30].

The Saskatchewan Department of Health has completed a business plan to assess the importance of rolling out the Saskatoon Health Authority's Community View application across the province. Accreditation Canada has cited Community View, recently completed with GeoConnections support, as a Best Practice.

H1N1 has heightened awareness of the potential for geomatics in Manitoba Health and Healthy Living. The most advanced provincial capacity for spatial epidemiology is located within Manitoba Agriculture; however the two departments are exploring collaborative opportunities.

[27] http://www.oahpp.ca/index.php
[28] http://www.ices.on.ca
[29] http://www.mclaughlincentre.ca/welcome/index.shtml
[30] http://www.ucalgary.ca/cipph/

British Columbia

British Columbia has the country's third central reference agency for the provincial public health system – the British Columbia Centre for Disease Control (BC CDC).[31] The Centre is an agency of the Provincial Health Services Authority that focuses on preventing and controlling communicable disease and promoting environmental health for the province. The day to day public health work of the BC CDC is done in support of regional health authorities, the Ministry of Health and the Provincial Health Officer.

British Columbia also has two universities that are actively involved in public health geomatics activities. The University of Victoria houses Population Data BC a multi-university, nationally active and recognised data and education resource that facilitates interdisciplinary research and teaching on the determinants of human health, well-being and development. It's Education and Training Unit [32] conducts a variety of public health geomatics training courses and has launched a health geomatics discussion forum to connect people working with health data and GIS. Simon Fraser University's (SFU) Faculty of Health Sciences [33] offers Canada's most comprehensive program in population and public health, and in cooperation with the Department of Geography, has just initiated a master's level program in public health geography.

British Columbia has demonstrated the strongest organizational development. The provincial government has a comprehensive Provincial GIS Strategy. The Ministry of Health and the BC Centre for Disease Control are mandated to establish strong geomatics support for public health. There is a BC Health Authority GIS Working Group. At least three of the health authorities, including Vancouver Island Health Authority (VIHA), Interior Health Authority (IHA) and Vancouver Coastal Health Authority (VCHA), have collaborated on GeoConnections supported projects.

Five of the six health authorities in BC have in-house GIS staff. They collaborate through a GIS Working Group that includes the BC CDC. GeoBC, a provincial government agency, looks to this group to define the geomatics needs of the health sector. VIHA is the most advanced delivery organization in the province regarding GIS. They have completed strategic and implementation planning, user needs assessment and capacity building projects with the support of GeoConnections funding. While the awareness of potential benefits of public health geomatics has been raised by these activities, further progress is limited by lack of support at the executive level of the organization, the inability to obtain funding for the development of applications, the low priority given to GIS by the organization's IT department and the need for adequate server capacity. Support exists for the adoption of applications developed by others on a provincial scale, perhaps with the involvement of GeoBC.

2.3.2 Leaders in Public Health Geomatics

Several organizations can be described as leaders in the use of geomatics in public health as described below. These organizations were each mentioned several times during the consultation process.

[31] http://www.bccdc.org/
[32] http://www.popdata.bc.ca/etu/courses/healthgeomatics
[33] http://www.fhs.sfu.ca/welcome-to-fhs#

Organizations:

- Public Health Agency of Canada (PHAC)

  Among national organizations, PHAC has demonstrated the most significant adoption of public health geomatics applications.
- Universities and Research Institutes

  Leading universities involved with public health related geomatics are Laval, Sherbrooke, McGill, Ottawa and Victoria. Research institutes outside of universities that are most involved are ICES in Ontario and the Children's Hospital of Eastern Ontario (CHEO).
- Provincial Departments of Health and Agencies

  The most advanced provincial organizations are INSPQ in Quebec, the Ministry of Health and Long Term Care in Ontario, Alberta Health Services and the British Columbia Centre for Disease Control in concert with the BC Ministry of Health.
- Regional Health Authorities and Local Health Units

  Leading the way are Montreal Public Health; Kingston, Frontenac, Lennox and Addington Public Health; Saskatoon Health Region; the Calgary Region of Alberta Health Services; and Vancouver Island Health Authority.
- Public Health Geomatics Support Organizations

  The Sault Ste. Marie Innovation Centre (SSMIC)[34] has been assisting public health agencies with the introduction of geomatics activities. SSMIC operates a Community Geomatics Centre (CGC) that provides consulting services and products to health and human services organizations, government and private sector organizations.

2.3.3 Progress from GeoConnections Support

The GeoConnections program of Natural Resources Canada has supported a variety of projects to attain and sustain a foot hold for geomatics in public health leveraging the CGDI. In the early years these projects had an environmental emphasis. That was followed by a period that had a strategic planning and user needs assessment focus. In more recent years most of the effort has been directed toward the development of applications.

Fourteen GeoConnections public health projects were carefully analyzed. The breadth of projects included capacity building, user needs assessments, and application development. The nature, characteristics and lessons learned of these projects is the subject of Section 3. Additional information for most of these projects can be found in Appendix B. For reference purposes, a unique alpha-numeric code prefixes each of the project names.

Seven of the application projects have been identified as practices worthy of replication across Canada (see list below). Some of these projects were still underway during the development of this document.

- (DH-1) Community Information and Mapping System

[34] http://www.ssmic.com/

- (DH-4) Mapping of AQHI and Associated Health Risk Factors in Ontario
- (HE-1) Geospatial mapping of respiratory and gastrointestinal hospital visit data through a regional, real-time, emergency department surveillance system (Infection Watch Live – IWL)
- (HHR-1) Ontario Health Service Provider Maps
- (CG-5) Comprehensive Community Information System – Community View
- (DS-2) Development of a Web-Based Secure Interface for Sequential Mapping and Spatial Exploration of Surveillance Data
- (DP–1) Guidelines for Anonymizing Geospatial Data for Health Applications

It is important to note that the applications developed to date present the opportunity for organizations to benefit from their review with the intention of either adopting them in their current state if feasible, or use them as models for their own development projects.

It is recommended that organizations refer to these successes by others as the organization makes its decisions about developing applications to meet their specific needs. By focusing in this way, managers, planners, designers and developers have a quick reference to explore opportunities to improve their geomatics services.

In addition, some projects related to organizational capacity building and development processes can be reviewed to provide guidance to an organization's future development processes.

As referenced in the previous section, Quebec and British Columbia have demonstrated the strongest developmental leadership at the provincial level. Other provinces and territories that are less well-developed could learn valuable lessons from these two provinces.

2.4 International Experience

The use of geomatics in public health has evolved to varying degrees in several parts of the world. This section discusses findings from an environmental scan with respect to international activities. The information listed is by no means comprehensive. Instead it provides an overview of some of the notable work accomplished to date.

A valuable resource for those seeking to understand or keep abreast of the research and activities occurring internationally in public health geomatics is to review the International Journal of Health Geographics. This journal is an open access, peer-reviewed, online journal fully dedicated to publishing quality manuscripts on all aspects of geospatial information systems and science applications in health and healthcare.[35]

[35] http://www.ij-healthgeographics.com

2.4.1 World Health Organization

The World Health Organization (WHO)[36] notes that until recently the use of geographic information systems in public health was largely limited in use due to two major problems: the prohibitive cost of hardware and the great complexity of software that made it extremely time-consuming as well as costly to extract information. They point out, however, that this has substantially changed in recent years with plummeting hardware prices and the availability of simple new devices. Their Public Health mapping and GIS program (Health Mapper) has been developed to provide greater access to simple, low-cost geographic and related data management and mapping systems.

WHO geomatics initiatives include:

- Public Health Mapping and GIS Programme[37];
- Since 1993, WHO's Public Health Mapping and GIS programme has been leading a global partnership in the promotion and implementation of GIS to support decision-making for a wide range of infectious disease and public health programmes;
- Global Alert and Response (GAR)[38]; and
- An integrated global alert and response system for epidemics and other public health emergencies based on strong national public health systems and capacity and an effective international system for coordinated response.

2.4.2 United States

US Department of Health and Human Services[39]

At the Centers for Disease Control and Prevention (CDC), GIS technology has been applied in unique and powerful ways to a variety of public health issues. It has been used in data collection, mapping, and communication to respond to issues as wide-ranging and varied as the World Trade Center collapse, avian flu, SARS, and Rift Valley fever. In addition, GIS technology was used to map issues of importance during the CDC response to Hurricane Katrina. This technology represents an additional tool for the public health response to climate change.

Agency for Toxic Substances and Disease Registry (ATSDR)

The ATSDR has expanded its use of GIS to help with epidemiologic studies and with emergency planning. They are incorporating as many databases as possible, including data from the Environmental Protection Agency's (EPA) Toxic Release Inventory, national hospital data, and others. ATSDR routinely uses GIS mapping as a tool to help illustrate plumes of exposures from available environmental data overlaid with demographic data for the surrounding population (particularly vulnerable groups such as young children, the elderly or pregnant women). This not only enables the health professionals who are assessing the possible health problems resulting from such exposures to better see what

[36] http://www.who.int/health_mapping/gisandphm/en/index.html
[37] http://www.who.int/health_mapping/en/
[38] http://www.who.int/csr/en/
[39] http://www.hhs.gov/

they are dealing with - but also gives community members a picture of their possible exposures.

2.4.3 United Kingdom

Considered one of the leaders in public health geomatics field, the UK's explosion in the use and interest of GIS and desktop mapping for health applications has resulted in the development of specialist health GIS and spatial analysis units such as those listed below.

***West Midlands Health GIS Service*[40]**

The Health GIS Service currently operates within the West Midlands Cancer Intelligence Unit where it is able to integrate health, socio-demographic and environmental data for use in epidemiological studies and health service analyses. The service makes use of geographic and non-geographic data sets available nationally and locally to commerce and the academic community. The service is able to respond to ad hoc requests for maps and information and can provide spatial analytical services to support research initiatives within the National Health Service (NHS).

***The Small Area Health Statistics Unit (SAHSU) in London*[41]**

SAHSU was established by the Government in response to considerable scientific and public interest in the distribution of diseases across small areas which arose following the identification of a 'cluster' of childhood leukaemia near the Sellafield nuclear plant in 1983. SAHSU is located in the Department of Epidemiology & Public Health, Imperial College School of Medicine, London. The main aim of SAHSU is to assess the risk to the health of the population of exposure to environmental factors, with an emphasis on the use and interpretation of routine health statistics.

***Public Health Observatories of England*[42]**

The Association of Public Health Observatories (APHO) represents a network of 12 public health observatories [43] (PHOs) working across the five nations of England, Scotland, Wales, Northern Ireland and the Republic of Ireland. They produce information, data and intelligence on people's health and health care for practitioners, policy makers and the wider community. Their expertise lies in turning information and data into meaningful health intelligence.

The explosion in the use and interest of GIS and desktop mapping for health applications in the UK has resulted in the development of specialist health GIS and spatial analysis units such as the West Midlands Health GIS Service [44] in Birmingham and SASHU [45] in London, and more recently the Public Health Observatories of England.

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40 http://www.wmpho.org.uk/wmciu/GIS3.htm
41 http://www.sahsu.org/index.php
42 http://www.apho.org.uk/
43 http://www.apho.org.uk/resource/view.aspx?RID=39438
44 http://healthcybermap.org/HGeo/west_midlands.htm
45 http://www.sahsu.org/index.php

The Government White Paper - Saving Lives: Our Healthier Nation - set two major objectives: to improve the health of the population as a whole and to improve the health of the worst off in society. In support of these objectives the White Paper announced the establishment of a Public Health Observatory in each of the NHS regions. The eight observatories will be linked together to form a national network of knowledge, information and surveillance in public health. These new observatories will also be a resource for enquiry; searching for and compiling information and datasets on the nation's health and distilling from them the knowledge to guide its improvement (www.pho.org.uk, 2000).[46]

2.5 Common Challenges

As noted through the project reviews, interviews and the on-line survey, many inter-related factors impact the success and/or sustainability of applying geomatics in public health. Most of these factors overlap and thus are difficult to discuss individually. This section discusses those factors consistently reported to impact the use of geomatics within public health organizations at all levels.

The three most significant challenges to using geomatics in public health (see Figure 2-4) as identified by stakeholders include lack of awareness at all levels, issues with data (e.g. sensitivity, availability, quality, currency), and cost.

Awareness

The project reviews confirmed that senior management levels within organizations lack the appreciation of the potential of geomatics which in turn impacts geomatics funding support. Geomatics initiatives are often seen as research projects and although interesting, valuable and revealing in their own right, are not appreciated or understood by management and even front line users for their underlying potential to offer a broader range of benefits to operational business processes.

This aspect is not new or unique to the evolution of geographic information systems (GIS). In the early days GIS expertise was very specialized and implementation was typically project based to meet the needs of a handful of users. Those that held the knowledge to use the tools to manipulate and analyse the data were not well versed or positioned to articulate and demonstrate the potential of geomatics to the business. From the research conducted, this situation also holds true for geomatics within the public health community. Fortunately many other sectors (e.g. natural resource management) have managed to progress to the point where GIS and geomatics is a fundamental aspect of several core business processes holding out hope for the public health sector.

However, it is not only senior management that lacks an awareness and appreciation of the potential for geomatics. Research showed that even public health practitioners exposed to geomatics applications – and thus have a general understanding of the potential and use - still have a difficult time using general spatial analysis tools to formulate ad-hoc queries. That is, thinking spatially when using tools is not something that comes naturally even though we all think spatially every day in the most mundane of decisions like where to park our vehicle. Training (e.g. how to use the tools, what data is available, what

[46] http://healthcybermap.org/HGeo/gis_in_the_nhs.htm

questions the tools can answer) directed at the public health practitioner, is especially required at the introductory curriculum level. Further to this point is that non-research practitioners generally lacked a strong understanding of the types of geomatics applications within public health. Moreover there was a significant lack of understanding of the accomplishments made by others.

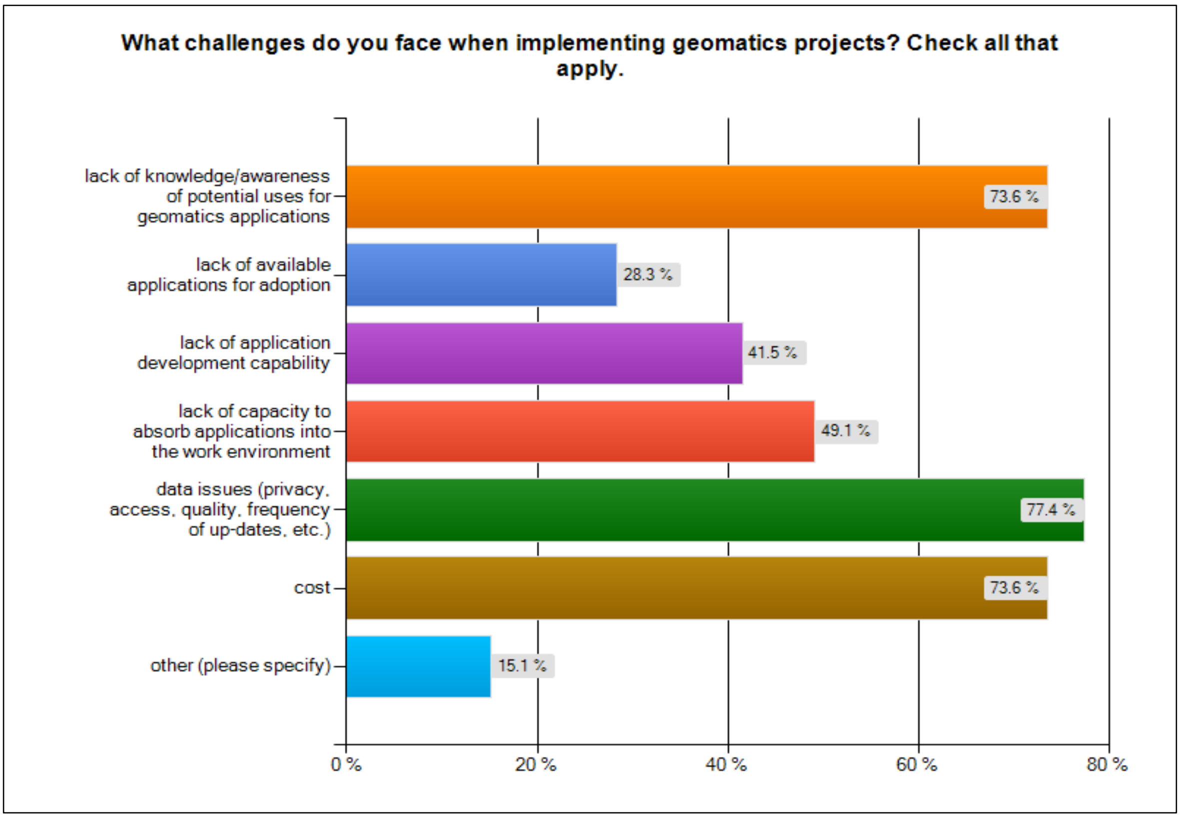

Figure 2-4: Survey Result – Challenges to Implementing Geomatics

Interestingly some educators with significant experience have addressed the real need for continued education within the scientific research domain. For instance, some epidemiological post graduate programs offered in BC institutes do not include geomatics as part of the core competency even though database technology and data management is core to the program and epidemiologists have lead the use of geomatics in public health.

Hence, awareness needs to be attacked on two fronts: enlightening senior management of the operational benefits of geomatics; and the education of public health practitioners to be able to think and work spatially through their educational curriculum.

Data

Despite the advances being made in accessing geospatial and public health data, challenges remain with data access, quality, standards and even knowing what is available. The result is that these data challenges can add significantly to project costs and schedule.

The identification and acquisition of data, both spatial and health related, at the resolution required to perform analysis and yield compelling results, was determined to be a significant hindrance to using geomatics. In part this can be attributed to a lack of knowledge of data available (information not published to metadata catalogues) and or misconceptions regarding known data source limitations. Also, of course, the required data is not available.

While national level data sets may have standards, they are not always shared across data sets (e.g. nomenclature is not consistent) and local level data sets are designed for local use and not for integration with other jurisdictions (e.g. similar data sets do not collect the same parameters). The result is considerable effort and cost may be required to access, integrate and clean disparate data sets.

Another significant aspect of public health data is its associated level of sensitivity (privacy, confidentiality). As a result of the restrictions applied to these data sets several stakeholders indicated that the administrative burden (e.g. forms to complete) and time to acquire health data necessary even for a single research project was prohibitive. Another facet of the sensitivity issue is that in order for the results to be shared the analysis must be presented in such a manner as to remove any privacy or confidentiality aspects from the information.

These challenges need to be assessed not only during application development but when the data set is initially being designed, relevant standards need to be assessed to ensure interoperability with other data sets at a later date.

Cost

Underlying all challenges to benefiting from geomatics is cost. Cost of hardware, software, data, application development, human resources, infrastructure, training and education are a few of the components that challenge geomatics use.

Several projects have incorporated various cost saving measures by individual organizations through solutions such as collaboration, human resource sharing, and sharing software licenses to fit the cost of implementation into existing budgets. These approaches have been effective to varying degrees.

By demonstrating through a business case to senior management the potential and value of a geomatics program in enhancing decision support at the operational level, the challenge of cost may be overcome and the road to institutionalizing the use of geomatics in the organization can be realized.

3 GeoConnections Funded Projects

Part of the research methodology for this project included a review of past and present projects funded by GeoConnections. This section summarizes fifteen past and two current projects of significance.

Through a review of projects to date, it is hoped the reader recognizes and learns valuable lessons from those that have gone before them on similar ventures. In the case of application development there may be opportunities to re-use what has been developed or at least avoid the pitfalls of others.

3.1 Overview of Project Characteristics

In the early years GeoConnections projects had an environmental emphasis, followed by a period that focused on strategic planning and user needs assessments. In more recent years most of the effort has been directed toward the development of applications and capacity building. The GeoConnections web site provides additional information on understanding the GeoConnections' funding.[47]

AMEC analyzed 36 of the 48 GeoConnections' public health projects. These projects demonstrated the following characteristics:

1. One-third (33%) had a primary focus on the determinants of health;
2. One-fifth (19%) are concerned with the social determinants of health;
3. Close to one-third had a primary focus on the design or development of comprehensive geomatics programs;
4. One-sixth had a primary focus on disease surveillance;
5. One-tenth primarily addressed user information and/or training needs;
6. Most projects (86%) were conducted to reflect the shared needs of multiple user organizations;
7. More than two-thirds (69%) of the projects assist organizations with budgeting for and deploying resources based on population needs;
8. Over one-half (58%) of the projects emphasized extensive consideration for potential users;
9. Close to one-half (47%) have the capacity to enable users to undertake forecasting and what-if analyses;
10. Close to one-half (44%) are aimed at helping users to respond to outbreaks;
11. Approximately one-third (36%) focused on identifying organizational needs and implementation plans for geomatics programs; and
12. Approximately one-quarter (28%) are concerned with exposure to pollutants and environmental factors.

[47] http://www.geoconnections.org/en/opportunities/fundingCriteria#opportunites

Geographical Distribution

The geographical distribution of the project seems to reflect the level of regional interest in public health geomatics. Over one-half (53%) of the projects were in Ontario, six (16%) were in British Columbia, four (11%) took place in the Prairie Provinces, three (8%) were in the Atlantic Provinces, and only one (3%) was in Quebec. Three (8%) were undertaken by Health Canada including PHAC.

Organization Type

Sixteen (44%) of the projects were undertaken by public health delivery organizations. Universities and non-governmental organizations carried out seven (19%) projects each. Federal and provincial government departments each sponsored three (8%) projects.

3.2 Brief Summary of Reviewed Projects

This section presents a brief summary of each of the projects reviewed and analyzed. A complete summary of projects is provided in Appendix B.

GeoConnections projects can be grouped primarily into four clusters – the determinants of health, disease surveillance, comprehensive geomatics programs / capacity building and user-centered requirements and design.

The determinants of health projects have mainly dealt with air quality. Projects involved with disease surveillance in general map the occurrence of infectious diseases. Comprehensive geomatics programs provide guidance for organizations wishing to move forward with strategic and business planning and internal capacity projects. User-centered projects focus on users' information needs and the supports they will need to make geospatial analysis a part of their normal work processes.

Id	Title	Category	Highlights	National Significance	Contact Information
DH -1	Development of Web Application and Services within the CGDI framework for Community Health Programs of the New Brunswick Lung Association	Determinants of Health	Enables community outreach and provides geospatial analysis for improved respiratory health education, disease prevention, research, knowledge transfer, and resource allocation. Training of users is an ongoing need for increased understanding of the CGDI and public health mapping applications. There is a learning curve, requiring demonstrations, presentations, and training sessions to familiarize end users with applications/services.	Addresses gaps that were identified in the CGDI: At the time of development there were no public health examples of Web Processing Services, Web Feature Services, Web Map Context Standard, and Data Schema… thus the project laid an important foundation for the public health community across Canada to utilize the CGDI for respiratory health applications. The new map viewer can be transferred or deployed at other organizations.	**Eddie Oldfield** NB Lung Assoc. (506) 455-8961 eddie.oldfield@nb.lung.ca
DH -2	Ontario Health and Environment Information System (OHEIS)	Determinants of Health	SAHSU's RIF System offers unique features that make it the ideal tool for a wide variety of projects that involve evaluating the spatial and temporal relationships between environmentally related diseases and environmental hazards.	This application has substantial utility for all jurisdictions in Canada. "… perhaps securely implemented in one central facility (e.g. Public Health Agency of Canada), with ready access to all necessary datasets at a fine level of granularity, disclosing sophisticated reports and graphics to authorized users without breaching confidentiality. "	**Dr. Eric J. Holowaty** Cancer Care Ontario (416) 971-9800, Ext. 1125 eric.holowaty@cancercare.on.ca
DH -3	Spatially Enabled Population Health Framework for Disease Surveillance	Determinants of Health	The overall goal of the project was to develop a web-based and spatially-enabled disease surveillance tool which allows for comprehensive analysis of population health ecology and disease. The prototype developed meets this goal and presents a sample solution for the	The project provides a practical example of disease surveillance related to population health analysis and showcases the application of a population health perspective in disease surveillance, in this case, communicable diseases. The project is relevant to all	**Clyde MacDonald** Health Information and Technology Branch BC Ministry of Health (250) 952-1449 Clyde.MacDonald@g

Id	Title	Category	Highlights	National Significance	Contact Information
			tangible use of Web-GIS technology for public health surveillance.	jurisdictions in Canada.	ov.bc.ca
DH -4	User Needs Assessment with Respect to Mapping of Air Quality Health Index in Ontario	Determinants of Health	Results indicate needs for an Air Quality Health Index (AQHI) mapping program with sufficient geospatial resolution of the information. Such a mapping service would enable recognition of spatial and temporal patterns of the index, it would improve the public awareness with respect to AQHI, it would support planning, decision and policy making as well as providing information inputs to population health risk assessment studies. User friendly accessibility of the information through the internet (a dedicated web application) came up as an essential user requirement.	The project is relevant to all jurisdictions in Canada. Mapping the AQHI will be of great value to public and population authorities at the national, provincial, and municipal levels across Canada in communicating the potential health impacts of air pollution and of poor air quality days. It will also provide valuable information to the Canadian public which will assist in making personal lifestyle decisions on how to respond to episodes of elevated air pollution. Health Canada, which has played a leading role in the development of the AQHI, requires this index in order to develop its health based risk communication and risk management strategies for ambient air pollution in Canada.	**Daniel Krewski** University of Ottawa (613) 562-5381 stherien@uottawa.ca
DP -1	Guidelines for Anonymizing Geospatial Data for Health Applications	Data Privacy	There is a clear need to provide Data Custodians with defensible guidelines to use to manage access to and disclosure of personal (health) information. The guidelines will be operationalized in an automated fashion and provided as part of an on-line service that can respond to queries or anonymize data sets submitted to it.	The objective of the project is to develop pan-Canadian evidence-based guidelines for anonymizing geospatial data. This project is scheduled for completion early in 2010.	**Khaled El Emam** Canada Research Chair in Electronic Health Information CHEO Research Institute (613) 738-4181 kelemam@ehealthinformation.ca
DS -1	Using real-time spatial information	Disease Surveillance	The Dracones system is in operation within the Montreal public health	The project is relevant to all jurisdictions in Canada.	**Dr. David. L. Buckeridge**

Id	Title	Category	Highlights	National Significance	Contact Information
	to manage communicable diseases		department. The system is used daily to validate addresses for new cases and to analyze the spatial distribution of cases for a wide range of reportable diseases.	There was a need for greater geographical resolution than current applications allowed. In terms of existing CGDI web services, it was determined that most CGDI-endorsed web services provide data at a resolution that is too low for (many) users' needs.	McGill University (514) 398-8355 david.buckeridge@mcgill.ca
DS-2	Development of a Web-Based Secure Interface for Sequential Mapping and Spatial Exploration of Surveillance Data	Disease Surveillance	The main objective of this project is to develop a secure web application enabling the valid spatial and temporal exploration and description of health surveillance data from various public health organisations. The tools within this application will support the early recognition of possible clusters and trends at local or regional scales.	The application will be made accessible to front- line public health practitioners and other public health professionals. Public health professionals will be equipped with improved health surveillance tools and will be better equipped to analyze public health issues.	**Pascal Michel** Chair GIS Network Public Health Agency of Canada (450) 773-8521 Ext. 18475 pascal.michel@phac-aspc.gc.ca
HE-1	Geospatial mapping of respiratory and gastrointestinal hospital visit data through a regional, real-time, emergency department surveillance system (Infection Watch Live – IWL)	Health Emergency Response	The project objective is to inform health professionals and the public directly about real time utilization of seven local Emergency Departments for respiratory and gastrointestinal illness to enable informed decision making. The significance of the application is that it is successfully functioning in an operational environment.	The results of this initiative seek to improve and protect the health of Canadians by allowing users to detect outbreaks in the community earlier than previous traditional methods and display these results for end-users."…other Health Units should plan to incorporate such a system in their own jurisdiction."	**Dr. Kieran Moore** Kingston, Frontenac and Lennox and Addington Public Health (613) 329-1191 kmoore@healthunit.on.ca
HE-2	UNA – GIS web-enabled Decision Support System (DSS) for Animal Emergencies	Health Emergency Response	The output of the eventual DSS will allow CVO/Food Safety and its stakeholders to effectively execute the four phases of emergency management with regard to animal disease emergencies:	The project clearly identified the range of needs of a variety of users who will benefit from the proposed DSS application. The final DSS should ideally be developed for national use with the	**Dr. Chris Green** Manitoba Agriculture, Food and Rural Initiatives (204) 945-7640

Id	Title	Category	Highlights	National Significance	Contact Information
			Prevention/Mitigation, Preparedness, Response and Recovery.	CFIA as the lead agency in recognition of its nation-wide responsibility for the management of animal disease emergencies.	chris.green@gov.mb.ca
CG -1	Strategic Planning for Capacity Development in Public Health Geospatial Information Systems for Eastern Health Region	Comprehensive Geomatics Programs	New linkages were made and existing linkages strengthened through this strategic planning process with expertise in GIS, information technology, health information, and public health becoming more integrated.	This is relevant background for organizations taking initial steps to introduce geomatics activities. Eastern Health was starting from a less-developed state regarding GIS capacity and applications than is found in several other provinces. By starting with strategic planning they placed themselves in a position to take maximum advantage of limited funding that will be available to address health-related GIS development needs.	**Dr. David Allison** Eastern Health, (709) 752-4192 david.allison@easternhealth.ca
CG -2	Developing a Shared Strategic and Business Plan for the Calgary Consortium	Comprehensive Geomatics Programs	The successful execution of a GIS Strategic Plan requires a number of steps to provide the greatest value and direction: 1) Creation of a metadata standard for the consortium 2) Development and implementation of a Spatial Data Warehouse in the public health agency 3) Creation of a detailed design for the geomatics application. 4) Development of a long-term hosting solution for the spatial data warehouse and the online application. Several western Canadian urban health regions are moving towards	This project is an excellent example of how a common vision and a collaborative effort can result in a plan that serves the needs of a variety of municipal/regional organizations that have common needs and a willingness to share information and technology. This project demonstrates that it is feasible for several users within the same geographical area, but with a limited amount of commonality in service mandates, to collaborate on geomatics initiatives. This occurs because there is a common set of geospatial information that serves each of their interests. Moreover, there are savings to be realized from such collaboration by the	**Dr. David Strong** Calgary Alberta, (403) 943-0272 david.strong@calgaryhealthregion.ca

Id	*Title*	*Category*	*Highlights*	*National Significance*	*Contact Information*
			developing Public Health Observatories. The United Kingdom observatories have a formal commitment to working collaboratively, to add value to existing health and social information, and to focus on identifying and describing health inequities. Spatial analysis and the use of mapping applications are the main tools used by the Observatories to root out health inequities.	avoidance of duplication of technology, software and specialized human resources. Public health agencies benefit as well by strengthening relationships with organizations that can assist them in their disease surveillance, outbreak response, environmental monitoring and health education activities. They can also, potentially, discover sources of expertise that can be called upon to assist them in their geomatics activities.	
CG -3	Strategic Plan for Health GIS Implementation in BC: A Focus on Health Surveillance	Comprehensive Geomatics Programs	The project highlights the benefits of a high level of government commitment to GIS. Following the BC approach avoids the pitfalls of piecemeal GIS development.	While broader in scope than public health, this project provides a template that other provincial and territorial governments with substantial existing geomatics infrastructure (often found in the natural resources departments) could be used to cost-effectively meet the GIS needs of ministries and other organizations in the health sector. As the Ministry adhered to CGDI and other recognized standards, information and models developed through this project and through the eventual operational use of an HGIS will be of interest and value to other organizations and jurisdictions.	**Russell Fairburn** BC Ministry of Health (250) 952-1439 Russell.Fairburn@gov.bc.ca
CG -4	Defining the Strategic and Business plans for An On-line Mapping portal To Monitor	Comprehensive Geomatics Programs	The overall goal of the initiative is to increase the capacity of the SPCO and key collaborators to use geomatics to understand and improve population health. The	The application is being developed to address social determinants of health and the needs of voluntary human services organizations. It is quite unique in its approach and	**Dianne Urquhart** Executive Director Social Planning Council of Ottawa

Id	Title	Category	Highlights	National Significance	Contact Information
	Neighbourhood Level Population Health Using the CGDI		primary objectives is to establish in Ottawa a sustainable on-line mapping portal to visualize, understand and monitor neighbourhood level population health, which can be replicated in other communities.	cold be a beneficial application on a county-wide scale.	(613) 236-9300 ext. 303 dianneu@spcottawa.on.ca
CG -5	Comprehensive Community Information System – Community View	Comprehensive Geomatics Programs	The Comprehensive Community Information System (CCIS) is a concept whereby intersectoral and inter-jurisdictional information sharing is enabled among many human services organizations with the objective of improving information availability, planning processes, resource allocation and service delivery. CCIS will provide an easy-to-use web-based tool that can be used to explore and analyze the characteristics of a community in a variety of ways.	CCIS is a unique combination of technology, information and community. There are some programs in North America that appear to have similar aspects but CCIS is quite unique. A similar product currently does not exist in Canada.	**Lara Murphy** Project coordinator Population Health Public Health Services Saskatoon Health Region (306) 655-4682 lara.murphy@saskatoonhealthregion.ca
U-1	Infectious Disease Simulation Tool – A Geospatial Decision Support System	User-centered	This was a comprehensive user needs assessment. It identified the specific needs of a broad variety of users. The design is user friendly and user training and support needs were specified.	While simulation models are useful, they are not as beneficial as active disease surveillance applications. The latter may also include modelling capability.	**Dr. Eileen de Villa** Peel Public Health (905) 791-7800 Ext. 2856 eileen.devilla@peelregion.ca
U-3	GIS Capacity Building and User Needs Assessment Project	User-centered	This project had a strong user focus. There was consideration given to the different needs of various user categories. Significant emphasis was placed on user training and support.	This project is very good example for other organizations to follow to ensure both the information and technical needs of users are met.	**Fiona Lawson** Population Health Analyst Vancouver Island Health Authority (250) 519-7076 Fiona.Lawson@viha.

Id	Title	Category	Highlights	National Significance	Contact Information
					ca
HH R-1	Ontario Health Service Provider Maps	Health Human Resources	The application was developed to empower health services staff to maintain an up-to-date accurate record of their contact and location characteristics, most importantly location of workplace. Such information assists managers with staff deployment decisions.	This is the only GeoConnections public health project to date that deals specifically with health human resources information. Such information is beneficial to all users of public health geomatics applications.	**Peggy Barwell** Manager, Development and Maintenance, Health Care Programs I&IT, Branch Ontario Ministry of Health and Long-Term Care (416) 326-1493 Peggy.Barwell@ontario.ca

Table 1: Summary of Reviewed GeoConnections Projects

4 APPLYING GEOMATICS IN PUBLIC HEALTH

This section speaks further to how geomatics can be effectively applied in the public health domain. It begins with an overview of the generic spatial analytical capabilities that are core to GIS. With this understanding in hand, the focus shifts to describing some of the business application areas and use of GIS to realize benefits. This section also lays the foundation for understanding the data requirements for public health geospatial data analysis as well as issues and approaches to working with sensitive geospatial data.

4.1 Spatial Analysis Fundamentals

Geographic Information Systems (GIS) enable two fundamental aspects not afforded to the user that relies solely on analyzing non-spatial data stored in tables in a database:

- Visualization of relationships only realized in map form; and
- Ability to spatially analyze or derive answers to questions directed at a map.

Spatial Visualization

Visualizing the spatial component of data (i.e. looking at a map) is obviously not something new. However, the ease and depth with which we can now present the spatial dimension of data has taken an enormous leap forward over the past two decades. Digital framework spatial data (e.g. road networks, water bodies, vegetation, etc) at a national level is readily available in Canada. Moreover, techniques to geo-enable data using municipal address allow data that is traditionally viewed and analyzed only in non-spatial databases to be included on a digital map and compared to other geographic layers of data. By doing so, relationships not observed in the database begin to materialize when shown on the map.

Two other enabling technologies within the realm of geomatics are GPS and remote sensing. GPS, or Global Positioning System, is based on a series of geo-stationary satellites that allow GPS devices to triangulate an accurate location of the device on the surface of the earth. By attaching GPS enabled devices to vehicles, ships or any other moving object, real-time geographic location (i.e. latitude and longitude coordinates) can be directly loaded into a GIS system display. Moreover, using a hand held GPS-enabled device, field collection of geographic data can also easily be performed.

With the emergence of web-enabled mapping tools such as Google Maps, main stream technology users now appreciate the power of remotely sensed imagery from satellites orbiting earth. These static images provide for an ideal spatial backdrop. Remotely sensed data also includes airborne imagery which can provide a further level of detail than from space. Moreover, technology that is able to capture the non-visual spectrum (e.g. radar) allows us to render this information in the visual spectrum.

Spatial Analysis

When viewing data on a map, whether in printed form or on a computer screen, we are naturally performing spatial analysis by viewing the spatial relationships to various objects on the map. Spatial analysis in a GIS is simply the automation of this same process. For instance, to identify where a specific address is located on the map we would use the street index guide to identify which page and where on the page (map) the street is located. In a GIS a query could be defined to do the same thing and a symbol on the map would appear. The GIS would do the searching in the tabular database for the correct street, position the viewing window over the street, display background geographic layers, and finally highlight the address desired.

Another type of analysis available in GIS is known as buffering. A buffer created around one or more map objects can then be used to identify the relationships with other map objects. For instance, we could identify the areas on a map that are not within 10km radius of health service centers and thus identify gaps in the coverage. Another example might be to buffer areas of confirmed cases of contamination. These buffers could then represent higher risk zones to be avoided.

Network analysis in GIS allows us to analyze data along such networks as roads, transmission lines, water routes, etc. Using network analysis we can determine such things as the optimal path (fastest, shortest, etc) between points on a map. Moreover, we can use the same underlying algorithms to determine the optimal locations for centers that have a fixed capacity. In this analysis the goal is to maximize network coverage without overlapping (cannibalizing) the area of an adjacent center. This type of analysis is used to determine the optimal location for a new facility given existing facility locations.

4.2 Application Areas

There are many areas where spatial information and analysis can be applied in the public health arena. Some of these include:

- Determining geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping populations at risk;
- Stratifying risk factors;
- Assessing resource allocation;
- Planning and targeting interventions; and
- Monitoring diseases and interventions over time.

Although geomatics does not belong to a single discipline, it is important to understand how fundamental spatial analysis capabilities can provide significant value to business decisions in this sector. This section reviews a few of these application areas and some of the applied geospatial analyses that can be performed.

Healthcare Service Planning

There is an important relationship between location and health, thus having a geographic perspective assists in public health tasks such as planning to improve healthcare service delivery. The figures below are a result of a service delivery planning project conducted by the Vancouver Island Health Authority (VIHA) known as SARIN (Seniors At Risk IHN)[48]. The goal of the SARIN project is to reduce hospitalizations for individuals aged 55+ with two or more chronic diseases. This map demonstrates the target population relative to service providers.

By visualizing this information in a geographic format, planners are able to identify how well their current service locations are situated to accomodate the target populations.

Further spatial analysis could be performed to measure the effectiveness of existing health service delivery. By creating buffer around each of the service delivery locations a specific radius (e.g. 50 kms) and then overlaying the buffered areas with the postal code polygons that define the target population, postal code areas that are beyond this minimum service delivery radius can be easily identified and the apporpriate actions taken to accomodate this pattern. It is important to note that this analysis would not be possible without the use of spatial data and GIS.

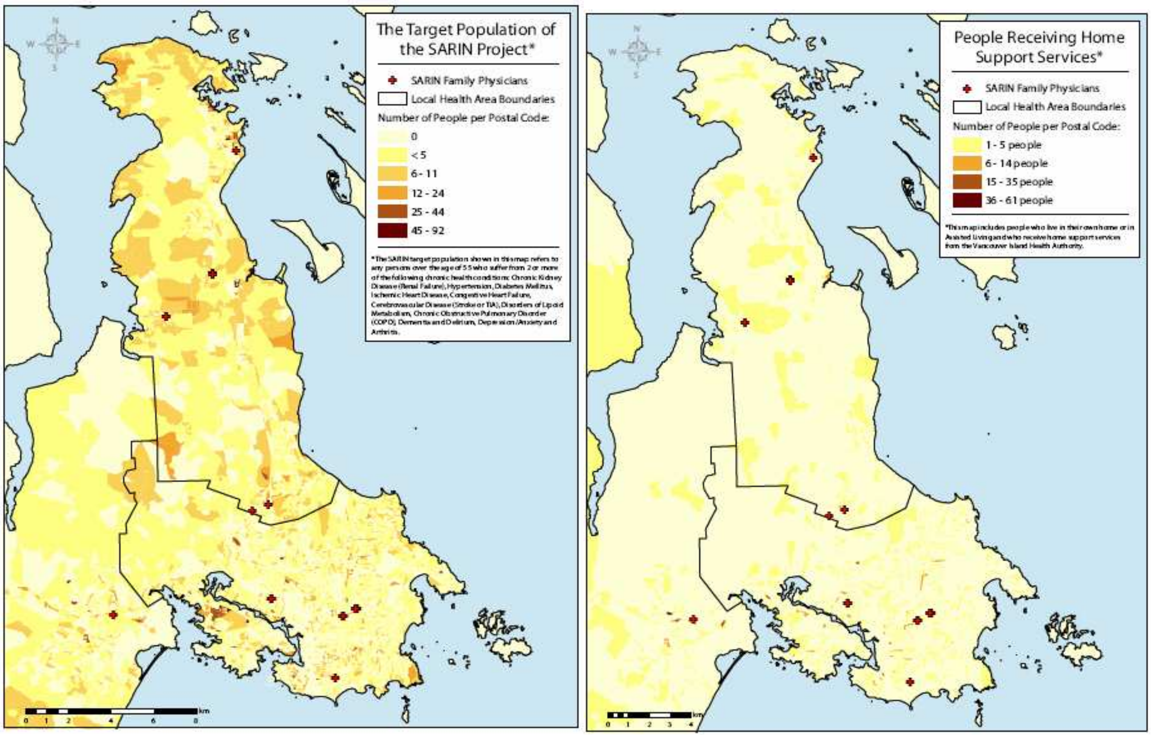

Figure 4-1: VIHA maps for Senior's at Risk Integrated Health Network (SARIN) project

[48] The Use of Geographic Information System (GIS) in Health Research, Analysis and Planning, C. Lightowlers, Population Data BC and GeoConnections

The figure below, also from VIHA, shows the most efficient route for the mobile needle exchange unit using the known location of Intravenous Drug Users.[49] This example takes advantage of the network analysis capabilities in GIS to determine the optimal path. In this case, rather than simply determining the shortest path from point A to B, a spatial analysis technique to resolve a problem commonly known as the "traveling salesman problem" can be used. That is, what is the optimal route for a salesman that must visit all of his clients at known locations and then return to his office. GIS can use a combination of brute force analysis (measuing every possibility) and heuristics (making assumptions) to resolve this problem in a practical amount of time. This is quite an accomplishment when you consider the number of possible combinations that could be attempted.

Figure 4-2: Mobile needle exchange route determined using network analysis

Using the network analysis capabilities found in GIS, other analyses can be performed that assist public health delivery planning. For instance, using a GIS technique sometimes referred to as "allocation", planners can execute what-if scenarios to measure the catchment areas of hospitals for example using the location of hospitals and the digital road network. Each catchment area can be constrained to a maximum travel distance and/or time. Similarly the resource capacity of each hospital (e.g. beds) can also be used as a constraining factor to define the catchment area such that when the hospital is at capacity. For example, assuming a fixed number of hospital beds required per person (e.g. 1 bed for every 750 people), areas in a given municipality that are "under" serviced can be determined based on their travel distance to their nearest hospital and the resource capacity of each hospital.

[49] The Use of Geographic Information System (GIS) in Health Research, Analysis and Planning, C. Lightowlers, Population Data BC and GeoConnections

Health Emergency Planning

Spatial analysis can also be used to forecast disease outbreaks and track them wherever they spread – across regional or provincial/territorial jurisdictions or even international borders. As cases are recorded, statistical analysis can reveal trends that can then be used to identify at-risk groups in the population. Using demographic and socio-economic census data collected by Statistics Canada, maps can be created in a GIS that depict where the at-risk groups are concentrated. Moreover, the locations of known cases can be plotted on a map by matching the address data of case records to a spatial street network with address information; as opposed to the traditional way of placing pins on a printed map to record specific incidents. Superimposing both known cases onto at-risk groups allows the emergency health planner to mobilize their resources more effectively.

In addition, spatial information can help to create and send reports, advisories, alerts and warnings at any level – local, national and international. As well, it can be used to make decisions on other health-related emergency actions, such as whether and when to initiate the production of a vaccine.

One application that also falls into this same category is VIHA's Emergency Management GIS (VEMGIS); a tool intended for use in the event of an emergency such as a tsunami, explosion, gas lead, etc. VEMGIS is an interactive, web based GIS tool that allows VIHA users to access detailed information related to emergency planning. It contains contact information for emergency management personnel and location information for facilities and resources such as generators and satellite phones (see Figure 4-3).[50]

Figure 4-3: Vancouver Island Health Authority's Emergency Management GIS (VEMGIS)

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50 The Use of Geographic Information System (GIS) in Health Research, Analysis and Planning, C. Lightowlers, Population Data BC and GeoConnections

Rapid Emergency Response

In emergency response, especially medical situations, every second counts. Often, the most critical time factor is the availability of basic information:

- Where is the patient (or event) located?
- Where are the nearest and most appropriate emergency resources (e.g. ambulances, helicopters, hospitals, firefighters, police officers)?
- What is the quickest route to get there?

Geomatics tools can be and are used in emergency response systems to resolve these and other questions. With this type of application geomatics is a natural migration from the non-digital practice of using paper maps and relying on telecommunications to guide the appropriate emergency response vehicles to the incident location.

Today onboard GPS transmit vehicle location and status information to a centralized dispatch centre. Incident locations are determined by geo-enabling the 911 address of the caller by matching the address to the street network GIS layer. Shortest path calculations are automatically calculated to all emergency vehicles within a minimum specific radius of the incident and the appropriate vehicle is automatically identified as the most suitable to dispatch.

On-board some emergency vehicles, map display screens have replaced printed map books that are difficult to see and maintain and are not interactive (e.g. cannot show the optimal route as determined by the dispatch center). Dispatchers are able to visualize in real-time the incident location and the location of responding vehicles using on-screen interactive mapping.

Using data and technology standards, interoperability enables critical information such as traffic accidents, construction, and other determinants that impact travel speed, to be shared with emergency responders and dispatch. These factors can be integrated into the road network model to more accurately reflect the current state of travel time through the network in real-time. Dispatchers are able to visualize in real-time the incident location and the location of responding vehicles using on-screen interactive mapping.

By removing the requirement to have local knowledge of traffic patterns and address locations, dispatch resources can be more efficiently centralized into fewer centers.

4.3 Data Requirements

Data required for GIS analysis in public health applications can be categorized as follows:

- Non-spatial public health data organized by health data type such as health indicators, diseases and health conditions, health service performance statistics, and injuries; and
- Geospatial data (aka spatial data) organized by map feature type (see Figure 2-1) such as census boundaries, road networks, administrative boundaries (e.g. school districts, electoral districts, and Native reserves), rivers and

lakes, health areas/regions, health service delivery areas, transportation infrastructure, energy infrastructure, place names, and land use.

Non-Spatial Public Health Data

As identified in the GeoConnections study known as Public Health Geospatial Information Reference Framework[51], several examples of non-spatial health data sources exist. These include:

- The Discharge Abstract Database (CIHI)
- National Trauma Registry (CIHI);
- National Ambulatory Care Registry (CIHI);
- Inventory of Federal/Provincial/Territorial Environmental and Occupational Health data Sources (PHAC);
- Inventory of Injury Surveillance Data Sources and Surveillance Activities (PHAC);
- Canada's key socioeconomic (demography, health and social conditions, household expenditures) database CANSIM (STC);
- Integrated Public Health Information System (PHAC); and
- Provincial health surveillance centres.

Geospatial Data

Over the past two decades significant public and private resources have been invested in creating a large amount of digital geospatial framework datasets at the national, provincial and territorial, regional and municipal levels. Moreover, spatial data format standards (e.g. OGC's ST_geometry database data type) and metadata standards (e.g. ISO 19115) and the importance of their use have evolved through the efforts of organizations such as GeoConnections and the Canadian Geospatial Data Infrastructure (CGDI). Through its CGDI framework, GeoConnections has endorsed a number of international technology standards defined by the Open GIS Consortium (OGC) such as the Web Mapping Service (ISO 19128), Web Feature Service and the Geographic Markup Language (GML) based on the widely used XML standard. These protocol standards promote the principle of maintaining data closest to source while enabling secure, author controlled, subscription access to spatial data via the internet.

Uptake on these standards by both users and technology service providers, both GIS and database vendors alike, has been significant. So much so that these standards have enabled users with smaller budgets to focus on applying geospatial data analyses rather than undertaking an often expensive and time consuming geospatial data collection exercise.

[51] Public Health Geospatial Information Reference Framework Data Categorization, Inventory & Standards Study Geospatial Information Reference Framework (DRAFT), September 9, 2009

Framework Data from Geoportal

A couple of examples of geospatial data sets are generated and distributed by Statistics Canada. These include Road Network Files (RNF) offered at a national, provincial, regional or municipal level and Census Boundaries used to disseminate census data in a spatial context.

Road Network Files include civic address data including address ranges on either side of each road network segment. The RNF data sets - or the equivalent public or private data offerings – provide the means by which non-spatial data that includes an address component (e.g. most health records) can be geo-referenced (see Geo-Enabling below). Moreover, these road networks provide the foundation for any sort of travel time and/or distance calculations.

Census Boundaries are also significant to public health practitioners since they provide the means by which key socio-economic variables collected for each household can be distributed by means of aggregation thus honouring the legal responsibility of upholding each individual's right to privacy.

Cost Recovery

Geospatial data sets are not always available free of charge to the general public or most organizations. Since the 1980's, the Canadian federal policy on distribution of geospatial data has been one of cost recovery. However more recently most departments are moving to an open access model. For instance, Statistics Canada's national 2005 RNF data set including address ranges on each side of each road segment can be downloaded free of charge.[52] The result is that depending on your specific data requirements, the cost can be significant.

Statistics Canada Data Liberation Initiative

The Data Liberation Initiative (DLI) is an excellent example of a cost effective method for improving data resources for Canadian post secondary institutions. Prior to the start of the DLI program, Canadian universities and colleges had to purchase Statistics Canada data, file by file. With the advent of the DLI, participating post secondary institutions pay an annual subscription fee that allows their faculty and students unlimited access to numerous Statistics Canada public use microdata files, databases and geographic files. Academic researchers now have affordable and equitable access to the most current statistics and other data, which gives them powerful tools to use in their analysis of Canadian society.[53]

4.3.1 Discovering Geospatial Data

The nature of public health analysis often requires data from a wide variety sources and disciplines. With such a vast amount of spatial and non-spatial data available the opportunity to make use of existing data is significant. However, discovering the right

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[52] http://geodepot.statcan.ca/Diss/2006Dissemination/Data/FRR_RNF_e.cfm?language=E&format=A
[53] http://www.statcan.gc.ca/dli-ild/about-apropos-eng.htm

data and then acquiring it in a timely manner is one of the challenges for public health professionals interested in applying a geographic dimension to their analyses.

Metadata standards used to define geospatial data sets has enabled the creation and widespread use of web based portals for browsing, searching, and in some cases downloading or ordering, geospatial data sets and web mapping services. The GeoConnections Discovery Portal (http://geodiscover.cgdi.ca/) shown below is one such example. This portal provides the ability to search on spatial, temporal and metadata characteristics of geospatial data and map based web services.

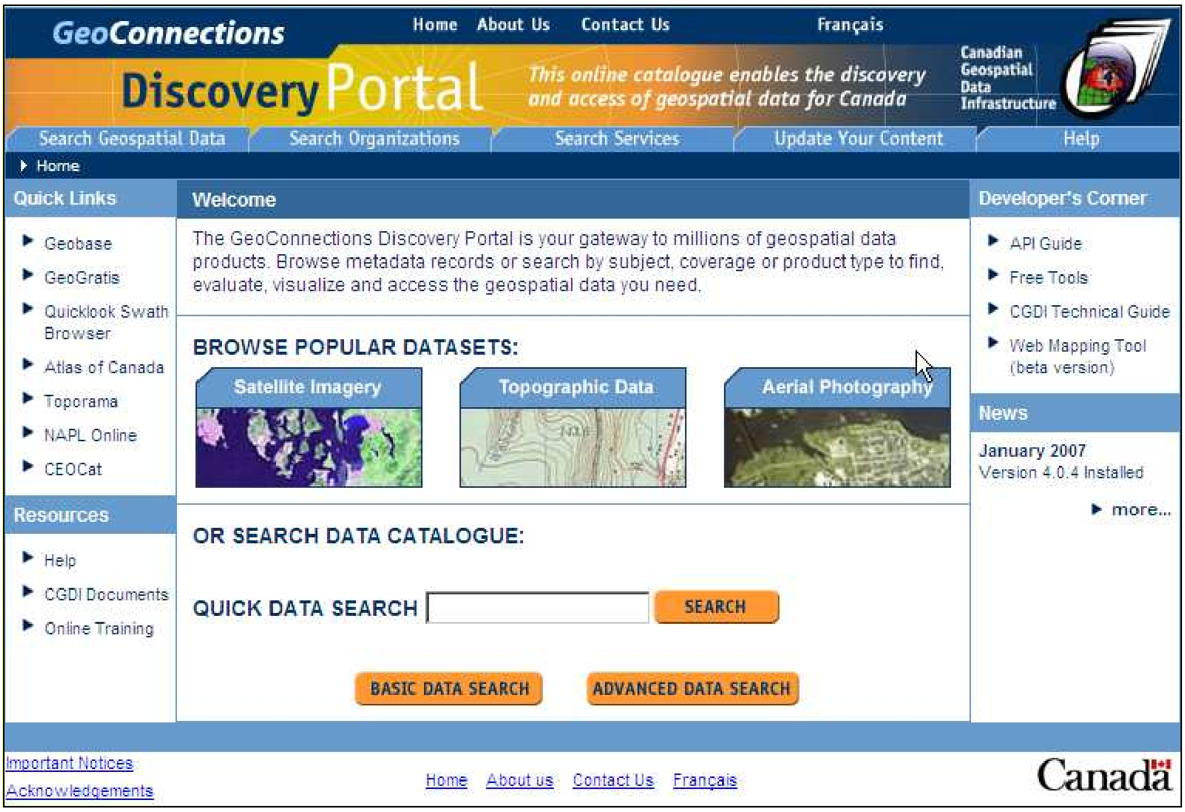

Figure 4-4: GeoConnections Discovery Portal

There are several other such examples of federal department web portals with access to geospatial data. Some of these are listed in the table below.

Name	**Description**	**Link**
GeoGratis	GeoGratis is a portal provided by the Earth Sciences Sector (ESS) of Natural Resources Canada (NRCan) which provides geospatial data at no cost and without restrictions via your Web browser.	geogratis.cgdi.gc.ca

Name	Description	Link
GeoBase	GeoBase is a federal, provincial and territorial government initiative that is overseen by the Canadian Council on Geomatics (CCOG). It is undertaken to ensure the provision of, and access to, a common, up-to-date and maintained base of quality geospatial data for all of Canada. Through the GeoBase portal, users with an interest in the field of geomatics have access to quality geospatial information at no cost and with unrestricted use.	www.geobase.ca
GeoScience Data Repository	The GeoScience Data Repository (GDR), is a collection of Earth Sciences Sector geoscience databases that is managed and accessed by a series of information services. This site allows you to discover, view and download, free of charge, the following information using these services: maps, geophysical surveys, geochemical and other geoscience data.	gdr.nrcan.gc.ca
Atlas of Canada	The Atlas of Canada provides authoritative, current and accessible geographic information products at a national level. Working with partners, the Atlas facilitates the integration and analysis of diverse data in order to increase overall knowledge about Canada.	atlas.nrcan.gc.ca
Topographic Map Search	The most common question we receive from map users is "Which topo map covers my area of interest?" Using interactive tools, you may search our database by NTS number, geographical name, geographic co-ordinates, or using a clickable map interface to locate any National Topographic System map sheet and its metadata (information about the map sheet) for any part of Canada.	maps.nrcan.gc.ca
Geographical Names of Canada	The Canadian Geographical Names Data Base (CGNDB) contains some 500 000 records, over two-thirds of which are currently official names, as approved by the Canadian Permanent Committee on Geographical Names (CPCGN). It is the fundamental national database to provide official names of mapping and charting, gazetteer production, and World Wide Web reference, and other geo-referenced digital systems. Over 30 attributes may be stored for any name, and the database is updated on a daily basis.	geonames.nrcan.gc.ca
National Air Photo Library	NAPL On-Line allows clients to search and retrieve metadata for over three million air photos using several criteria, including official place name, geographical coordinate, National Topographic System map number, or Roll and Photo number. NAPL On-Line visually depicts the 'footprint' of air photos on a seamless map background. After a search is completed, the air photos can be ordered from NAPL.	airphotos.nrcan.gc.ca

Table 2: Federal Geospatial Data Web Portals

There are also several provincial geospatial data web portals that include mechanisms for discovering and accessing geospatial data. By no means an exhaustive list are the examples of provincial web portals listed below.

Name	Description	Link
GeoBC	GeoBC provides a window to data and information sources provided by various ministries and agencies from the Natural Resource Sector within the British Columbia Provincial Government. The focus is on spatial and attribute data and associated applications that allow display and interaction with the data.	www.geobc.gov.bc.ca
GeoSask	GeoSask is a centralized public website that provides one clear online access point to different types of maps and geographic information related to Saskatchewan land from across various government sources. And, for all but the most complex downloads, GeoSask is free to search and download.	www.geosask.ca/Portal/ptk
Land Information Ontario	Land Information Ontario (LIO) manages geographic information for use in maps and Geographic Information Systems (GIS). LIO has a web-accessible data warehouse that contains more than 250 different layers of geographic data. The data ranges from the location of underground wells to satellite imagery. More than 2,000 registered users deposit and extract geographic data from the LIO Warehouse. Users include federal government departments, other provincial ministries, municipalities, public health units, conservation authorities, universities and colleges, boards of education and private sector organizations such as utility companies and land developers.	www.mnr.gov.on.ca/en/Business/LIO/
GeoNOVA	The GeoNOVA Portal is the Province of Nova Scotia's gateway to geographic information about Nova Scotia. Geographic data access is our goal. The Nova Scotia Geographic Catalogue is a gateway for discovering geographic data products. Users can browse metadata records or search by subject and spatial extent. The Geographic Catalogue comes in two flavours: Users searching for Geographic Data and Geographic Data Providers who maintain and update their catalogue records.	www.gov.ns.ca/geonova
Le Québec géographique	Québec géographique is a portal that gives you access to all maps, atlases and GIS products available in departments and agencies of the province government of Quebec.	www.quebecgeographique.gouv.qc.ca

Table 3: Provincial Geospatial Data Web Portals

Geospatial Information Reference Framework

Notwithstanding the web based portals above and the ISO 19115 metadata standard for describing geospatial data, locating specific data to meet the needs of public health researchers and geospatial analysts is still a challenging task; especially for those with less geomatics experience.

To assist public health practitioners, GeoConnections sponsored a 2009 report to propose a Geospatial Information Reference Framework targeted towards the Canadian public health community. This report entitled “Public Health Geospatial Information Reference Framework – Data Categorization, Inventory & Standards Study”, proposes a common vocabulary to describe geospatial data in the context of public health, and has two major elements: a categorical scheme and an inventory of data sources. The categorical scheme takes into account the terminology, classes, and standards that are used within the public health community. The categories provide a structured terminology that helps in communication amongst individuals, networks, and systems. In particular, categories facilitate communication between data providers and data users. They are helpful for keyword searches, for data mining, to build catalogues, to model data, and to organize stored data. Categorical schemes group concepts into semantically proximal classes, which facilitate browsing for potentially useful information or seeking information similar to a known source. This catalogue of geospatial information would be useful to public health analysts who want to use a geographic information system (GIS) to create maps or analyze spatial factors that affect health.

At the time of writing, the catalogue has been populated with some national geospatial data sets. The purpose was to test the Geospatial Information Reference Framework. GeoConnections is currently reviewing this framework. Once it has been vetted, the hope is for a custodian to further populate, enhance, and maintain the framework on behalf of Canadian public health professionals.

4.3.2 Geo-Enabling Data

Geospatial analysis leverages geography as a framework for integrating, analyzing and presenting desperate data. Geospatial data sets by definition include explicit geographic coordinates that define map features (e.g. administrative area for local health units), and characteristic information that describe individual features (e.g. local health unit name and resource capacity).

However, most public health data analysis is evidence based using health records information to track incidents and identify correlations with other data. In the case of spatial data analysis, correlations are sought between the location of the incident and the location of other factors such as distance from the nearest hospital, proximity to environmental determinants, socio-economic profile of the area where the subject resided, etc. To perform this analysis the health incident must be assigned a geographic location so that spatial comparison can be made. This process is known as geo-enabling but has also been given names such as georeferencing, geocoding and address matching.

Anyone who has typed their address into a web based mapping portal has used a geo-enabling process. The street address you typed in is non-spatial data that is then matched to existing geospatial data sets (e.g. road network) that includes address information assigned to each road segment. When the correct match is found, the process is completed by assigned a geographic location (i.e. coordinate) to the address type in relative to the street segment map feature. Once the address is geo-enabled it has entered the common geographic framework for conducting further spatial analysis.

One of the most common ways to geo-enable public health data is to do so via address information. Address (or some form thereof) is inherent in most public health sector data sets such as hospitals, clinics, homes and businesses. By comparing and matching address data elements of health data (e.g. address number, street name, street type, province, and/or postal code) to the corresponding address data elements of the geospatial street network, health data can be geo-enabled.

Where the data to be geo-enabled contains postal codes, the Postal Code Conversion File (PCCF) and PCCF+ tools developed by Statistics Canada are available to geo-enable this data to various census geographic boundaries (e.g. Dissemination Areas (DA), Census Subdivisions (CSD), etc.).

Postal Code Conversion File (PCCF)

The geographic coordinates attached to each postal code on the PCCF are commonly used to map the distribution of data for spatial analysis (e.g. clients, activities).

Postal Code Conversion File Plus (PCCF+) [54]

The Postal Code Conversion File Plus (PCCF+) is a complementary product to the Postal Code Conversion File (PCCF). PCCF+ automatically assigns a full range of geographic identifiers (down to dissemination area, block, and latitude, longitude) based on postal codes. PCCF+ is based on the latest Postal Code Conversion File and the Postal Code Population Weight File produced by the Geography Division of Statistics Canada. PCCF+ uses weights to allocate postal codes linked to multiple dissemination areas according to the distribution of population for a given postal code. This allows researchers and geomatics professionals to geo-enable almost any data set containing postal codes with correlation to Statistics Canada geographic data.

4.4 Working with Sensitive Data

Especially true in the public health community is the concern of maintaining confidentiality for sensitive health data and thereby honour legislative and/or internal policy requirements. Just as this is true for non-spatial data analysis in public health applications, so to must privacy be considered when conducting spatial analyses and presenting results in map format. Similar to private information of incidents in a purely non-spatial study, point locations on a map identifying incident home addresses which could compromise the individual's privacy can not be openly published. However, use of GIS displays and related databases raises the potential of compromising privacy standards, therefore some precautions are necessary to avoid pinpointing individuals based on spatial data. Because the perceived risk of working with sensitive data in public health is so widespread, it is important to ***educate decision makers on matters of data privacy including mechanisms to share and protect this data***. The emphasis should be on the fact that practices are in place in numerous organizations to effectively deal with the sensitive data issue.

This section discusses some of the issues with sharing geospatial public health data and approaches to sharing sensitive data where necessary.

4.4.1 Issues with Sharing Data

Information is the lifeblood of public health practice and sharing data amongst stakeholders is critical to improving information processes.

[54] http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=82F0086X&lang=eng

In the aftermath of the 2002 – 2003 Severe Acute Respiratory Syndrome (SARS) outbreak in Canada, a number of high profile external reports pointed to gaps in information systems and information sharing practices. Since then, the Public Health Agency of Canada has been collaborating with its local, provincial and territorial counterparts to develop principles and tools for sharing information.[55]

There are two significant issues that impact the sharing of geospatial public health data. The first issue is that of privacy, the second is the need-to-know what is being done with the shared data and how is it being safeguarded.

Privacy

The environment in which an organization operates is dictated by the legislation, policies, mandates, guidelines, agreements and standards by which it abides. The most powerful of these elements is the legislation governing an organization.

Without exception the most far reaching legislation concerning sensitive data in Canada are the Privacy Act, its private sector equivalent the Personal Information Protection and Electronic Documents Act and their provincial and territorial counterparts. These privacy laws and policies regulate the collection, use and disclosure of personal information by government and govern the manner in which personal information is managed by the private sector.[56]

In relation to personal information, privacy is the right of individuals to determine for themselves when, how and to what extent information about them is communicated to others. Confidentiality is a third-party obligation to protect the personal information with which it is entrusted. It is a duty of care to maintain the secrecy of information, and not misuse or wrongfully disclose it. Security is the process or manner of assessing the threats and risks posed to information and taking the appropriate steps to protect the information against unauthorized access, use, intrusion, loss or destruction.

There is often confusion about the differences between privacy, confidentiality and security. More specifically, confidentiality and security are often confused with "privacy protection". So the distinctions are significant: privacy, a fundamental right; confidentiality, an obligation to protect information; and, security, the process of protection.[57]

Within the Canadian federal government the Treasury Board requires that all databases be subjected to a Privacy Impact Assessment prior to it being developed and the data collected. This process ensures that the sensitivity of the data is well understood within the context of the Privacy Act and that appropriate safeguards are taken to protect the sensitivity of the data.

The nature of public health data is that it is very private when dealing with records of individuals. It is also the nature of the data that while it tends to be collected at the individual level, it is most frequently used in an aggregated manner. Once data is

[55] http://www.phac-aspc.gc.ca/php-psp/information_sharing_practice-eng.php
[56] Treasury Board Privacy Impact Assessment Policy, http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=12450
[57] Health Canada Privacy Impact Assessment (PIA) Tool Kit – Nov. 2006

aggregated to a level that an individual cannot be identified from the data set, then the privacy issue is removed from the data thereby removing the privacy constraint from sharing. As a result, the mechanisms to protect the data is primarily a concern at the point of data collection where stringent measures need to be put in place to protect the data, to fully inform the individual as to why the data is being collected and to seek permission to use it beyond the immediate purpose for which it is collected.

Most organizations that are sharing large volumes of data have the mechanisms in place to protect the data both within their organization and in sharing it externally and if it is a federal organization then they have undergone a privacy impact assessment to determine under what conditions the data can be shared.

Need-To-Know

Several organizations need-to-know that the data they are sharing will be adequately protected by the user and their organization as well as wanting to know how the data is being used to ensure it is not being used inappropriately. There is often a concern by Data Custodians that the data will be misinterpreted or used inappropriately in an analysis.

The issue is that once the data has been released by the Data Custodian the security of the data is now dependent upon the policies, procedures and security mechanisms of the recipient organization. All the agreements and security mechanisms put in place do not replace the basic need for the Data Custodian to trust that the data recipient will respect any agreements associated with the data and treat it accordingly. To gain this trust the data provider generally want to know how the data is to be used, who will have access to it, what security mechanisms will be applied to the data and what are the policies and training requirements of the requesting organization.

For this reason many organizations require Data Consumers to submit a formal application for access to the data. The types of questions may include elements of the following:

- Name, address, organization, department, contact information of the applicant;
- Professional status (Dr., etc.) and member number of the applicant;
- Specifics of the data requested (data set, data attributes, areal extent);
- How is the information to be used;
- Who will have access to the data;
- Who is ultimately responsible for the safeguarding of the data in compliance with any agreements and metadata related to the data;
- For the organization accountable for the request, what safeguarding policies, training and mechanisms are in place; and
- Have you requested data in the past.

If Data Consumers are requesting access to private data they need-to-know such data is formally assessed before any sharing agreements are implemented.

4.4.2 Approaches to Sharing Data

This section identifies various mechanisms that can be used to support the distribution of PH geospatial information to qualified users.

Data Custodians sharing geospatial public health data may use mechanisms to ensure data is shared and used responsibly including:

- Instruments such as Agreements and Licences;
- Anonymizing the geospatial data by creating a new data product that has the privacy aspects removed or altered;
- Metadata defining security to be applied to the data; and
- Training of data owners and users to ensure data is appropriately handled and a trusted relationship is ensured.

In practice a combination of these mechanisms are generally used to ensure the overall protection of the shared data is maintained.

Overview of Instruments Types

Instruments include agreements and licenses that are formalized between an originator and receiver of geospatial data and sets out the terms and conditions for the protection of the data. The following information has been drawn from the "GeoConnections Dissemination of Geographic Data Best Practices Guide" [58] which describes the instruments in detail and has templates for the different instruments in its appendices.

Agreements

Federal government departments and agencies routinely enter into arrangements between themselves governing collaboration on matters of mutual concern or interest. Such arrangements are described in informal agreements, known variously as "gentlemen's agreements", "handshake agreements", memoranda of understanding (MOUs) or memoranda of agreement (MOAs). The terms MOUs and MOAs are used interchangeably in the Government of Canada context.

MOA is the general term used to refer to an agreement that is not intended to have any legal effect, and it is the preferred vehicle to evidence arrangements between federal departments and agencies to exchange information, cooperate or coordinate programs to optimize the benefits from each department's efforts. As opposed to a legally binding agreement (such as a licence) it only describes general cooperation procedures.

[58] The Dissemination of Government Geographic Data in Canada: Guide to Best Practices, GeoConnections, version 2, 2008
http://www.geoconnections.org/publications/Best_practices_guide/Guide_to_Best_Practices_Summer_2008_Final_EN.pdf

Licences

Licences are used by Federal Departments/Agencies when entering into data use arrangements with other levels of government or non-governmental organizations. Such arrangements should be evidenced by a legally binding licence agreement.

The key characteristics of four (4) license models are:

- **Unrestricted Use** - promotes wide use and re-use of the licensed geographic data, with few restrictions on how the data may be used and allows for further distribution;
- **End-Use** - provides for a more restricted grant of rights, with no rights to redistribute. The end-use model is appropriate in instances where the producer of the geographic data wishes to grant access to its data while retaining control over the number of users and the manner in which it is used and where there are confidentiality and security concerns;
- **Reseller** - appropriate where the stated dissemination objective of the producer of the geographic data is to enhance dissemination opportunities and to promote wide use of its data through established distribution channels. The reseller does not, as a matter of practice, deploy significant intellectual effort in transforming the geographic data; and
- **Value-Added Reseller** - allows the value-added reseller to develop and distribute products and services that incorporate the licensed geographic data, thus enhancing its market penetration, user uptake and revenue generation potential.

Methods of Anonymizing the Data

An alternative to denying access to safeguarded data is to anonymize the data and still retain the overall knowledge of the source data in the end product.

There are three main means of removing the sensitivity in environmental geospatial data:

- Aggregate or statistically summarize data;
- Generalize (randomize) the spatial locality or geo-code; and
- Modify or remove attribution (i.e. those columns/fields that are sensitive)

The most common means of anonymizing public health data is by aggregating or statistically summarizing data by bringing multiple features together within a larger framework in order to obscure the details. Common approaches include amalgamating data higher up the chain of a hierarchy than the level at which the data was collected. For instance reporting at a Census Sub Division level (polygons) rather than at a Postal Code (smaller polygons) or civic address (points) level. How many levels up the hierarchy the data must be amalgamated may be dictated by the sensitivity of the data.

Disseminating data collected during the national census by Statistics Canada presents the same challenges faced by public health practitioners wanting to reveal their analysis results. Private information must be aggregated to a level such that an individual's information cannot be re-identified after the aggregation has taken place. For instance, if the spatial aggregation areas were too small, large spikes in values (e.g. income) may allow someone to be identified by cross referencing other information (e.g. the size of home they live in). For this reason Statistics Canada uses a census geography layer known as Dissemination Areas (DA) (formerly known as Enumeration Areas or EA) to spatially aggregate their socio-economic data for dissemination purposes. Moreover, unlike the predecessor EA boundaries that changed significantly with each census, Statistics Canada intentionally manufactured DA boundaries so that they would remain constant as much as possible. This allows for easier spatial-temporal research to be conducted.

A GeoConnections sponsored project focused directly on the subject on anonymizing data. The project, led by Dr. Khaled El Emam, principal researcher at Electronic Health Information Laboratory (EHIL) within the CHEO Research Institute, is producing the Guidelines for Anonymising Geospatial Data for Health Applications. The project description is DP-1 in Section 3 and Appendix B.

In addition to the guide, the results of this project have recently been commercialized as a product by Privacy Analytics Inc. The product, known as Privacy Analytics Risk Assessment Tool (PARAT), is aimed at removing the guesswork of re-identifying information. According to their website, “Using peer-reviewed techniques, PARAT measures and manages re-identification risk. Only PARAT can protect against all known types of re-identification attacks. It optimally de-identifies information to protect individual privacy while retaining the data's value. ...PARAT allows you to easily and safely disclose your valuable data”.

Metadata

Metadata is commonly known as “data about data and services”. It is the data describing context, content and structure of records and their management through time. It describes the data including details about data ownership, quality, time of collection or update, attribute information and how it can be accessed and obtained. Metadata is essential for understanding the data product and knowing its purpose or limitations and is an essential element in ensuring that data recipients understand the data limitations and reduces the chance of misinterpretation or miss use in an analysis.

Training

There are two aspects to the training of people in the protection and appropriate use of public health geospatial information. There are those that originate the content and those that utilise the content.

Those responsible for originating content are required to be trained in the method of assessing sensitivity as the process begins with them. They need to understand the policies and legislation governing their organization in order to appropriately define whether the data is sensitive and they need to understand the methods by which the data may be changed in order to assess whether this is a viable approach to removing sensitivity from the data.

Those that utilize the content must be trained in how to manage and safeguard the content within their organization and how to represent it in any resulting derived products.

This is critical as any misuse of the data can destroy the trust between organizations and likely result in more stringent restrictions being imposed on the data going forward.

5 INSTITUTIONALIZING GEOMATICS

For geomatics to progress and achieve traction within public health organizations the mindset must shift such that the use of geographic information and technology is viewed as a fundamental operational requirement and included in operational budgets rather than as a seemingly useful tool funded on a case by case basis. Concepts on how to achieve this evolution is the subject of this section.

5.1 Raising Awareness

Geomatics software and data standards have matured such that it is rarely technology or data that is the barrier to implementing a geomatics solution. Research consistently indicates that the single most important objective to realize the tipping point of institutionalizing geomatics in organizations is to raise awareness and support at the senior management level regarding the potential of geomatics in public health. For those that have geomatics background, recognizing the potential of adding the spatial dimension to problem solving is second nature. However, our research clearly confirms that senior management in most public health organizations do not share this same understanding or appreciation.

A common element of the public health geomatics projects that have been most successful has included a coordinated effort to educate senior management. A good example of strong management support for public health geomatics initiatives can be found in Saskatoon Health Region's budgeting commitment to geomatics, resulting in a number of thriving public health geomatics initiatives. GIS capacity at the Region's Public Health Observatory is being used to support a variety of projects and initiatives including:

- Health status reporting;
- Epidemiologist support;
- Program utilization reviews and planning;
- Support for Health Promotion and Healthy Growth; and
- The Community Comprehensive Information System (CCIS)[59]

There is no single methodology proven to be successful in raising awareness to senior management. However, from the project review sessions and workshops, as well as drawing upon standard information management and information technology practices, some key aspects are integral to success.

For instance, identifying a ***Champion*** within an organization is a common characteristic of initiatives that achieve success. The champions must have the respect and drive within an organization to influence senior management to provide support. They are able to recognize and articulate how geomatics fits within business processes, as well as the potential of applying geomatics technology and spatial information such that it will directly improve the organization's business outcomes.

59 http://www.saskatoonhealthregion.ca/your_health/ps_public_health_pho_work_areas_geographical_info.htm

Another key individual is the ***Executive Sponsor***. By focusing awareness and business improvement potential on one or more senior management members and obtaining their commitment, the likelihood for a geomatics initiative to be approved and/or sustain traction is greatly improved. Executive sponsors can articulate the messages amongst the decision makers and ideally have the budgetary authority to leverage at least the development of the business case for geomatics.

Champions recognize the importance and potential of geomatics but often have very limited resources (e.g. reference material, hardware, software, data and time) to build their case. One of the techniques identified during workshops is to ***market the potential of geomatics with low cost maps that bring powerful messaging***. One stakeholder indicated that they secured significant funding by presenting maps at every opportunity to senior management and effectively explaining how the map information could impact the business outcomes if applied internally. One stakeholder described maps as a thousand pictures each worth a thousand words. Another point raised during the workshops was that having a map that illustrates new information that could not be derived in a strictly tabular form provides for the most impact on the viewer. Seeing a relationship that can only be realized by applying a spatial lens is a very powerful message. Explaining how that information can be applied in an operational environment is fundamental to closing the awareness gap.

The key message is to ***focus on how the geospatial information fits within, and benefits, specific existing business processes***. Presenting geomatics as a general use tool will shift focus of the discussion towards technology and costs.

5.2 Meeting the Business Requirements of Public Health

5.2.1 Business Planning

Whether seeking funding for a one-off research project, developing an application for a regional user base, or implementing a geomatics program to support public health efforts province wide, the business plan is an essential step in this process. The type of business plan forged depends on the scope and scale of the envisioned initiative and whether multiple organizations are involved. For instance, the content of the business plan may be as brief as a statement of work defining the scope and financial and time constraints of the small project. However, in larger projects, a strategic plan may be required and/or a business case that articulates business objectives to be addressed, implementation and maintenance costs and time frames, major deliverables, and - equally important – benefits and success factors. Regardless of the size of the project, a ***well crafted business plan is important in gaining acceptance*** beyond the executive sponsor and securing funding.

Although the costs involved with a proposed geomatics initiative are not terribly difficult to define and estimate, according to a Geospatial Information & Technology Association (GITA) report ("Building a Business Case for Geospatial Information Technology: A Practitioner's Guide to Financial Strategic Analysis"[60], March 2007), identifying benefits and estimating there financial impacts is a tricky task for most managers. Moreover, those tasked with this responsibility are perceived as promoting the project and thus their

[60] Available through the GITA website - http://gita.org/roi/

financial benefit estimates are carefully considered by decision makers; especially considering the initial development costs are often high. Referencing the GITA report, managers can leverage the appropriate principles and concepts derived over several years of experience and research.

With a business plan in place a tool is created to share a common understanding of the business potential of the initiative; large or small. This information represents a milestone in most projects whereby a go or no-go decision is made by senior management. Another advantage to documenting the plan is that if the initiative does not receive approval, characteristics upon which the no-go decision was based can quickly change (e.g. a sudden appearance of an infectious disease such as SARS or H1N1) and the plan can be easily re-instated.

Although every business and jurisdiction has its differences, the business strategies and business cases deriving from the GeoConnections funded projects (see Section 3) can be leveraged as templates and idea generators for those seeking to develop a business plan.

Experience shows that many project failures can be linked to poor communication in terms of business requirements and a lack of measurable success factors. Failure is often attributed to a lack of understanding between the business justification for embarking on the project and the anticipated business outcomes.

Even for geomatics projects that are considered research in nature and represent a one-off result or solution (e.g. map and report), documenting the business purpose and plan to achieve the intended outcomes is beneficial to predecessors and receptors of the information.

5.2.2 Organizational Models for Geomatics Services

As part of the planning process, organizations must define how they are going to manage the delivery of geomatics services by considering such factors as the business processes being affected, the volume of work anticipated, the cost, and existing internal capacity to absorb the services, to name a few.

A key consideration is the relationship between geomatics and public health knowledge within the organization. It is essential that there is clear communication and understanding between these two knowledge sets. Models that organizations have used to deliver geomatics services include:

- Public Health **Subject Matter Experts** (epidemiologists, researchers, planners) who can employ their geomatics knowledge to processes data, analyze data and produce map products. In this model the work tends to be performed on an ad hoc basis with limited standards in place and the sophistication of analysis and reporting relies on the geomatics level of knowledge of the Subject Matter Expert;
- A **geomatics trained professional supports** a team of **Subject Matter Experts** to work collaboratively to processes data, analyze data and produce map products. In this model the work is more structured and at least local standards are in place to support coordinated use of data and techniques.

This model relies on the geomatics professional to be able to understand the modeling techniques, terminology and objectives of the public health sector;

- A **team of geomatics and information management professionals** provide a service to the organization to define business requirements, develop workflows, develop applications and data management processes, and support users in analyzing data and producing end products either as a regular production process or as ad hoc efforts. In this model the information management team works formally with the **Subject Matter Experts** to define the workflow processes in order to design and implement operational systems. This model relies on the information management team to be able to understand the modeling techniques, terminology and objectives of the public health sector. It also provides a structured and supported operational environment for the users; and
- Participate in a **network** that collaboratively provide a service to the organization to define business requirements, develop workflows, develop applications and data management processes, and support users in analyzing data and producing end products either as a regular production process or as ad hoc efforts. This model is similar to the previous approach except that the participating agency is not carrying the full cost and generally ends up with access to a wider set of tools.

The first two models are subject to failure when one or more resources leave the organization. This is because there tends to be little documentation of the tools and processes and there is not a critical mass of knowledge in the organization which may be exacerbated by replacement personnel who do not have the required geomatics expertise. The second model is more stable as long as the geomatics expertise is retained.

The last two models ensure the depth of knowledge is available and that processes are well structured and documented, allowing for new resources to learn the system architecture. However, the information management team approach requires a large and sophisticated organization to support such an infrastructure.

The Network approach allows for costs, knowledge, techniques and tools to be collaboratively developed and shared across multiple organizations. There are two network models that have been recognized, one is Subject Matter Centric and the second is Geomatics Centric.

In the Subject Matter Centric approach the focus of the network is on public health information management in which geomatics is recognized as an enabling technology.

In the Geomatics Centric network, the expertise of the network is first and foremost geomatics and is serving a larger community of interests than just public health. These networks work across sectors and benefit from the sharing of data and techniques from various disciplines (municipal, natural resource management, utilities, etc.). Examples of this model include Ontario's Sault Ste Marie Innovation Centre (www.ssmic.com) and British Columbia's GeoBC (www.geobc.gov.bc.ca) initiative.

5.2.3 Building Capacity

Capacity is also consistently seen as a factor to impeding the uptake of geomatics within organizations. Most stakeholders interviewed had access to very limited resources or relied on their own weak understanding of geospatial analysis. One stakeholder noted that a significantly greater amount of capacity exists amongst the public health research community than public health practitioners supporting operational uses but even so the real numbers of individuals was still very low.

For organizations to be successful they must invest in building the capacity of both primary users to make use of, and understand the outputs of, the applications that they adopt, and those with geomatics expertise to address ad-hoc requests and research projects taking advantage of the full suite of geomatics tools available to them.

Several GeoConnections funded user-centered projects identified in Section 3 provide excellent examples of effective capacity building approaches. The key requirements from a user perspective are to introduce applications that meet their needs, awareness of the benefits, ease of use, sufficient training (including basic geomatics concepts) and technical support. Training of users is an ongoing need for increased understanding of the CGDI and public health mapping applications. There is a learning curve, requiring demonstrations, presentations, and training sessions to familiarize end users with applications, the underlying spatial analysis capabilities and services.

For those requiring more advanced geomatics skills, it was noted during the workshops that there is very little in the way of even introductory geomatics courses offered in any post secondary public health curriculum. Examples of universities that do make the link are McGill University and University of Manitoba which both teach public health geomatics courses of an advanced post graduate level. The only broader spectrum GIS course curriculum identified that focused on public health was Population Data BC. According to their website Population Data BC is a multi-university, nationally active and recognised data and education resource facilitating interdisciplinary research and teaching on the determinants of human health, well-being and development.[61] Although their curriculum targets public health researchers, their curriculum includes fundamental geomatics concepts valuable to a broader audience.

There are also tangential groups whose interests should be accounted for. These are occasional or low priority users, non-users who may be affected by use and stakeholders who are not direct users but may have an interest in a site or product such as: [62]

- Delivery staff;
- Managers; and
- Planners.

[61] www.popdata.bc.ca
[62] Environmental Health Systematic Review, Laval University, November 30, 2007

5.3 Technical Assistance

This section provides the reader with connections to and examples of valuable resources and insight to assist in the successful implementation of geomatics initiatives.

5.3.1 Development Methodologies

For those looking to deliver geomatics services to their organization, history has shown that success is most often achieved when a methodology has been adopted to ensure the implemented service meets the original business requirements and users' expectations.

Several information technology based development methodologies exist today. The traditional waterfall approach popular in the 1980's attempts to gain all user input upfront, is document heavy and does not respond well to changing user needs. Newer methodologies focus on an iterative development methodology that ensures the end user is engaged throughout the development life cycle and relies heavily on user feedback of frequent pre-releases to guide effort. This newer approach seen in methodologies such as IBM's Rational Unified Process (RUP), Agile and Extreme Programming ensure the end-user is integral to defining the solution which has been accepted as a much more likely technique to achieve success in systems or application development.

The approach of defining requirements up front and iterative development are supported by GeoConnections. Published on the GeoConnections website is a document entitled "Understanding Users Needs and User-Centered Design" (www.geoconnections.org/publications/Key_documents/UNA_UCD_Guide_V4_eng.pdf). This document guides the user through essential steps in capturing requirements that address business objectives to focusing on iterative user input to guide the design of tools. GeoConnections feels so strongly that a user centered approach is the correct path to success that they require that funded development projects adhere to the guidelines in this publication.

Fundamentally the importance of having and embracing a development methodology is more significant than which methodology is chosen.

One example of the importance of using a methodology is the New Brunswick Lung Association web portal project. The project struggled until a methodology was put into practice which allowed the team to regain control of the project, clearly communicate requirements, define system functions and execute the application development.

For those that have managed to develop geomatics applications for operational use it is also worth noting that part of the methodology should include a step to ***proactively seek user feedback*** on the usefulness of the application. According to the survey results feedback was usually gathered in a passive manner.

5.3.2 Standards

The need for data and application sharing highlights the importance of interoperability standards for visualizing, accessing and describing geospatial data in facilitating information sharing between agencies. There is proof that interoperability standards enhance public health research.[63] For instance, a public health agency that uses location-based information to map the spread of a disease will be better prepared to predict the disease's physical course and its rate of spread. And, health officials will be better equipped to deal with the disease and minimize its effects than they would be without these resources.[64]

Canadian Geospatial Data Infrastructure (CGDI)

By using international standards endorsed for the CGDI for instance, an organization can share and integrate data or applications with those from other organizations. In fact, by adopting standards new data sets can be added to a system without having to develop additional functions to process each new data set. This characteristic offers two main advantages. First, interoperability will often produce richer and more useful information than a single data set can provide on its own. Consequently, the value of data or an application rises. And second, the exporting of technology, data, and expertise to other countries is more likely to occur.[65]

With respect to the public health geomatics community, with the constraints of funding, software, data storage, and skilled resources, it is even more important to embrace the CGDI standards to leverage data held by others and offered as a CGDI endorsed mapping service (e.g. Web Mapping Service). By doing so, the cost of data storage, data maintenance and service delivery is incurred by the Data Custodian.

One example of a successful implementation of these standards is the New Brunswick Lung Association's web map portal. This web site uses Web Mapping Service (WMS), Web Feature Service (WFS) and Web Processing Service (WPS) services for:

- thematically viewing program data, health & environmental data, and base map layers (for visual referencing);
- spatially referencing health and environmental information, at different geographic scales / boundaries; and
- modeling health information using various geo-statistical methods, on the fly (based on user-selected parameters), then integrating value outputs to geography and producing a thematic map

Based on this information, users could make better informed decisions about responding to chronic disease and pandemic influenza, as well as visualize the impact of our programs in New Brunswick. This application leveraged the CGDI as the backbone for the exchange of WMS/WFS (web mapping) services and geospatial data, with other service-providers in Canada, the US, and abroad. Moreover, the web services of the New Brunswick Lung Association have also been published to the CGDI, so that other health/environmental organizations can find and access the services, e.g. to view our maps in their map viewer.

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[63] http://www.eomag.eu/articles/665/enhancing-public-health-research-interoperability-standards-for-earth-observation-systems
[64] http://www.geoconnections.org/publications/General_information/public_health_english.pdf
[65] http://www.geoconnections.org/en/communities/developers/standards

Another good example of leveraging the CGDI standards is the newly released e-commerce web site known as MapSherpa (www.mapsherpa.com). Although not targeted at the public health community, this new site demonstrates how national framework spatial data available free of charge through NRCan and other non-NRCan source data published via CGDI standards, can be consumed by this web application and offered to its users via a single web based user interface for producing custom maps. All of this is made possible through the use of CGDI standards and protocols such as the Web Mapping Service (WMS) CGDI endorsed standard.

More information and resources supporting the CGDI standards is available at www.geoconnections.org/en/communities/developers/standards.

Data and Metadata

Like the CGDI standards for sharing geospatial data and processes, standards for data content and describing data (metadata) are significant to bringing geomatics into public health organizations.

Most databases abide by some form of standards with the large national databases applying consistent standards. However one issue lies with small regional data sets not using the same standards as adjacent jurisdictions causing significant difficulties in integrating the information for comparison or analytical purposes.

Our research also indicates that many different overlapping data standards are used which when attempting to integrate various nomenclatures used by different organizations becomes a challenge. Coordination between these standards is lacking. The first priority is to specify a unified nomenclature and a common taxonomy (categories) based on the existing standards that will enable those interested in public health related data to first locate the required data quickly and secondly be able to integrate these data sets.

Such is the focus of the Public Health Geospatial Information Reference Framework project conducted on behalf of GeoConnections. The intention of this study is to develop a framework of common vocabulary to describe geospatial data in the context of public health. This framework has two major elements: a categorical scheme and an inventory of data sources. The categorical scheme proposed provides the structured terminology that, if adopted and maintained in the future, could effectively facilitate communication between data providers and data users. The inventory of data completed for this report is limited to national data sets at this time. However, this limitation was due to time constraints and not constraints within the framework. The framework has no limitations of geographic scale or jurisdiction to the data it supports.[66]

There are various data and metadata standards presently used and there is no one single standard used by all public health organizations participating in data development and sharing. Our research has identified the following organizations and data and metadata standards:

[66] Public Health Geospatial Information Reference Framework Data Categorization, Inventory & Standards Study Geospatial Reference Information Framework (DRAFT), September 9, 2009

Data Standards:

- Treasury Board Secretariat of Canada Policies, Standards and Guidelines[67]
- Statistics Canada[68]
- CIHI – Canadian Coding Standards[69]
- GeoBase[70]
- CGDI (Canadian Geospatial Data Infrastructure)[71]
- ISO/TC 211 Geographic information/Geomatics[72]

Metadata Standards:

- Federal Geographic Data Committee (FGDC)[73]
- ISO 19115 [74]

The Treasury Board of Canada Secretariat has recently established the Standard on Geospatial Data for the Government of Canada. The Standard on Geospatial Data supports the Policy on Information Management and the Policy on the Management of Information Technology of the Government of Canada. The Standard will facilitate interoperability across institutions and increase their ability to identify, understand, use, and share geospatial data. This standard also allows institutions to maximize the reuse of existing mapping and related products.

The scope of the standard currently comprises two ISO standards: ISO 19115 Geographic information - metadata and ISO 19128 Geographic information - Web map server interface. For use in the Canadian Geospatial Data Infrastructure (CGDI) the national GeoConnections program has previously endorsed both standards.

The standard came into effect June 1, 2009, and federal Departments will have until May 31, 2014 to fully implement the standard.

Further information on the standard is available from the Treasury Board of Canada Secretariat: http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=16553&section=text. Federal government departments can access additional implementation guidance on the standard at: http://www.gcpedia.gc.ca/wiki/Standard_on_geospatial_data.

More information and resources supporting the Government of Canada Standard on Geospatial Data is available at:
http://www.geoconnections.org/en/communities/developers/standards/gc75

67 http://www.tbs-sct.gc.ca/cio-dpi/pols-eng.asp?who=/cio-dpi/
68 http://www.statcan.gc.ca/mgeo/index-eng.htm
69 http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=news_dir_v10n1_icd10_e
70 http://www.geobase.ca/
71 http://www.geoconnections.org/en/communities/developers/standards
72 http://www.isotc211.org/
73 http://www.fgdc.gov/
74 http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=26020
75 http://www.geoconnections.org/en/communities/developers/news/getDoc=872

5.3.3 Vendors and Consultants

Vendors and consultants are sources for technical assistance and can add significant value towards successful implementations of public health geomatics. They tend to be used to provide specific expertise that is lacking in the organization and to supplement the internal team for defined periods of time and pieces of work.

Vendors

The role of vendors is to provide their clients with the technology and resources to implement the services they require to meet their business requirements. They deliver tangible products such as:

- Software;
- Data;
- Hosting services; and
- Training.

Vendor presentations, user conferences and in-office demonstrations are an effective means of gathering information on how to utilize geomatics technology. Vendors also have considerable knowledge of common and sector specific data sets that can benefit your analysis. Moreover, user groups associated with many software vendors allow collaboration on questions, ideas, and how to resolve technical issues.

With the capacity of GIS skills in the public health community so low, vendors can and should be considered if and when the solution required involves customizing the vendor product(s) via an application programming interface (API) for developers.

Another advantage of including vendors in the geomatics implementation plan is that they will sometimes offer software and/or services as in-kind contributions for competitive and non-competitive reasons. For example, without in-kind contributions from the software vendors, the New Brunswick Lung Association project would not have been able to go forward with their project.

Vendors also offer training in their software for both introductory and advanced users. However, those that benefit most from these courses are those that make use of the software regularly. Courses tend to be practical in nature rather than stressing the theory as most customers expect.

In addition to the numerous organizations that deliver purely consulting services most vendors supplement their product services with consulting services.

Consultants

An advantage to employing a consultant is that they can assist in determining what technology best meets the needs of an organization. With respect to software decisions, vendors will naturally be biased towards their own products, whereas a consultant can remain vendor neutral and suggest one or more technical solutions possibly from different vendors or a combination of open source and commercial off-the-shelf offerings.

In terms of conducting business planning, consultants can facilitate the definition of business requirements and calibrate expectations regarding outcomes. If an internal resource attempts to lead the same business requirements gathering process, they are sometimes met with cynicism believed by other stakeholders to be pushing their own agenda rather than looking out for the best interest of the business.

Additional value added from consultants is to mentor and provide guidance when formulating business plans, eliciting business requirements and developing business cases. Consultants should provide a methodology and ensure the appropriate steps in the process are followed.

Consultants are often more niche focused than vendors and so it is important to recognise the focus that would best serve a particular organization's need. Is it:

- Strategic planning and requirements definition;
- System architecture;
- System Design, Development and Implementation;
- Maintenance and Support;
- Data loading and QA; and / or
- Public Health

5.3.4 Support Networks

The importance of knowledge sharing and collaboration in general and public health geomatics in particular is well known and is important to successful implementations. Some collaboration activities presently used by public health geomatics professionals include knowledge-base portals, networking, education, support, conferences and workshops.

Organizations can benefit by referring to the successes of others as they make decisions about applications to meet their needs. By focusing in this way, managers, planners, designers and developers have a quick reference to use to explore opportunities to improve their geomatics activities. Public health organizations routinely enter into arrangements between themselves governing collaboration on matters of mutual concern or interest. These agreements pertain to sharing technical expertise, costs of data, software and hardware infrastructure. This is especially true for the members of smaller public health organizations and stakeholders.

The GeoConnections Public Health Portal[76] promotes sharing and use of data, applications and best practices and showcases a number of successful public health geomatics applications.

[76] http://www.geoconnections.org/en/communities/publichealth/index.html;jsessionid=E8899A3ACD280442726F913667F8866C.app2

The CGDI (Canadian Geospatial Data Infrastructure) offers the public health community two main advantages. First, public health professionals can use geospatial data and the CGDI for analysis and decision making, bringing geographic and temporal aspects to the study of public health issues and approaches. And second, by providing access to a network of databases over the Internet, the CGDI assists health jurisdictions throughout the country to interact and share data more efficiently and securely.

There are many geomatics applications within the Public Health Agency of Canada (PHAC) that are used in consultation and collaboration with provinces and territories on outbreak management, health promotion, emergency management, etc. Surveillance is the main line of business where geomatics is used, but there are also some examples of analytical and decision making applications. The Public Health Map Generator is a spatial epidemiological tool that uses geomatics.[77]

Internationally, EUPHIX is a web-based knowledge system for health professionals, policy makers and others. It presents structured European public health information, giving a special insight into similarities and differences between EU Member States.[78]

5.3.5 Software

A decision regarding which geomatics software to use is a decision that has implementation impacts regardless of whether the decision is to use commercial off the shelf (COTS) software purchased from a vendor, or open source (OS) software that is free to use.

The survey (see Figure 5-1), project reviews, and workshop sessions confirmed that COTS is the most common approach followed closely by a combination of COTS and OS software coexisting as part of the solution and to a limited extend a pure OS environment.

COTS software is felt to be the only alternative for some users yet in other circles, such as academic and scientific institutions, OS is preferred. Some of the reasons cited by respondents of the survey for preferring OS included the cost savings, importance of non-alignment to a specific software vendor and freedom from licensing. They prefer the flexibility to modify if required, the efficacy and the essential openness of the collaborative OS community. A good example of this is the course offerings provided by Population Data BC whereby all course expect the students to use OS software.

Others argue that open source is not practical in their case citing a lack of direct technical support, richer out-of-the-box functionality, preconfigured applications, stable products and defined product development schedules for COTS. Moreover, the pool of knowledgeable resources to use and/or customize, if necessary, OS software is arguably smaller than with some of the more popular COTS software.

As mentioned above, however, some projects (e.g. New Brunswick Lung Association web mapping project) use a combination of OS and COTS software. Some geomatics users prefer to use COTS software (if available) to manage and maintain spatial data as well as conduct spatial analysis, yet rely on OS software tools (e.g. Minnesota Map Server) for

[77] http://www.geoconnections.org/en/aboutGeo/successStories/id=1243
[78] http://www.euphix.org/object_document/o4581n27010.html

presenting maps over a web based interface thus taking advantage of the strengths of both types of technology.

There are really no hard rules on which type of software should be adopted and it is important that the advantages and disadvantages of each be understood and considered when planning geomatics implementations.

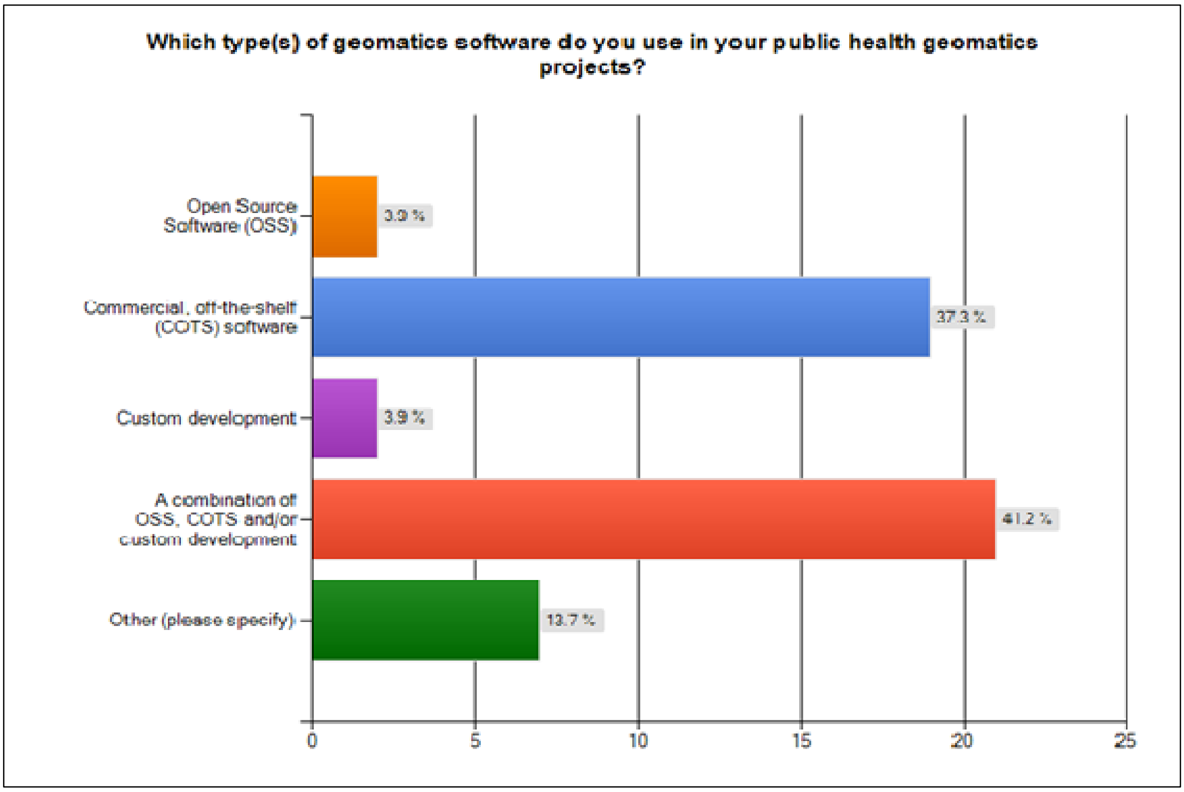


Figure 5-1: Survey Result – Geomatics Software Types Used

5.3.6 Existing Custom Applications

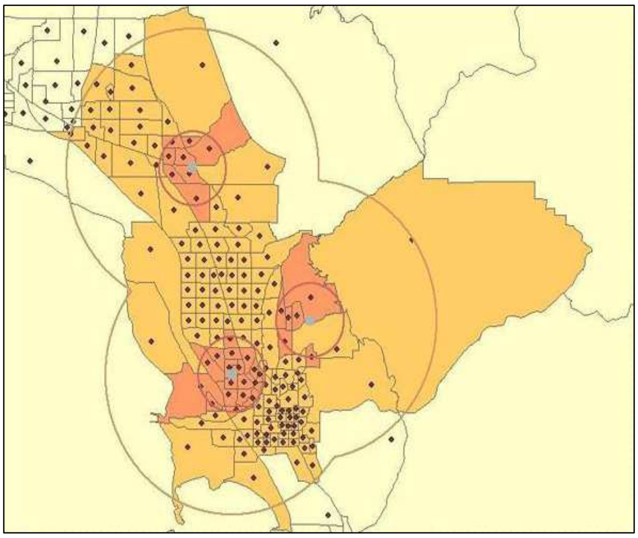
While the ad-hoc use of out-of-the-box functionality or preconfigured applications satisfy many organizations' requirements, others require more sophisticated applications to meet their operational requirements. Several public health geomatics based custom applications have been developed around the world with varying degrees of user uptake. Some of the applications developed through the GeoConnections funded projects are good examples.

For those requiring more than an out-of-the-box solution to meet specific needs, it would seem natural to take advantage of others accomplishments as a cost effective and efficient approach (assuming they are willing to share) to implementing a solution. At a conceptual level this makes logical sense. However, unless the application was designed to be portable, in practice there are usually so many differences with the application, available data, and technical environment regardless of the common desired end result, taking the application as-is and "plugging it in" to another organization's environment is not simple and in many cases not even a feasible exercise. A small set of the issues that may arise include:

- Lack of similar data;
- Differing data formats;
- Technology to be deployed is not supported within the target environment; and
- Conflicting business rules (e.g. data privacy legislation).

This is not to suggest, however, that reviewing the applications and tools developed by others is not valuable. At a minimum the ideas, concepts, lessons learned, business logic, designs, costs and other aspects are all very valuable pieces of information to be mined and considered.

Figure 5-2: RIF Application Display



For this reason, the reader is encouraged to, at a minimum, review the GeoConnections funded projects summaries found in this document for the potential of re-use. If nothing else, lessons learned and the power of networking may provide valuable information.

On the other side of the spectrum there are cases where applications were designed for multiple deployments and are so similar that customizing it to fit and organization's technical, data and business environment is the best approach. Such was the case for Cancer Care Ontario (see Section 3 and appendix for detailed project review) when they were interested in a disease surveillance tool. This project was able to identify an application originally developed in the United Kingdom and re-use to meet their needs. The application was originally developed by the Small Area Health Statistics Unit (SAHSU) within the Department of Epidemiology and Public Health at Imperial College London, England. Known as the Rapid Enquiry Facility (RIF), the purpose of this application is to rapidly address epidemiological and public health questions using routinely collected health and population data (see Figure 5-2)[79]. Initially designed as a tool for SAHSU staff to analyse routinely collected health data in relation to environmental exposures in the UK, several European countries as part of the European Health and Environment Information System (EUROHEIS) project subsequently transformed RIF for their use. The US Centers for Disease Control and Prevention (CDC) and SAHSU are collaborating to adapt and enhance the UK RIF software for use in CDC's National Environmental Public Health Tracking (EPHT) Network. Ontario Long Term Care was able to adapt the version of the

[79] Source: http://www.sahsu.org/sahsu_studies.php#RIF

application that was currently being used by the CDC in the United States and has provided feedback and enhancement suggestions to the core development team.

5.4 Best Practices

As noted in Section 2.5 and throughout this document, challenges exist on several fronts (e.g. people, technology, and data) when bringing geomatics technology into public health organizations. And of course underlying all of these is a general lack of funding to support geomatics initiatives.

This section summarizes in no particular order some best practices targeted at combating these challenges. Some of these were discovered through the project reviews, the on-line survey, and the on-site and on-line workshops, while others are grounded in traditional software development practices and information technology where applicable.

5.4.1 General

Raise awareness of executive management on the potential of geomatics in terms of the benefits to business processes and resolution of hot issues. This step is fundamental to taking the process to the next stage of integration into the organization by securing funding to create business plans, proof of concepts, acquiring resources, etc.

Identify a champion to lead the effort of identifying business areas where geomatics can have a benefit on the business processes and outcomes. This resource must have sufficient understanding of geomatics, public health challenges and organization business processes to be able to marry technical geomatics solutions with business issues (perceived or otherwise). **Identify an executive sponsor** to provide senior management influence with the geomatics initiative.

Develop and document a business plan appropriate to the scale of the initiative. Having a business plan (e.g. strategic plan, business case, business requirements, user needs assessment), establishes the business justification for the geomatics initiative, defines budget requirements, and an implementation schedule. If not adopted immediately, documenting the plan preserves it for when circumstances change so that the plan can be re-used or modified accordingly.

Engage, collaborate and pool human and physical resources with partners. Standards associated with data and technology allow for sharing of physical resources to support geomatics efforts. Especially for the smaller regional and local health authorities with very limited resources and demand for geomatics services, pooling resources has proven to create a powerful and cost effective option.

Leverage consultants and vendors appropriately. With limited resources and both technical and business planning experience, using consultants to recommend and guide processes can be a cost effective and valuable experience. Moreover, using the resources of vendors for implementation and training can expedite the delivery schedule.

5.4.2 Application Development

Insist on adopting a software development methodology. Software development methodologies enforce a structured process that increases the likelihood of meeting the specified business requirements and user needs. GeoConnections' User Needs Assessment (UNA) and User Centered Design (UCD) are two components of a full system development life cycle methodology worth considering.

Research availability of existing applications/tools to meet needs. That is, if and where possible avoid recreating the wheel. Even if applications and tools are not readily portable to another technical environment, lessons learned and techniques used can be valuable information going forward.

Adopt and leverage CGDI standards and others that promote interoperability. Adopting standards such as those defined within the CGDI allow for interoperability, maintenance of data closest to source, and ultimately lower costs of acquiring, maintaining and storing data to support applications.

Document applications / tools. By documenting the application (e.g. business purpose and outcomes, data sources, technology used, geospatial analysis techniques adopted, data sensitivity concerns) others may be able to re-use the application or gain insight into techniques they may be able to adopt into their own applications, further encouraging the collaboration and knowledge sharing. Most importantly it retains the system knowledge within the organization.

Focus on single application area of high interest. Targeting a smaller application scope initially that has a significant and measurable impact on the business is an effective means of obtaining substantial success and securing additional funding.

5.4.3 Additional Best Practice Resources

Additional noteworthy sources for best practices discovered during the research phases are listed in the table below.

Title	Description	Reference
BC Environmental and Occupational Health Research Network GIS Group Wiki!	Members of the BCEOHRN GIS Peer-to-Peer/Mentoring Group are invited to use this tool for sharing articles. Feel free to explore the capabilities of this wiki below.	http://bceohrngis.pbworks.com/Best-Practices
Population Data BC	Population Data BC, a multi-university platform, is BC's first pan-provincial population health data service. They provide researchers with timely access to data and training to address research questions on human health, well-being and development.	http://www.popdata.bc.ca/etu/bestpractices
ESRI Inc.	A Best Practice report on Early Detection and Response to Infectious Disease.	http://www.esri.com/library/bestpractices/early-detection.pdf

The Dissemination Of Government Geographic Data In Canada: Guide To Best Practices	GeoConnections sponsored report provides various models for sharing geographic data.	http://www.geoconnections.org/publications/Best_practices_guide/Guide_to_Best_Practices_Summer_2008_Final_EN.pdf

Table 4: Additional Best Practice Resources

APPENDIX A – ACRONYMS

Acronym	Definition
APHO	Association of Public Health Observatories (UK)
API	Application Programming Interface
CDC	Center for Disease Control
CGDI	Canadian Geospatial Data Infrastructure
CHEO	Children’s Hospital of Eastern Ontario
CIHI	Canadian Institute for Health Information
CPHA	Canadian Professional Health Association
DSS	Decision Support System
FSA	Forward Sortation Area
GIS	Geographic Information System
GITA	Geospatial Information & Technology Association
GPS	Global Positioning System
ICES	Institute for Clinical Evaluative Sciences
IHA	Interior Health Agency
IM	Information Management
IT	Information Technology
INSPQ	Institut National de Santé Publique
IRIS	Infostructure de Recherche Intégrée en Santé
MOHLTC	Ministry of Health and Long Term Care
NHS	National Health Service (UK)
NPHS	National Population Health Survey
NRCan	Natural Resources Canada
OAHPP	Ontario’s Agency for Health Protection and Promotion
OGC	Open GIS Consortium
PCCF	Postal Code Conversion File
PHAC	Public Health Agency of Canada
PHO	Public Health Observatory
SAHSU	Small Area Health Statistics Unit
SFU	Simon Fraser University

Acronym	Definition
SSMIC	Sault Ste. Marie Innovation Centre
VCHA	Vancouver Coastal Health Authority
VIHA	Vancouver Island Health Authority
WFS	Web Feature Service
WHO	World Health Organization
WMS	Web Map Service
XML	Extensible Markup Language

APPENDIX B – SUMMARY OF REVIEWED GEOCONNECTIONS PROJECTS

GeoConnections has funded more than thirty geomatics projects in support of geomatics in the public health sector. These projects can be grouped primarily into six clusters – the determinants of health, disease surveillance, health emergency response, comprehensive geomatics programs, user-centered and health human resources.

AMEC reviewed a select group of these projects to gain insight into project challenges, lessons learned and national significance of each project. Project documentation was reviewed by the project team followed by interviews with key project personnel to validate, clarify and gain further perspective into their projects.

The fourteen projects selected for more in-depth review intentionally represent a cross-section of geographical jurisdictions and organization type (e.g. government, NGO, regional authority and academia). The following table lists the projects reviewed by category.

ID	Category/Project Name	Jurisdiction	Organization	Completion Date
	Determinants of Health			
DH-1	Development of a Web Application and Services within the CGDI framework for Community Health Program	New Brunswick	NGO	March 2008
DH-2	Ontario Health and Environment Information System	Ontario	NGO	June 2008
DH-3	Spatially Enabled Population Health Framework for Disease Surveillance	British Columbia	Provincial government	August 2007
DH-4	User Needs Assessment with Respect to Mapping of Air Quality Index in Ontario	Ontario	Academia	July 2008
	Disease Surveillance			
DS-1	Using Real-Time Spatial Information to Manage Communicable Diseases	Quebec	Academia	March 2008
	Health Emergency Response			
HE-1	Geospatial Mapping of Respiratory and Gastrointestinal Hospital Visit Data through a Regional, Real-time, Emergency Department Surveillance System	Ontario	Public health unit	January 2009
HE-2	UNA – GIS web-enabled DSS for Animal Emergencies	Manitoba	Provincial Government	December 2008
	Comprehensive Geomatics Programs			
CG-1	Strategic Planning for Capacity Development In Public Health Geospatial Information Systems	Newfoundland and Labrador	Regional health authority	February 2009
CG-2	Developing a Shared Strategic and Business Plan for the Calgary Consortium	Alberta	Regional health authority	September 2007
CG-3	Strategic Plan for Health GIS Implementation in BC: Focus on Health Surveillance	British Columbia	Provincial government	April 2008
CG-4	Defining the Strategic and Business plans for An On-line Mapping portal To Monitor Neighbourhood Level Population Health Using the CGDI	Ottawa	Social Planning Council of Ottawa	
	User-centered			

U-1	Infectious Disease Simulation Tool – A Geospatial Decision Support System – User Needs Assessment	Ontario	Public health unit	June 2008
U-3	GIS Capacity Building and User Needs Assessment Project	British Columbia	Regional health authority	May 2009
	Health Human Resources			
HHR-1	Ontario Health Service Provider Maps (OHSPM)	Ontario	Provincial government	

DH-1 – Development of Web Application and Services within the CGDI framework for Community Health Programs of the New Brunswick Lung Association

Development of Web Application and Services within the CGDI framework for Community Health Programs of the New Brunswick Lung Association

Project Id:	68122 (DH-1)
Project Category:	Determinants of Health
Project Sponsor:	New Brunswick Lung Association (NBLA)
Collaborators:	CARIS - initial vendor
	ESRI Canada – concluding vendor
	University of New Brunswick - Geodesy and Geomatics Engineering and Computer Science faculties
	New Brunswick Public Safety, Emergency Measures Organization
	National Research Council – Institute for Information Technology
	Public Health Agency of Canada – CEPR
	Open Geospatial Consortium
	A-Maps Environmental Inc
	Quebec Lung Association
	University of Southern Maine
	University of Michigan, School of Public Health, Department of Epidemiology
	National Center for Atmospheric Research, Environmental and Societal Impacts Group
Contact	Eddie Oldfield
	65 Brunswick Street, Fredericton, NB, E3B 1G5
	Telephone number: 506 455-8961
	Fax number: 506 462-0939
	Email address: eddie.oldfield@nblung.ca

Project Description

Purpose

To provide NBLA staff, researchers, respiratory health therapists, epidemiologists, and the general public with a user-friendly web application for the exploratory and descriptive analysis of respiratory health information, hypothesis-generation and decision-making.

This project addresses the need for a web mapping application and services in support of Community Health Programs of the NBLA, targeting respiratory health issues.

The objectives / outcomes stated for this project included:

- To implement applications to support analysis and discovery of geospatial data;
- To improve awareness and prevention of respiratory diseases in New Brunswick;
- To enable asset mapping for improved prevention and public education programs;
- To enable the exploration of disease distribution to seek possible explanations in factors linked to environmental, social, or geographic health determinants;
- To demonstrate NBLA's application and services to Lung Associations across Canada toward building a National Framework on Respiratory Health; and
- To promote the growth and enrichment of CGDI in the public health sector.

The services offered by this application include Respiratory Health Public Map Viewer Web and Processing Services for statistical models that render health data. These services will also allow for:

- Mapping thematic information with existing geo-layers.
- Conduct statistical analysis for visualization of health information. The statistical rendering of data would result in a map layer(s) with time component / sequence. Statistical methods would include Normalization and Clustering models.

Intended Benefits

The application and services developed in this project significantly enhance the NBLA's ability to work with the public health community to address respiratory diseases. It provides maps, graphics and tables for respiratory diseases as an effective tool for education and public awareness. The application and services in this project provide quicker access to geospatial data to understand trends in respiratory disease. Furthermore, it allows dissemination of this information efficiently to respiratory health professionals, educators, researchers, and policy makers. The application and services can help to identify the degree of support for populations affected by disease and where education or prevention programs are needed. As a result of accessing web map services in the CGDI, education and prevention programs can be targeted to populations that show a higher incidence of respiratory diseases, in geographic areas where the disease is most prevalent. This enables the measurement of the impact of programs and comparisons across geographic areas.

Information that provides the public with health-protective information will reduce the number of people affected by respiratory illness and therefore reduce costs to the health-care system.

Effected Stakeholders

User needs assessments

A questionnaire was used to survey and assess the GIS requirements of the end-user community, especially respiratory health professionals who may access the application and services for improving respiratory health among New Brunswickers. Participants of the survey included members of the research network, respiratory health professionals, government health authorities, health educators, emergency management personnel, and other professionals concerned with respiratory health issues.

As part of the implementation plan, NBLA conducted a User-Centered Design Process, fully engaging end-users in the design, development, and testing phases.

Users fall into three categories of experience in using GIS applications. The application and services were tailored to each of the three user-experience categories. The three categories are as follows:

General Public: No prior GIS knowledge, limited time, limited resources, requires basic visualization. The application must be quick and easy to use, at no cost. No advanced GIS functionality required.

Novice User: Basic knowledge of statistical analysis, knowledge of epidemiology, limited time, limited skills, limited resources, requires basic visualization. The application must be quick and easy to use, at no cost. User may require training / tutorials. No advanced GIS functionality required.

Experienced User: Knowledge of GIS, statistical analysis, epidemiology, requires visualization and advanced analysis capabilities for hypothesis generation and evidence-based decision making. The application must still be easy to use, at no cost. User may require training / tutorials.

User Evaluation

The NBLA conducted the usability test with participants at the NB Emergency Operations Center (focus group) and the NBLA (Community Outreach and Health Education Project Managers). All feedback collected indicates the user is satisfied the developed application has met expectations / needs.

Approach and Methodology

A new web-mapping application was developed using the CGDI framework. As part of the application, access is provided to new web processing services, to enable statistical representation of respiratory health information. This project used eight CGDI WMS/WFS services.

This project was built upon a strong partner network. The collaborators have expertise in the application of Geographic Information Systems and geospatial analyses to public health, with particular emphasis on addressing respiratory health issues.

The geographic coverage included all of Canada, to provide a context for the New Brunswick respiratory health maps. The design focused on enabling the analysis of respiratory diseases at local, regional, and provincial scales. The services deployed in this project include data and resources in New Brunswick. The project made use of thematic and framework data available from GeoBase, Canadian Atlas, Statistics Canada, and the Public Health Agency of Canada. The application can be transferred or extended to other adjoining provinces and states, including the creation of new maps and services.

The application was built to reflect User Friendly Design:

- Visibility – Buttons, Lettering and Links are easily discerned (i.e. tool tips) and easy to access.
- Memory Load: the application and services run with a maximum wait time of 15 seconds. A maximum of 20 concurrent users was expected.
- Feedback: Users can contact technical support, Lung staff, and use online collaboration tools to provide feedback on the application and obtain support from the user community. The website has a feedback form.
- Accessibility: the application is web-accessible, directly from the NBLA official website. The Public Map viewer is available on the website with no registration required for general public users. All data is privacy protected.
- Orientation / Navigation: The website and application contain a tutorial and help menu. The viewer is self-contained, and navigation is all within one browser window.
- Errors: Errors and Bugs will be ironed out through an ISO testing process at CARIS. If errors occur, users may report them using the feedback mechanisms.
- Satisfaction: It is expected that this application and services will increase user satisfaction in performing tasks essential to their work in respiratory health fields.
- Language: The application supports English and French. Data available in the application will be provided in the language of origin.
- Visual Design: the visual design represents the professional and health aspects of the organization. As such, it uses the organization's official color palette.

Use of Standards

The New Brunswick Lung Association's GIS initiative is aligned with the CGDI framework for visualizing and accessing spatial data. Following the same CGDI framework, the application and services developed in this project will facilitate sequential mapping and spatial exploration of respiratory health data, requiring the use of the CGDI endorsed standards as well as new OGC standards.

National Significance

According to Respiratory Diseases in Canada (2004, Canadian Lung Association) – authored by CIHI, Canadian Lung Association, Health Canada, and Statistics Canada – more than three million Canadians cope with serious respiratory diseases such as asthma, COPD, lung cancer, influenza, pneumonia, bronchiolitis, tuberculosis, cystic fibrosis and respiratory distress syndrome. Lung disease such as COPD will be the third largest killer in Canada by 2020.

The NBLA will share its services and application in the CGDI with other Lung Associations across Canada, toward building a national infrastructure focused on respiratory health. Partners may provide data / WMS services, in order to address respiratory health issues across health jurisdictions. The project will be promoted to the North East Border Health Initiative, as a model for cross-border mapping of respiratory diseases.

This application addresses gaps that were identified in the CGDI: At the time of development there were no public health examples of Web Processing Services, Web Feature Services, Web Map Context Standard, and Data Schema… thus the project laid an important foundation for the public health community across Canada to utilize the CGDI for respiratory health applications.

The new map viewer can be transferred or deployed at other organizations.

This project reflects an application that relates to:

- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

This project had a strong user focus which included a comprehensive identification of user information needs. User categories were clearly identified and specific needs were addressed. The ease of use was considered to be of medium complexity.

Universal Applicability

Utility at a national level is unclear and the application has not been adopted by other provincial lung associations.

Key Results and Lessons Learned

This project implemented new CGDI Web Processing Services, to enable statistical representation of respiratory health information, mapping values representing disease prevalence to geometries provided via WFS, or stored in Shapefile or Oracle Spatial.

Communication and coordination are very important between partners – face to face meetings with technical group and senior management are needed to ensure everyone understands expectations and constraints on deliverables.

Development of services based on new standards challenges developers because of unfamiliarity. Technical resources at universities, geomatics consulting organizations and the CGDI should be consulted to validate specifications.

Training of users is an ongoing need for increased understanding of CGDI and public health mapping applications. There is a learning curve, requiring demonstrations, presentations, and training sessions to familiarize end users with applications/services.

Greater Access to health and environment data is still needed in the CGDI. This NBLA-developed application added respiratory health data, base map data, WFS features, and additional (value-added) map layers for use via CGDI, which will benefit all public health users of CGDI.

DH-2 – Ontario Health and Environment Information System (OHEIS)

Ontario Health and Environment Information System (OHEIS)

Project Id:	53928 (DH-2)
Project Category:	Determinants of Health
Project Sponsor:	Cancer Care Ontario (CCO)
Collaborators:	Small Area Health Statistics Unit, Imperial College, London, England
	SENES Consultants Ltd.
	GIS Infrastructure, Office of Public Health Practice, Public Health Agency of Canada Biostatistics and Epidemiology Division of the Safe Environments Program, Health Canada
	ESRI Canada
	Association of Public Health Epidemiologists of Ontario
	Wellington-Dufferin-Guelph Health Unit
	Durham Region Health
	Toronto Public Health
	The Centers for Disease Control, Environmental Health Tracking Branch
Contact	Dr. Eric J. Holowaty
	Senior Consultant, Division of Preventive Oncology
	Cancer Care Ontario
	620 University Avenue
	Toronto, Ontario
	M5G 2L7
	Telephone Number: (416) 971-9800, Ext. 1125
	Fax Number: (416) 971-6888
	Email Address: eric.holowaty@cancercare.on.ca

Project Description

Purpose

The OHEIS project aimed to improve understanding of the links between environmental hazards and associated health outcomes, through the development, testing and deployment of a comprehensive, standardized geographic information system for the rapid assessment of these relationships at larger and smaller levels of geography. This will substantially facilitate non-communicable disease surveillance and risk assessment.

Intended Benefits

Cancer is the top cause of premature death in Canada and is expected to consume a steadily increasing amount of health care resources, largely because of population growth and aging of our population.

The study of spatial variation in the rates of disease occurrence is now widely recognized as vital to our understanding of disease causation, as well as clearly demonstrating the impact of disease interventions, particularly in the areas of primary prevention and screening. Traditionally, the standard tool for describing geographic variation in disease risk has been mapping or cartography, usually displaying disease rates by geo-political areas. More recently, techniques of standardizing these rates to facilitate comparisons include adjusting or controlling for differences in age, sex, socio-economic status, and behavioural risk factors. As well, modern techniques of geo-spatial analysis add further improvements in providing uncertainty estimates and better separation of independent random variation in the underlying rates from spatial features (e.g. auto-correlation) and temporal trends. Many of these modern requirements have been integrated in SAHSU's RIF (Rapid Inquiry Facility) application, providing an opportunity for CCO and the public health community to engage in sophisticated spatial analysis with a minimum of new software development.

Easier access to high quality spatial information on cancer is of particular relevance at the moment because of marked increases in the incidence of some cancer types (e.g. non-Hodgkin's lymphoma, melanomas, thyroid cancer, and testicular cancer). Additionally, with effective screening programs now in place for both breast and cervical cancers, and with the advent of a new screening program for colorectal cancer, improved spatial information on both cancer incidence and mortality would greatly assist the planning and evaluation of screening programs, and the conduct of future research activities. More sophisticated spatial analysis could also better address the public's concern about the relationship between environmental pollutants (e.g., landfills, incinerators, highways and roads, smelters and refineries, nuclear plants and many other industrial facilities) and cancer risk.

The OHEIS Project implemented a surveillance system considerably more sophisticated than that currently offered by the Public Health Agency of Canada (e.g. Cancer Surveillance On-line). It operates at a much higher spatial resolution (i.e., at the postal code level), thus allowing for more exact analysis of exposures and outcomes. Secondly, the RIF Application implemented as part of the OHEIS Project is closely integrated with statistical software such as R, SAS, and SaTScan, allowing for more sophisticated analysis.

The rapid methods of mapping and analysis introduced through the OHEIS project will be particularly appealing to public health agencies at the local, provincial and national levels. Where rapid surveillance demonstrates no evidence for raised disease risks, this will allay public concerns particularly where the methods are scientifically valid and the findings are open and transparent to the general population and media. If, on the other hand, surveillance results suggest that the true risk is indeed elevated, and not likely a chance finding or attributed to confounding factors, then more detailed explanatory studies can be planned and undertaken and/or hazardous exposures can be reduced or eliminated.

Ultimately, the OHEIS project will play an important role in providing rapid and accurate information to policy-makers, scientists and the general public at local, provincial and national levels.

Effected Stakeholders

The most immediate users of OHEIS will be epidemiologists, statisticians, planners and administrators at Cancer Care Ontario who require more sophisticated mapping of patterns of cancer across Ontario, and wish to conduct more sophisticated spatial and spatial-temporal analyses of the relationship between geographic patterns of cancer and antecedent exposures and other determinants.

Users will also include local public health departments who have a statutory mandate to investigate environmental and occupational health concerns at the local level as well as epidemiologists and other scientists at governmental and academic levels.

The general public and the media constitute another important group of users. And ultimately, it is anticipated that use will spread well beyond Ontario, as is currently the case with the implementation of SAHSU's RIF System across Europe and the U.S.A.

RIF training was provided to the partners primarily through one-on-one sessions with OHEIS team members. These sessions provided an introduction and demonstration of the RIF, with particular emphasis on the implementation of Canadian Census data, and an orientation to the RIF database.

The RIF application was deployed to collaborators. As part of the deployment, the collaborators were provided with the RIF database in Microsoft Access format, which included population age and sex data by Census of Canada geographic units, as well as the accompanying Census shape files. For each collaborator, CCO has provided support to enable their successful implementation of the RIF.

Approach and Methodology

The project was undertaken in three systematic phases.

Phase One, the Feasibility Phase, was undertaken to assess the feasibility of implementing a GIS System for point/line/area source investigations as well as cancer and environmental exposure mapping within Ontario. It was modeled on a system (the Rapid Inquiry Facility (RIF)) which is now in place in five European countries and is currently under the final stages of enhancement and testing, for deployment across State Health Departments in the U.S.A. Collecting and specifying the requirements for a GIS application is a difficult but critically important step, especially for end-users who are not fully familiar with the nature of the project. The challenge arises from the need to explicitly determine all of the aspects and constraints that can impact design, development and deployment. The initial phase of user requirements determination for OHEIS focused on the receptiveness of the public health community for GIS tools, and the best ways of OHEIS communicating with end-users. This was done through an easy-to-complete questionnaire posted on a website. The survey was distributed to the active membership of the Association of Public Health Epidemiologists of Ontario.

The Second Phase, Implementing and Enhancing the RIF Application in Ontario, included the exploration and enhancement of existing generalized modules for disease and exposure mapping, as well as exploring techniques for handling inconsistencies and errors in the data, and assessing the availability of useful measures and indices of socio-economic status and behavioural risk factors (e.g., smoking, reproductive factors) derived from Canadian data sources. The project team adapted a checklist of functional and non-functional requirements originally developed by the BEST-GIS Consortium (European Commission, 1998). This framework has been used extensively in many European countries to guide requirements specification and usability testing.

The Final Phase of this project, the Testing and Deployment Phase, assessed the effectiveness and cost efficiency of the new OHEIS System in addressing two real and controversial concerns about environmental exposure and cancer risk in Ontario. Traditional ecological methods of inquiry are fraught with major problems in relation to data quality and access, statistical methods, substantial consumption of analytic resources, and time delays. The traditional cross-sectional approach inherent in these studies faces substantial inferential problems and the results are often held as implausible by other scientists and the lay population alike. As an additional but very important element of this Testing Phase, the project undertook an historical cohort approach to assess the plausibility of the traditional ecologic findings. This approach has seldom been undertaken because of the cost and complexity. However, CCO, in particular, was ideally suited to implement such an approach, both because of the availability of historic population files for such research, and because of considerable experience at CCO in conducting historical record linkage studies between population rolls, the Ontario Cancer Registry and the Ontario Mortality Database.

Map data will be distributed electronically through a CGDI-enabled web server, allowing users to have full control over the displayed output using a desktop GIS program. Further analysis by other parties will then be possible using other CGDI-enabled resources, such as the road network data from the Atlas of Canada. OHEIS data can then be incorporated into other public health research projects and a link with Toronto Health Profiles will be sought. ESRI's ArcIMS program was used on the server, being a natural choice since the RIF is built on ArcView and integration with ArcIMS was seamless. The user requirements survey indicated a willingness of in the public health community to use the RIF and to incorporate GIS methods into their research and decision making, and thus there should be a strong demand for this resource.

The data in the Ontario Cancer Registry are confidential patient records, and rules for their dissemination are set out in the Personal Health Information Protection Act. The consequences of this are that data at the finest spatial resolution will only be available to users at CCO. However, cancer risk surfaces at a coarser spatial resolution can be made more widely available, provided that no incidence counts less than five are given.

A combination of commercial off-the-shelf (COTS) and open source software (OSS) was used. OGC compliant services were also employed.

Use of Standards

The RIF is based on the ArcGIS Suite, which became fully OGC (Open Geospatial Consortium) compliant following the release of ArcGIS version 9.2 in December, 2006. This allows for the full use of CGDI formats for accessing data, exchanging data between collaborators, and for disseminating results.

National Significance

Experience at SAHSU (SASHU, 2003) has shown the very definite advantages of compiling all datasets within one organizational setting, where they have been collated, integrated and interpolated within one relational database, only accessible through a secure private network. This enables both rapid data access and maintenance of a high level of security. This also permits rapid follow-back of potentially erroneous data. It should be noted that the time and effort required to compile and maintain such a large relational database are not small. It requires dedicated, skilled and experienced staff and resources, not only during development and implementation, but as part of an ongoing program of maintenance and further enhancements.

Full scale deployment could well include a pan-Canadian system, fully CGDI compliant, perhaps securely implemented in one central facility (e.g. Public Health Agency of Canada), with ready access to all necessary datasets at a fine level of granularity, disclosing sophisticated reports and graphics to authorized users without breaching confidentiality. The CCO believes this is the ideal model to strive for.

This project reflects an application that relates to:

- Analysing spatial and temporal trends;
- Mapping population groups at risk; and
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk.

Specific User Focus

The process and the resulting application reflect the full range of user interests, including the identification of user information needs, specifying the needs by user categories and ensuring adequate user training and support.

Universal Applicability

This application has substantial utility for all jurisdictions in Canada.

Key Results and Lessons Learned

The proponents believed that it would be wasteful of public resources to design and implement a GIS system from scratch. Based on consultations with local partners, the U.S. Centers for Disease Control, State Health Departments and other cancer registries, it became apparent that SAHSU's RIF System offers unique features that makes it the ideal tool for a wide variety of projects that involve evaluating the spatial and temporal relationships between environmentally related diseases and environmental hazards. The RIF's proprietary system offers the combination of being based on sound statistical methodology and providing a user-friendly yet flexible computing environment. Much success has been demonstrated in producing results that are credible to scientists and the lay public alike, even when sources provide sparse information (Jarup, 2004). The most valuable features of the RIF system are:

- Robust environmental hazard and disease mapping modules that enable the rapid conduct of health impact assessment (detailed reports available in 1-3 days); and
- A hazard analysis module that permits sophisticated, credible definition of populations exposed to different levels of hazards, with careful evaluation of exposure/dose response relationships.

A sophisticated disease mapping capability for surveillance of health outcomes potentially related to environmental exposure, including robust statistical functions for smoothing crude disease rates to overcome problems of sparse data, as well as adjustment of these rates and risk ratios for important confounders (e.g. SES, smoking).

DH-3 – A Spatially Enabled Population Health Framework for Disease Surveillance

A Spatially Enabled Population Health Framework for Disease Surveillance

Project Id:	79906 (DH-3)
Project Category:	Determinants of Health
Project Sponsor:	Provincial Health Officer's Office and Population Health and Well-Being Division, BC Ministry of Health
Collaborators:	GeoConnections Canada
	Integrated Land Management Bureau, BC Ministry of Agriculture and Lands
	BC Centre for Disease Control
	Office of Public Health Practice, Public Health Agency of Canada
	Vancouver Island Health Authority
Contact	Clyde MacDonald
	Health Information and Technology Branch
	BC Ministry of Health
	1515 Blanshard St.
	Victoria, BC V8W 3C8
	Telephone number: (250) 952-1449
	Email address: Clyde.MacDonald@gov.bc.ca

Project Description

Purpose

The overall goal of the project was to develop a web-based and spatially-enabled disease surveillance tool which allows for comprehensive analysis of population health ecology and disease.

Intended Benefits

This interactive web-based spatial health information system supports disease surveillance with the following features and functions:

- Baseline spatial information including points, lines, and polygons that are framed in spatial scales appropriate for surveillance of diseases such as influenza, water-borne enteric diseases and vaccine-protective communicable diseases;
- Profile of the populations residing in those spatial entities;
- Socio-economic and vulnerability indices of populations at risk;
- Physical environmental data layers that are related to disease surveillance;

- Interactive web-based spatial analytical tool used to spatially display, identify, query and analyze both health and disease information;
- Identify disease clusters, patterns of disease distribution over time and space, disease diffusion paths, and predict potential targeted communities based on the analysis; and
- Tools to deploy summarized information including tables, charts, and maps to support decision and policy making.

Effected Stakeholders

The data layers integrated to the web-GIS tool were carefully chosen to meet users' requirements collected from user meetings and workshops. These data layers include seniors' health care data, community resources, and Aboriginal community settlements. Some data layers that users expressed an interest in are not available for this tool either due to lack of data or lengthy data acquisition processes. However, these data layers will be considered for future development.

The web-GIS user interface was designed to be user friendly. Users approved and endorsed the working prototype at the end of the user workshops. Early user workshops generated valuable input into the design and functionality of the tool. Users demonstrated interest in building the tool by providing ideas, suggestions and feedback to the project team.

The application enables users to perform spatial analyses for communicable disease surveillance in BC Web-GIS integrates health data with spatial data in several modules and overlays information on base maps for visual presentation and includes an intuitive interface for easy use with minimal instruction.

Approach and Methodology

The project was conducted in four phases:

- Define
    - User needs
    - Application functional requirements
    - Required data sources
    - Required spatial information layers
    - Measurements, indices, and analytical methodologies
    - Required information products
    - User community capacity and training requirements
    - Cross organization requirements to support / sustain application
- Design
    - Establish Technical Working Group
    - Analyze user needs feasibility and delivery options
    - Analyze standards requirements

- Identify re-usable AHIP components
- Develop technical design plan
- Validate technical design plan with Technical Working Group

- Build

  - Develop BETA application
  - Plan and hold end-user and Technical Working Group interim results validation meetings
  - Test and Complete
  - Develop application test plan
  - Document user feedback

- Develop change / enhancement plan

  - Develop training, support and sustainability plan
  - Implement training, support and sustainability plan

As team members and stakeholders came from several different organizations (MOH, BCCDC, ILMB, etc.), frequent communication activities were important to the success of this project. Types of communication included:

- Regular project team meetings;
- End-user workshops;
- Interim prototype demonstrations;
- E-mails;
- Phone calls; and
- Additional meetings.

In the future, the Web-GIS tool will be made available to identified end users including Health Authorities, the BC Centre for Disease Control, and the BC Ministry of Health/Provincial Health Officer. The first step in this wider deployment is the transfer of the current laptop version of the proof-of-concept to a server environment. Only designated users will be granted to access to the tool for demonstration purpose. Any operational release will be through the BC Ministry of Health Aggregated Health Information Project and as such subject to full Privacy Impact Analysis and compliant with applicable information delivery legislation, policy and standards.

Use of Standards

MapViewer from Oracle is the Web-GIS front-end. MapViewer supports some of the CGDI standards such as WMS and is capable of requesting and displaying some of the CGDI content in GeoBase through WMS, such as geographic names, CDED and NRN. The decision was made to use WMS and access similar but richer map layers hosted in the Land Resource Data Warehouse (LRDW) by the Integrated Land Management Bureau for the following reasons:

- To access current and future data requirements that are not available from CGDI, such as hydrographic features including coastlines and aquifer vulnerability mapping that is related to drinking water quality;
- Requirements of certain data content such as street names;
- Requirements of different levels of details or scale of data, such as 1:20,000 and 1:250,000; and
- Requirements of customizing the contents.

Other CGDI standards, such as WFS, were considered but not implemented. In the case of WFS, there are concerns about access control, security, and performance in dealing with large volumes of sensitive health care related data. This is an area that requires further exploration.

The project team recommends that CGDI focus on developing technologies and providing guidelines on best practices in transactional WFS, access control and improving performance.

National Significance

The project provides a practical example of disease surveillance related to population health analysis and showcases the application of a population health perspective in disease surveillance, in this case, communicable diseases.

This project reflects an application that relates to:

- Timely identification of the geographic distribution of diseases
- Analysing spatial and temporal trends
- Mapping population groups at risk

Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk

Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets

Assessing resource allocation

Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology

Specific User Focus

The application was built to reflect the specific information needs of the British Columbia public health community. It includes an intuitive interface for easy use with minimal instruction.

Universal Applicability

The project is relevant to all jurisdictions in Canada.

Special Challenge Addressed

Methodology validation resulted in challenges for the team as validation methods were not available and gaps existed in published methodologies for this type of application. Therefore it is recommended that there be investment in methodology development for the future.

Key Results and Lessons Learned

The project has been a success in terms of achieving objectives for features and functions identified in the original proposal.

The project developed and illustrated that multiple sources of information can be framed and analyzed comprehensively for the purpose of population health assessment and analysis. Documents produced throughout the project demonstrate the steps taken in data acquisition, data analysis and methodology creation for the purposes of health surveillance.

A working prototype of an interactive web-based spatial health information system supporting disease surveillance has been developed and validated through internal demonstrations to the project team. Furthermore, an entire framework composed of data acquisition processes, data analysis methodologies, and modules for displaying spatial information have been created as a foundation for future developments.

After methodology development, the next significant barrier to development was the selection of appropriate software to build the application. The developer spent a considerable amount of time evaluating different options based on desired functionality and was very successful in implementation. However, there were some limitations encountered. For example, the chosen tool (MapViewer) does not have a built-in WMS adapter which is necessary to enable base map layer retrieval from ILMB's WMS server. Therefore, the developer had to custom-build this feature.

The use of sensitive health information always involves privacy issues. The conflict between protection of privacy and use of relevant health information for appropriate applications needs to be resolved so that information can be used without risk of identifying personal information.

Effective collaboration between different organizations was essential to the success of the project. Collaboration involves not only the partnerships of each organization, but also a clearly identified role that each collaborator will take in the project. In addition, the project lead organization must hold regular update meetings to communicate with the collaborators and discuss issues raised for an on-time solution.

Natural Resources Canada / Ressources naturelles Canada

DH-4 – User Needs Assessment with Respect to Mapping of Air Quality Index in Ontario

User Needs Assessment with Respect to Mapping of Air Quality Index in Ontario

Project Id:	254852 (DH-4)
Project Category:	Determinants of Health and User-centered
Project Sponsor:	McLaughlin Centre for Population Health Risk Assessment, Institute of Population Health, University of Ottawa
Collaborators:	City of Ottawa City of Toronto Health Canada Environment Canada Statistics Canada Ontario Ministry of the Environment A-MAPS Environmental Inc. Media-X Systems Inc.
Contact	Daniel Krewski, Professor and Director, McLaughlin Centre for Population Health Risk Assessment, Institute of Population Health, University of Ottawa 1 Stewart Street, Suite 318, Ottawa, ON K1N 6K9 Administrative Assistant: Suzanne Therien Telephone number: 613-562-5381 Email address: stherien@uottawa.ca

Project Description

Purpose

The purpose of the project was to conduct the User Needs Assessment (UNA) with respect to the Mapping of an Air Quality Health Index (AQHI) in Ontario. The focus was on confirmation of previously identified needs, identification of additional needs as well as verification, refinement, detailed analysis and prioritization of all the identified needs. The UNA addressed the design of the AQHI mapping service, requested content of the service, functionality, requirements with respect to periodicity, spatial and temporal resolution and additional information to be included in the mapping products.

Intended Benefits

The objectives of the project were:

To identify regions within Canada that demonstrate unacceptably high levels of air pollution in terms of increased health risk from exposure to air pollution.

Provide sufficiently high spatial resolution of the information; facilitate air quality decisions at the local level.

Ensure the availability of a health based air quality index which will ultimately permit the design of Canada Wide Standards for criteria air pollutants that take into account the joint effects of multiple pollutants as embodied in the AQHI.

User friendly access to detailed maps of the AQHI which will enable the design of air quality management strategies that target regions in Canada that are of most concern from the point of view of population health.

Effected Stakeholders

User groups include public health and environmental health decision makers at the federal, provincial and municipal/regional levels - environmental planners, medical epidemiologists, managers of environmental protection, senior scientific advisors of air quality and meteorology, senior health and environmental advisors and analysts. Just as they have different roles and responsibilities in their daily work, so too did they have each different priorities and needs within the scope of this project.

Primary Users

Municipal/regional governments are responsible for 'delivering' services related to ambient air quality and health impacts at the local level. Their main responsibilities include: creating policies for the mitigation of climate change and protecting air quality; promoting and protecting public health; reducing pollutants associated with public transit; ensuring politicians are informed; ensuring public are informed about air pollution; developing and reviewing policies for the city that might affect health; doing advocacy; doing public education and outreach; building air quality and climate issues into the planning process as well as doing policy development work around the planning process; reviewing certificates of approval and looking at other land issues. They work closely with community representatives to disseminate information about poor air quality (i.e. smog alerts).

The NGOs, such as the Lung Association, work closely with populations vulnerable to the health impacts of air pollution.

Secondary / Tertiary Users

Health Canada's mandate with respect to air pollution and other environmental contaminants is to identify the hazards to the Canadian population, develop strategies to mitigate these hazards and work with others to reduce the identified risks. Health Canada's primary activities comprise targeted research to address gaps in the scientific evidence base and assessment of risk by evaluating the overall weight of evidence.

Environment Canada is the principal partner in formulating risk management strategies.

The provincial government users focus mainly on monitoring all environmental media (i.e. air, water, waste, land use). Their core business is 'clean air.' Their responsibilities include monitoring air and informing the public about air quality and providing information on health implications.

The general public can access information they can use to minimize their risk-exposure. This includes nursing homes, day cares, the Red Cross and recreation departments whose clients are often vulnerable.

Approach and Methodology

The UNA methodology entailed three phases:

- Planning the assessment
- Conducting the assessment
- Interpreting and reporting the results

In the first phase the project team established a steering committee of stakeholders including federal, provincial and municipal government representatives and environmental non-governmental organizations. The project team maintained contact with the steering committee through teleconferencing and email.

In the second phase the assessment was conducted using qualitative methods through focus groups and interviews. Together the interviews and focus groups were used to build and create user profiles, usage scenarios and gather attitudes of the participants on the AQHI product. The methodology for determining user needs was applied in full accordance with the guide "Understanding Users' Needs and User-Centered Design" published by GeoConnections.

Qualitative methods were employed in order to explore and obtain feedback on ideas for project design, characteristics of the users, their goals and motivations as well as uncover potential challenges or hidden issues related the AQHI product. Qualitative methods were deemed appropriate for this assessment given the number of users being targeted, the need for a more detailed and in depth understanding of user needs and the limited resources for this assessment.

The UNA focused on requested content of the service, functionality, requirements with respect to periodicity, spatial and temporal resolution and additional information to be included in the mapping products.

The final phase involved interpretation of the data and reporting the results. The research results were implemented in the design of the AQHI mapping service.

After the presentation of the mapping results, collaborators had the opportunity to readjust their original needs and, if feasible add some new ones.

Following the completion of the interview reports, the steering committee met to discuss the planning for the interpretation of the results. Under the direction of Dr. Daniel Krewski, the objectives and implementation plan were developed and refined based on the results of the UNA findings and conclusions.

The project team met on an ad-hoc basis (at least bi-monthly) as needed. Progress was reported to the steering committee through the circulation of periodic interview reports. Users were kept informed regarding the progress of the project and were communicated the final results. Each individual interview report was circulated to each participating user to invite them to provide feedback on their interview.

Within the academic community knowledge translation activities included seminars and workshops. More specifically, the research team presented a seminar on the project as part of the Institute of Population Health Seminar Series, held weekly on campus at the University of Ottawa and attended by professors, researchers and graduate students interested in population health issues.

Project details were made available to the general public via the McLaughlin Centre website (www.mclaughlincentre.ca) which houses information regarding air pollution and other environmental health risks of concern to Canadians. A number of users access this site regularly which has enhanced credibility and draws an international audience given the Centre’s designation in 2005 as a recognized PAHO/WHO Collaborating Centre in Population Health Risk Assessment.

Use of Standards

All services comply with the OGC standards and protocols.

National Significance

A report from the Canadian Medical Association forecasts that illness and health impacts due to poor ambient air quality will only worsen over time (see CMA, 2008a; 2008b). There is growing concern about the negative effects of air pollution on population health. Within this context, the Mapping of Air Quality Health Index (AQHI) in Ontario project aims to develop better tools for public health authorities to communicate these risks so the public can better protect themselves.

The AQHI maps of air quality would provide near real time information on the population health impacts of air pollution at a very fine level of spatial resolution. This information would be of great value to Health Canada in gauging the population health impacts of air quality in Canada and in communicating this information to Canadians in a manner that will inform decision making by members of the public on how to avoid adverse health outcomes on days of high air pollution.

The air quality data generated through a synoptic mapping approach greatly enhances Canada's ability to manage the well known health risks associated with ambient air pollution.

By taking into account health impacts, the new AQHI represents a major advance over existing indices of air quality, which represent only exposure to criteria pollutants. The AQHI will be of great value to public and population authorities at the national, provincial, and municipal levels across Canada in communicating the potential health impacts of air pollution and of poor air quality days. It will also provide valuable information to the Canadian public which will assist in making personal lifestyle decisions on how to respond to episodes of elevated air pollution. Health Canada, who has played a leading role in the development of the AQHI, requires this index in order to develop its health based risk communication and risk management strategies for ambient air pollution in Canada.

This project reflects an application that relates to:

- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

This work strongly relates to the identification of user information needs. It also categorizes the various users who could benefit from the use of the application.

Universal Applicability

The project is relevant to all jurisdictions in Canada.

Key Results and Lessons Learned

Effective use of the AQHI depends on user-friendly accessible information and Canada-wide dissemination mechanisms which can be achieved through standardised web-based mapping and publishing methodologies required and advertised by the Canadian Geospatial Data Infrastructure (CGDI).

Results of the UNA clearly indicate needs for an AQHI mapping program with sufficient geospatial resolution of the information. Such mapping service would enable recognition of spatial and temporal patterns of the index, it would improve the pubic awareness with respect to AQHI, concerning the vulnerable groups in particular, it would support planning, decision and policy making as well as it would provide information inputs to population health risk assessment studies. Easy and user friendly accessibility of the information through the Internet (a dedicated web application) came up as an essential user requirement.

DS-1 – Using real-time spatial information to manage communicable diseases

Using real-time spatial information to manage communicable diseases

Project Id:	54142 (DS-1)
Project Category:	Disease Surveillance
Project Sponsor:	McGill University (Departments of Epidemiology and Biostatistics, and Geography)
Collaborators:	Direction de santé publique de Montréal (DSP)
	Montreal Chest Institute (MCI)
Contact	David. L. Buckeridge, M.D., Ph.D.
	Assistant Professor, Department of Epidemiology and Biostatistics
	McGill University
	1140 Pine Avenue West
	Montreal, QC H3A 1A3
	Telephone number: (514)398-8355
	Fax number: (514) 843-1551
	Email address: david.buckeridge@mcgill.ca

Project Description

Purpose

The short-term objective of this project was to facilitate the incorporation of spatial information and spatial analysis into the process of case management, contact tracing and surveillance for infectious diseases in Montreal. This objective was realized by developing an application that allows:

- Capturing, at the point of care during the management of cases, spatial information about the cases and contacts, as well as the locations of contact;
- Rapidly transmitting from hospitals to the public health department, health and spatial data describing cases and contacts;
- Automatically geocoding and analyzing, in real-time, case and contact spatial information to identify possible disease transmission in the community;
- Sharing case information and analysis results over a secure network; and
- Facilitating emergency management and response by developing an application suitable for rapidly transmitting spatial and health information about cases of emerging infectious diseases and quickly identifying ongoing disease transmission in the community.

The long-term objective is to improve the public health detection and timely intervention of respiratory infectious disease outbreaks, by facilitating the flow of spatial information from healthcare institutions to public health departments, the analysis of spatial information within public health departments, and the sharing of spatial data and analyses between public health institutions. The developers also intend to build upon the spatial analysis functionality to include additional methods of analysis such as social network models and to explore the use of the application for automated sharing of disease information among health departments. This will effectively extend the CGDI into the public health community of practice, and it is anticipated that the application and the services that it will provide will become a model for sharing spatial disease information within the public health community.

Intended Benefits

Incorporating spatial information into surveillance will allow public health personnel to identify ongoing disease transmission rapidly. Because early detection and intervention effectively halts the spread of disease, improved detection of disease clusters should decrease the number of people who become ill with and die from infectious diseases.

The automatic transmission of data frees up the resources previously needed to transfer information manually (e.g., via mail and fax) and it also saves the resources and eliminates the errors associated with re-entering the information. From an analysis perspective, surveillance analysts at the DSP have an integrated view in real-time of all infectious disease cases on the island of Montreal, including spatial information about the cases. This integrated spatial view, with supporting analytic methods, allows surveillance personnel to identify clusters of disease cases more readily than is possible with current methods for analysis. In addition, other public health personnel within the DSP who are concerned with the interaction of social determinants and disease will be able to use the interactive analysis component of the application to conduct research and planning related to preventive interventions.

In the longer-term, the ability to use CGDI-endorsed services to share information between public health departments should enable the real-time sharing of infectious disease case information to identify outbreaks that may span jurisdictions. This automated information sharing would replace manual or ad hoc processes, which should reduce costs and administration.

Effected Stakeholders

Surveillance analysts at the DSP needed: (1) an integrated view of information about infectious disease cases and contacts collected at both the MCI and the DSP, (2) accurate spatial information about locations (e.g., home and work addresses) associated with cases and contacts, (3) the ability to prospectively analyze spatial information in order to identify space-time relationships among cases and contacts that may indicate ongoing disease transmission in the community, (4) the ability to retrospectively analyze collected spatial information in order to enhance their understanding, over the long-term, of the factors associated with acquisition and transmission of infectious diseases, and (5) the ability to share electronic data about cases within and beyond the DSP.

This project has met these needs by designing, developing and implementing the Dracones web-based mapping and spatial analysis software. Dracones interfaces with the relational database that holds data describing reportable diseases in Montreal, extracts a subset of those data for all cases of disease (in response to a user-specified query), validates and corrects addresses of cases, and then makes the data available for spatial display and analysis. Users can query and display cases on a map in conjunction with other data (e.g., streets, political boundaries, locations of schools, stores and other points of interest) and perform spatial statistical analyses to identify clusters of disease.

Primary Users

Case management teams – public health nurses and surveillance analysts

Secondary / Tertiary Users

Public health planners

Public health departments in neighbouring areas

Approach and Methodology

The project implementation plan included five distinct phases: define, design, build, test and implement, and disseminate the results. The specific tasks that were accomplished in each project phase are described in the following sections.

Phase 1 – Define System

Time was spent defining the requirements for the system interaction with users at the MCI and the DSP. The Technical Team and members of the Analysis Team met with the User Team to review progress in defining the application and progressively refine understanding of the specific requirements of the system. The Technical and Analysis Team members developed the requirements document and incorporated feedback from the user meetings. In addition, Technical Team members reviewed the current database structures at the MCI and the DSP and consulted with network support staff at both institutions to identify possible technical constraints on the application.

Phase 2 – Design System

The Analysis and Technical Teams designed the overall architecture and to ensure that the design meets the system requirements. At weekly meetings the Teams presented the evolving design to the User Team to identify possible problems from the users' perspective.

The specific responsibility of the Analysis Team during this phase was to identify and describe appropriate approaches to automated geocoding, prospective analysis, and retrospective analysis.

The specific responsibility of the Technical Team during this phase was to identify and describe appropriate approaches to the overall architecture, the data-capture component, the messaging component, and the use of CGDI-endorsed web-services for information sharing. In addition, the Technical Team iteratively defined the user-interface through ongoing consultation with the User Team and the Analysis Team.

Phase 3 – Build System

User consultation meetings continued throughout this phase in order to allow the Technical and Analysis Teams to present prototypes to the User Team and iteratively refine the system components.

The programmers implemented and continually evaluated software that allow transmission in real-time of TB case and contact data from the MCI to the DSP over the RTSS.

Once the initial work on the mapping component was completed, they developed the spatial analysis component. This entailed using the Java Topology Suite to develop the ability to efficiently search across multiple point locations signifying case and contact locations) to identify points occurring closer in space and time than expected. They also developed interfaces to allow existing spatial analysis methods in R and SaTScan to be called through the analysis component in a modular manner.

Phase 4 – Test and Implement System

The fourth phase of the project involved installing the hardware and software on-site at the MCI and DSP and testing the functionality of the software in a working environment. The Technical Team verified the installation of the software. Once the system was installed, the User Team worked with the Technical and Analysis Teams to work through simulated and real prospective and retrospective analyses in order to ensure the correct system function from the users' perspective.

Phase 5 – Disseminate Results

The final phase of the project entailed meeting with stakeholders to demonstrate and publicize the report and to prepare manuscripts for circulation to stakeholders in public health and other disciplines. Information about the project was communicated through a number of venues. A research paper describing the Dracones system was prepared and the system was discussed with research and public health colleagues in the United States. At the national level, the project was presented at the 2007 Canadian Public Health Association Conference and the 2008 PgCon (PostGres Congress). The project was also summarized in an edition of the NRCan newsletter. Provincially, the project was discussed with the Quebec public health institute and other public health departments. Regionally, a workshop was organized for public health personnel from Montreal and other regions of Quebec that may be interested in implementing the Dracones software within their jurisdiction.

Use of Standards

The project team made extensive use of CGDI standards within the Dracones application, mainly through the implementation of the MapServer software. They were not able to make extensive use of CGDI services due to the need for high-resolution spatial data (e.g., street networks and places of interest within the city of Montreal), which are generally not available through such services.

The focus in software development was to re-use existing software libraries, applications, and standards to create a robust, open-source, extensible application. In doing so, they used a number of CGDI applications and CGDI-endorsed standards and services in novel ways.

To address the limited resolution of the available services, the team developed a repository of high resolution spatial data for Montreal, and incorporated CGDI-endorsed web-service standards to share the data with the public health community. Through this approach, the application effectively extends CGDI into the public health community and lays the framework for further development in this area. In order to support the integration of health-related geospatial data across public health departments, they implemented the Web Map Service (WMS) specification.

The Geodata Discovery Service specification was incorporated in the application in order to facilitate the identification of data suitable for integration across public health departments. This technology creates a standard infrastructure for public health departments to search for geospatial data held within other public health departments in surrounding regions. Access to the information was credentialed, to ensure that private health data are made available only in accordance with current data privacy and public health legislation. They also used the CGDI-endorsed Federal Geographic Data Committee (FGDC) Content Standards for Digital Geospatial Metadata (CSDGM) to describe the data at the public health department. The Geographic Markup Language (GML) was used to encode the geospatial data for transmission from the Montreal Chest Institute (MCI) to the public health department.

For data storage and analysis the team used existing open source software platforms, many of which were developed with CGDI support.

National Significance

At the time of its completion the application was innovative in at least four distinct ways that relate to the use of spatial information in public health. The first innovation is the systematic and standards based incorporation of spatial information into the management of cases and contacts of communicable diseases.

The second innovation is the support that the proposed application provides for the distributed management of communicable disease cases with the facility for the automated ‘push’ of health and spatial data to a public health department.

The third innovation is in the nature of the prospective spatial analysis that the application will perform. The application automatically searches for possible disease transmission as each new case arrives by considering the multiple locations reported for each case (e.g., home, work, and recreational locations), and searches for possible overlap with the multiple locations reported by previous cases.

The fourth innovation is the capability that the application has for credentialed sharing of spatial health information using web-services. The application allows streamlined information sharing among regional public health agencies.

Example of Application Types

- Timely identification of the geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

This work strongly relates to the identification of user information needs. It also categorizes the various users who could benefit from the use of the application.

Universal Applicability

The project is relevant to all jurisdictions in Canada.

Special Challenge Addressed

There was a need for greater geographical resolution than current applications allowed. In terms of existing CGDI web services it was determined that most CGDI-endorsed web services provide data at a resolution that is too low for the users' needs.

Key Results and Lessons Learned

It became clear early in the project that a large proportion (approximately 15%) of the addresses contained in the database of the public health department were not valid. As a consequence, an address correction model was developed for the Dracones system.

There were technical challenges related to dependence on other 'legacy' systems and data quality. Some barriers were encountered in integrating Dracones with the relational database system used at the public health department. Those barriers were due to inconsistencies in the data model of that system and the limited flexibility of the proprietary interface used to access that system.

It took considerable effort on the part of the development team to maintain the active participation of the staff at the public health department, despite their strong interest in the project. This barrier was attributable mainly to short staffing and staff turnover.

Adoption of open source geospatial technologies is not straightforward for traditional IT departments. There were issues related to the technical training of the staff and their concerns over the lack of support for the software.

HE-1 – Geospatial mapping of respiratory and gastrointestinal hospital visit data through a regional, real-time, emergency department surveillance system

Geospatial mapping of respiratory and gastrointestinal hospital visit data through a regional, real-time, emergency department surveillance system (Infection Watch Live – IWL)

Project Id:	227126 (HE-1)
Project Category:	Health Emergency Response
Project Sponsor:	Kingston, Frontenac and Lennox & Addington Public Health (KFL&A), Kingston, Ontario
Collaborators:	Infonaut
	ESRI Canada
	The Sault Ste. Marie Innovation Centre (SSMIC)
Contact	Dr. Kieran Moore
	Kingston, Frontenac and Lennox and Addington Public Health
	221 Portsmouth Avenue
	Kingston, Ontario (Canada), K7M 1V5
	Telephone number: (613) 329-1191
	Fax number: (613) 634-6299
	Email address: moorekieran@hotmail.com kmoore@healthunit.on.ca

Project Description

Purpose

This project aimed to inform health professionals and the public directly about real time utilization of seven local Emergency Departments for respiratory and gastrointestinal illness to enable informed decision making. In particular the spatial visualization of this data will allow infection control practitioners, family physicians, community access centers, long term care facilities, schools and child care centers amongst others to know immediately of the current respiratory and gastrointestinal infectious activity in the community. This will provide immediate access to data to assess the current level of activity of illness in communities served and whether they are located in a "hot" zone. The desired goal is to reduce morbidity and mortality in the community from infectious illnesses by providing the right message to the right people in the right place, at the right time.

Intended Benefits

The online presentation of data will free up resources by negating manual notifications via email and/or phone. The spatial view along with analytic methods will allow the surveillance team and other health care professionals the ability to identify disease outbreaks in a timely manner. Other public health personnel will be able to use this data to plan effective disease control strategies, implement infection control measures and education campaigns. The project will make available to a broader audience a valuable public health surveillance tool and enhance general awareness of infectious disease in the community.

Effected Stakeholders

The main end-users of the application are the Medical Officers of Health from KFL&A Public Health and Hastings and Prince Edward Counties Health Unit (HPECHU), local physicians/nurses and hospital administrators. Other users include local citizens, child care professionals, school staff, employers, police and fire officials and community care access centres. All have real-time access to geospatial data on a regional basis informing them of respiratory and gastrointestinal outbreaks and link them directly to further information to ongoing epidemiological analyses such as viral lab tests (e.g. Influenza and RSV results) and results of suspected reportable gastrointestinal diseases. The product incorporates a zero-learning curve GIS interface design; a tool that is easy to use and understand upon an initial visit by members of the general public.

Under the Health Promotion and Protection Act (HPPA) several user needs assessments have been done at KFL&A Public Health for the Kingston Township and Rural Areas looking at medical care, child care, transportation and areas of high service use. User Needs Assessments (UNA) are also an ongoing process under the HPPA and are an essential part of quality assurance. During the pilot phase of the Emergency Department Syndrome Surveillance (EDSS) a UNA was performed which interviewed nurses, emergency department physicians, public health workers and emergency management officials asking what modifications were needed to improve the display of the bi-weekly reports, how they were reported and published and what information was most beneficial to these end-users. Not only does the EDSS meet the requirements of the HPPA, the collection and dissemination of the EDSS fulfills the obligations of the Medical Officer of Health (MOH) under the HPPA. This new, innovative presentation of the data within this GDSS enhances the priority of the MOH to improve the health of Ontarians through informed decision making and implementing appropriate precautions.

Proven techniques for building user-centered information systems were applied throughout system development. These include:

- Identification of a pool of potential users from the general public that represent a variety of demographics, geographic locations, and technical proficiency;
- Regular contact with the potential user pool, including user interviews, focus groups, and Joint Requirements Planning (JRP) techniques;
- Development of Use Cases, and graphical / textual models of user requirements;
- Prototyping application design for discovery, observation, and validation of user needs;

- Structured walk-though; and
- User acceptance testing.

As primary users, Public Health and hospital emergency department staff, need to view infection data. Infection Watch Live has the capability in the advanced maps for the user to ‘zoom in’ on particular areas at which point all of the important landmarks (e.g. hospitals, long term care facilities, schools, daycares and large employers) become visible to the user. Each landmark has name, address and contact information attached to it when the user ‘cursors’ over each individual point of interest.

Family Physicians need help to confirm assumptions / diagnosis; patient education and reinforcement of behaviour. Doctors can use Infection Watch Live as a reference point of what is occurring in real-time in the emergency departments in regards to respiratory and gastrointestinal illness. This in turn may help physicians better prepare for their visiting patients on any day. Doctors can also direct patients to the website which has information and fact sheets pertaining to these illnesses which can reinforce the suggestions given to their patients.

Health care institutions, schools and large employers need population illness information to plan for HR shortages caused by absenteeism, better inform families and to refer their stakeholders to a central repository of disease information. Administrators and business managers will be able to use Infection Watch Live on a daily basis much the same way as physicians would. They can see what is going on in the community and around their institution and plan for potential staffing shortages due to circulating illnesses. Newsletters and announcements can also be made based on the information from the website for precautionary measures aimed at employees and parents of schoolchildren.

The general public has a need to be informed about infections: symptoms, precautionary information, fact sheets and recovery periods. They now have a website that they can use to be proactive when they think their children or themselves have an illness. With the many resources available on the website the hope is that community members will stay out of hospital emergency rooms when unnecessary which will decrease the burden on physicians and also help mitigate the spread of disease.

Many other geographic regions such as the rest of Ontario, bordering provinces and bordering states, can view data from the EDSS system.

Approach and Methodology

The development team created a Geospatial Decision Support System (GDSS) that uses anonymized, non-identifiable, real-time hospital respiratory and gastrointestinal data, in an effort to improve the sharing of information and enhance communication between the community, professional end-users and decision makers. This was accomplished through an existing real-time (EDSS) system in Kingston. The EDSS system has already been demonstrated to be a valuable addition to the public health surveillance toolkit and has been recognized provincially and internationally as a highly valued and worthwhile approach to disease surveillance. The EDSS system had alert investigations that are shared with appropriate decision makers but the GDSS enhancement provides greater geographic data and include anomaly detection and is open for public viewing via simplified maps but does not include enhanced analysis to protect the privacy of the data.

Spatial information and analysis was added to maps which includes water systems, schools, long-term care facilities (LTC), public health unit boundaries, primary care facilities and clinics, hospitals, forward sortation area (FSA)boundaries, streets and railway layers. Data is mapped by postal codes collected at time of triage at a minimum of seven local hospital emergency departments which represent approximately 700-800 visits per day. The Interface is a static mapping visualization that allows limited layer and drill down capability with explanatory notes on outbreak and lab results. Users do not have access to actual data or any further descriptors that would allow for the identification of cases. The viewing of temporal, time-series respiratory visit data is also incorporated to spatially illustrate how the yearly respiratory season (e.g. Influenza) is progressing across the region, local health unit areas, and the province of Ontario. Similarly, time series data may be used to display typical gastrointestinal or norovirus seasonality. The decision support system will be distributed online as a link on the Public Health Unit's website and show daily, real-time fluctuations in emergency department volume data from hospitals within the KFL&A Public Health Unit and the Hastings and Prince Edward Counties Health Unit (HPECHU).

Use of Standards

The team leveraged existing CGDI standards and technologies to incorporate spatial information into respiratory and gastrointestinal surveillance and to enable new CGDI-endorsed data and services.

The application enables real-time integration of proprietary services (e.g. EDSS, ESRI map services) with CGDI-endorsed standards and services. Such integration enables KFL&A Public Health to more easily interoperate with other entities in Canada and overseas that are using the CGDI.

The map layers required by the application will be provided from the Public Health Agency of Canada which supplied the existing EDSS system with many of its layers to date. Additional organizations, data and services will be further evaluated for their ability to extend existing geospatial information relative to the scope of this project. Where feasible from a system performance perspective, data will be consumed using CGDI-endorsed web services.

By developing the application with CGDI-endorsed standards, spatial and non-spatial data are more easily shareable through a variety of means. For example, since data is described using the CGDI-endorsed FGDC CSDGM, the spatial data generated by the tool is expected to be more easily discovered. Data published as WMS and WFS, and data sets extractable as GML enable the data to be more easily consumed by, or otherwise shared with, other CGDI partners. Geolinked Data Access Services provides the potential for sharing the data generated with non-spatial applications.

Advantage is taken of additional standards such as Web Map Context, Web Processing Service and Filter Encoding within the application context of the GDSS, as standard means of controlling the display of the map service for end-users, and to exact control underlying attribute data and query results, respectively.

National Significance

This initiative addresses the Public Health thematic area and both the Population Health Surveillance and Health Emergency Response and Inter-Emergency Planning priority issue outlined by GeoConnections. The results of this initiative seek to improve and protect the health of Canadians by allowing users to detect outbreaks in the community earlier than previous traditional methods and display these results for end-users. Numerous elements all point to the usefulness of the application and other Health Units should plan to incorporate such a system in their own jurisdiction.

Keeping this tool running will show other areas of Ontario and possibly Canada that such a project is worthwhile and should be implemented on a wide scale. This 'pilot' project has the potential to allow for the sharing of GIS expertise and data in the tracking of diseases.

In general personal data privacy should not be an issue for public health applications as they use anonymized data and do not involve patient identifiers or specific geographic locators beyond postal code nor do they deal with diagnostic data.

Substantial expertise is available to undertake the development of geomatics applications for public health. Public health agencies have among their staff persons with skills in analysis, research and project management, although their geomatics experience may be limited. To assist them there is a wealth of willing expertise in geomatics health activity in not-for-profit agencies, universities and the private sector.

The business case for more public health geomatics development and use is strong. Development and maintenance costs are relatively low when compared with the added efficiency and effectiveness of public health agencies that result from their introduction.

This project reflects an application that relates to:

- Timely identification of the geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

The application was designed to meet the needs of a variety of users with differing needs. The application is very user friendly. There is a formal procedure for the on-going assessment of user satisfaction.

Universal Applicability

Infection Watch Live, developed by Kingston, Frontenac and Lennox & Addington Public Health, is a leading national practice that should be universally introduced to the public health community across Canada

Key Results and Lessons Learned

The advanced maps section of IWL posed a problem as it really slows down the overall performance of the website. This is due to the functionality of zooming in and out and the dynamics of these maps. This was overcome by limiting the number of users that have access to these maps. It was felt that most users don't need the drill down capability. The advanced maps section is password protected and only key stakeholders (e.g. doctors, nurses, administrators) are granted access.

The major hurdle of this project proved to be with the launch and the implications that IWL will have on the community. Key users such as health unit Medical Officers of Health and managers expressed concern about the public and media's reaction to maps showing 'red, elevated areas of activity'. Meetings took place between the creators of IWL and stakeholders to map out protocols and the appropriate actions that need to be taken in certain situations.

Natural Resources Canada / Ressources naturelles Canada

HE-2 – User Needs Assessment, GIS Web-Enabled Decision Support System for Animal Emergencies

User Needs Assessment, GIS Web-Enabled Decision Support System for Animal Emergencies

Project Id:	355846 (HE-2)
Project Category:	Health Emergency Response
Project Sponsor:	CVO/Food Safety Knowledge Center, Manitoba Agriculture, Food and Rural (MAFRI) Initiatives
Collaborators:	Canadian Food Inspection Agency (CFIA)
	Prairie Farm Rehabilitation Administration (PFRA)
	Emergency Measures Organization (EMO
	Public Safety Canada (PSC)
	Public Health Agency of Canada (PHAC)
	AMEC Earth and Environmental (Consultant)
Contact	Dr. Chris Green
	Manitoba Agriculture, Food and Rural Initiatives
	545 University Crescent, Winnipeg MB R3T 5S6
	Telephone number: 204-945-7640
	Fax number: 204-945-8062
	Email address: chris.green@gov.mb.ca

Project Description

Purpose

The lack of a well developed decision support system to support all phases of animal emergency disease management (prevention/mitigation, preparedness, response, recovery) severely hobbles the ability of CVO/Food Safety to fulfill its role in preparing for and managing animal disease emergencies in Manitoba.

This lack of a decision support system to coordinate and track disease eradication efforts puts Manitoba agricultural production, as well as the health of Manitobans at unacceptably high risk. Unless an animal disease outbreak is immediately contained within the first few days of its introduction, it can rapidly decimate the affected industry. Rapid containment of an animal disease outbreak is also critical to ensure that potentially zoonotic diseases do not move from animals into the human population. This is especially a concern with AI, where it is feared that the AI virus could mutate into a form that could cause significant illness and mortality within humans (Pandemic Influenza).

In order to address this provincial short-coming, the intent is to develop a GIS-enabled Web-based Decision Support system to maximize the capacity of industry and government in Manitoba to prevent, prepare for, respond to, and recover from an animal disease emergency in as coordinated, timely and effective manner possible. The system will dynamically capture and integrate in real time a diverse range of spatial, industry and surveillance data and will generate and distribute the maps and analytical reports required to effectively plan for and manage an animal disease emergency. The system will be designed and deployed in such a manner as to ensure that all emergency response information is handled in a secure and confidential manner.

The purpose of this phase of the project was to conduct a User Needs Assessment (UNA) which is the first stage in the development cycle for the proposed system. It is intended to provide CVO/Food Safety with the most appropriate informational, functional and operational requirements for the decision-support system to meet its organizational objectives as well as internal and external stakeholder requirements. It is also, a component of support for an application for additional GeoConnections funding to build the required system.

The objectives of the User Needs Assessment were to:

- Identify and prioritize the core business functions/user needs that the decision support system must address in the four functional areas relevant to emergency preparedness (prevention/mitigation, preparedness, response, and recovery);
- Identify the technology requirements to implement the system at both central and end-user levels;
- Identify the range of data sources required to feed the system, as well as the CGDI endorsed standards, specifications, services, and technologies that could be employed in the application;
- Explore issues relating to data confidentiality and security, and the legal frameworks/MOUs required for sharing data between jurisdictions;
- Delineate opportunities for interoperability between the proposed system and existing data systems;
- Identify methods/strategies required to ensure that core premise data is complete, accurate, and up to date;
- Scope out long-term issues relating to system ownership, sustainability, maintenance and enhancements; and
- Generate a technical business requirements document of sufficient detail to facilitate rapid progression to the "build phase" of the system (development of detailed functional requirements and application build).

Intended Benefits

The output of the eventual DSS will allow CVO/Food Safety and its stakeholders to effectively execute the four phases of emergency management with regard to animal disease emergencies:

Prevention/Mitigation.

The system will support the prospective identification of provincial regions at highest risk of disease transmission. Farms in these regions can be targeted for intensive prevention efforts.

Preparedness.

The system will support the execution of realistic disease simulation and table top exercises. This allows participants to learn and improve their response capabilities and it allows the user to remain familiar with the use of the system.

Response.

The system will provide a mechanism for "one-stop" capture of all relevant emergency information and the dynamic integration and mobilization of these data for improved decision making. This is the core component of the system as it will enable decision makers to determine:

- Whether disease is suspected to be present on a premises
- Whether there is a disease outbreak
- If there is a human health risk
- The magnitude of the outbreak
- What and where is the at risk animal population
- The control are and impacted premises
- If movement control is required
- What to communicate to stakeholders

Recovery.

The system's information will provide an empirical basis for implementing fair compensation programs for affected producers, working with international trading partners to demonstrated disease free status, following up potential long-term effects on the human population and supporting post-outbreak debriefing exercises.

More specifically, it is envisioned that the system will have the data exchange mechanisms to capture and integrate core spatial framework data from the CGDI and the Manitoba Land Initiative (MLI), up-to-date agricultural premise and animal count information from local industry/commodity group databases, laboratory testing data from the provincial veterinary laboratory, and disease investigation / surveillance data captured in both provincial and federal systems including the Canadian Food Inspection Agency's (CFIA) Canadian Emergency Management Response System (CEMRS).

The system will have the capacity to use these data to serve out Internet based surveillance maps of infected and at risk premises generated through risk buffering, centrally track the infection and control status of affected premises, generate tabular estimates of the number of animals at risk, infected and destroyed, create prioritized work lists to guide the work of surveillance and destruction crews, and generate bio-secure routing scenarios/options to minimize the possibility of further disease spread from infected animal carcasses to uninfected premises en-route to a disposal site. Historical information captured within the system during the response stage of the emergency will be available for managing recovery activities and for retrospective analysis of the outbreak.

Effected Stakeholders

There are two groups of project stakeholders and they will have varying roles in the Decision Support System for Animal Emergencies:

- Government Agencies;
- Direct users. The MAFRI will use the system to mitigate, plan and prepare for as well as respond to an animal disease emergency. The CFIA will use the system to prepare for as well as respond to an animal disease emergency;
- Indirect user. The PFRA&E will provide geomatics support to prepare for as well as respond to an animal disease emergency;
- Recipients of information. EMO, PSC and PH will receive information during a response to an animal disease emergency; and
- Non-Government Organizations. The various producer organizations will be very restricted users of the system. They will receive information to prepare for and coordinate communication with their producer group during an animal disease emergency.

Primary Users

These users require a rich set of analytical capabilities and act as synthesizers of data for analysis and publication. There will be two such users. The MAFRI will have full direct access, while the CFIA will have full direct access for desktop exercises and during the response period.

Secondary / Tertiary Users

The PFRA&E will have limited direct access in their geomatics support role as well as access to the communication portal and as a recipient of information products. Manitoba producer organizations will have limited access to the system during desktop exercises and the response period as well as access to the communication portal and as recipients of information products.

The tertiary users will only have access to the communication portal, primarily consuming output products of the system such as situational awareness information and reports. This group includes EMO, PSC and PHAC.

The project was successful in meeting end-user needs, i.e., provided end-users with clarity on the wide range of user needs which must be addressed when building a decision support system for animal emergencies, and of the critical technological and organizational issues which must be addressed for such a system to be built, managed and sustained successfully over time.

Approach and Methodology

The approach taken for this project was to review existing documents, use workshops and interviews to define the user needs and to assess the system environment. The project activities included:

- A project planning session with the project steering committee to:
  - Review baseline requirements defined through previous work
  - Verify the structure of the UNA document
  - Define the approach to the requirements definition workshops
- Government Stakeholder Workshop attended by MAFRI, CFIA, PFRA&E,EMO, PH and PS Canada:
  - Reviewed and defined the business requirements as a group
  - Through group sessions defined the functional and informational requirements of the higher level business requirements
  - Each group reviewed the work of another group
  - In a full participant session reviewed and commented on the functional informational requirements as well as the roles and responsibilities of each organization
- Producer Stakeholder Workshop attended by the MAFRI, Feather Boards, Pork Council and Transportation representatives:
  - Reviewed the project objectives, discussed the requirements defined in the previous workshop and presented the system concept
  - Reviewed the Premises Database legislation and what it means to this project
  - In open discussions addressed the producer organization roles in an emergency and the interaction they expected with MAFRI and the system during an emergency response

Use of Standards

The UNA addressed how CGDI standards would be implemented in a system build. The proposed application will be built using CGDI compliant mapping technology. Where available, the application will utilize data from the CGDI-compliant Web Map Services (WMS) from various federal and provincial government agency sources. These will include several framework spatial datasets such as administrative boundaries, biodiversity data, topographic data, land use/land cover, aerial ortho-imagery and geographic place names. The application will use standards that are described under the National Agriculture and Food Traceability System (NAFTS) and the CGDI Critical Infrastructure Data Model for the storage and management of livestock premise and sub-premise data. Any transfer of livestock premise information from third party Industry sources will utilize CGDI compliant Extensible Mark-up Language (XML) file format.

National Significance

Since the project was developed with the involvement of several federal partners, it is anticipated that the final DSS will have significant potential to be deployed by other jurisdictions across Canada. CFIA, for example, has nation-wide responsibility for the management of animal disease emergencies, but currently does not have in place the geospatial decision support systems required to optimally mange emergency situations. The only Canadian jurisdiction with such a DSS is Quebec.

This application would relate to several application types, including:

- Timely identification of the geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

The project clearly identified the range of needs of a variety of users who will benefit from the proposed DSS application.

Universal Applicability

The final DSS should ideally be developed for national use with CFIA as the lead agency in recognition of its nation-wide responsibility for the management of animal disease emergencies.

Key Results and Lessons Learned

The major lesson learned included:

- The importance of working with a contractor who is willing and able to meet tight time-lines; and
- The importance of taking the time for stake-holders to work through complex issues in order to come to an understanding of the perspectives of others when defining user requirements - this results in a richer and more comprehensive understanding of user needs.

CG-1 – Strategic Planning for Eastern Health Region

Strategic Planning for Capacity Development in Public Health Geospatial Information Systems for Eastern Health Region

Project Id:	359128 (CG-1)
Project Category:	Comprehensive Geomatics Programs
Project Sponsor:	Newfoundland and Labrador Eastern Health Region
Collaborators:	Newfoundland and Labrador Centre for Health Information
	Division of Community Health & Humanities, Faculty of Medicine, Memorial University
	Department of Geography, Memorial University
Contact	Dr. David Allison, Regional Medical Officer of Health
	Eastern Health,
	20 Cordage Place, St. John's, NL,
	Canada A1B4A4
	Telephone number: (709) 752-4192
	Fax number: (709) 752-4873
	Email address: david.allison@easternhealth.ca

Project Description

Purpose

The significant demographic, economic, and ecologic differences between the urban and rural communities serviced by Eastern Health make it important to conduct population health surveillance that considers these differences. Geospatial information is essential in understanding the ecological context in which diseases occur and is vital to preventing or dealing with outbreaks, especially in such a large and complex service area. Rural communities within Eastern Health have also recently experienced significant industrial development and will continue to do so in the coming years with the proposed construction of a new nickel processing plant and an oil refinery, among other proposed projects. Geospatial information will be essential in monitoring the potential impacts of these developments on population health. The rural office of Eastern Health participated in the development of the Public Health Map Generator with the Public Health Agency of Canada. This process highlighted the need for a more robust geospatial tool and databases amenable to geospatial analysis that could be easily accessed and shared within the organization and with its external partners.

Eastern Health did not have the capacity to use or access geospatial data. Along with an increasing awareness of its usefulness within the public health community there is an increase in the utilization of public health data for surveillance and decision-making. Together, these developments now provide a strong foundation that Eastern Health and its partners looked to strengthen during the strategic planning process in order to incorporate geospatial information into public health.

The ultimate objective is to develop a web-based health information tool that can be used to support population health surveillance. This tool will integrate geospatial information to allow public health officials in communities serviced by the Eastern Regional Health Authority to conduct enhanced population health surveillance and emergency planning.

The objectives of this initial project were to develop strategic and business plans that will ensure the tool is sustainable, that the planning process stimulates a collaborative engagement of regional and provincial services, and leverages the Canadian Geospatial Data Infrastructure.

Intended Benefits

Population health surveillance reports of chronic and communicable diseases and many determinants of health are currently not readily available with sufficient geographical information. The information that public health users obtain is often out-of-date or inaccurate, which can compromise decision making. Building public health GIS capacity will enable Eastern Health to integrate spatial and epidemiologic data to enable analysis of variables that play important roles in communicable and chronic disease prevention and control. This integration is essential for health policy planning, decision making and ongoing surveillance efforts. GIS can provide public health staff with the ability to locate high prevalence areas and populations at risk and improve decisions on resource allocation. Building GIS capacity would complement ongoing decision-making support efforts for public health (i.e., Panorama) as well as support efforts around health service delivery (i.e., Congos, Electronic Health record).

One of the benefits coming out of this project was the establishment of strategic partnerships with Eastern Health and its collaborators. The strategic planning process will help to bridge information silos, fill information gaps, ultimately improve decisions related to programming and resource allocation and provide direction for public health surveillance. In addition to providing support to programming over the long term, the plan will assist in preparing for public health emergencies such as outbreaks and pandemic influenza.

The vision is to have a geospatial infrastructure and shared human resource capacity with Eastern Health partners that will allow the organization to incorporate 'place' based information and analyses into routine public health activities. Eastern Health also envisions having information that will support community planning by economic zone boards, municipal governments, and NGOs. An added value would be training and research opportunities. For example, one of the university partners, the Department of Geography has a Geographic Information Sciences diploma program which would benefit from the learning opportunities and skills enhancement that would come with this project, just as Eastern Health and its other partners would benefit from the added human resource capacity.

Strategic planning is the first step towards building a web-based health information tool that can be used to support population health surveillance for public health programs and for responding to public health emergencies. The intended results of this initial project are to develop strategic and business plans that will ensure the tool is sustainable, that the planning process stimulates a collaborative engagement of regional and provincial services, and leverages the Canadian Geospatial Data Infrastructure.

The system will have the ability to tap into numerous, interoperable and up to date data sources in order to better identify disease trends, avert risks and prepare for public health emergencies. For example:

- Data on population density, and infrastructure location, would aid in both identifying disease trends and preparing for an epidemic;
- Mapping of determinants of health such as income, education and risk factors such as smoking rates or obesity can contribute to the understanding of the impact of diseases and interventions or the need for specialized services;
- In combination with information on cases and time of onset of symptoms, data on the routes of municipal water supply lines could provide key “place” data in an enteric outbreak investigation;
- Layered data on population density, emergency response location and proximity would also aid in all hazards and pandemic planning; and
- Decisions with respect to the allocation of public health resources throughout the region could be better informed with geographical information related to population density, distribution of determinants of health and distances traveled in the delivery of services.

Effected Stakeholders

The use of geomatics by epidemiologists, health practitioners, policy-makers and others within the public health community is growing. The capacity to access and appropriately use geospatial data is of particular importance in regions where epidemiologic expertise is limited yet there is definite need to accurately assess population health issues and respond effectively. Ultimately, strategic planning would provide the necessary foundation for placing this capacity into the hands of key public health practitioners and decision makers within the Eastern Health Region and provide a focal point for development across the province.

The strategic planning process provided an opportunity for Eastern Health to collaborate with various key external stakeholders and to increase dialogue between divisions within the organization. Through this process, support from Eastern Health’s Executive team was obtained and as a result the organization and its partners are more committed and better positioned to build GIS capacity.

Primary Users

Eastern Health:

- Medical Officer of Health
- Epidemiologist
- Communicable Disease Nurses
- Manager of Environmental Health and Communicable Disease
- Research Assistants

- All Hazards Emergency Response Coordinator
- Pandemic Emergency Response Coordinator and Planning Specialists

Secondary / Tertiary Users

Epidemiologists - Newfoundland and Labrador Centre for Health Information (NLCHI)

Researchers - Memorial University of Newfoundland

Statisticians - Newfoundland and Labrador Statistics Agency's Community Accounts

Approach and Methodology

A general assessment of current capacity and limitations with respect to hardware and human resources was undertaken and a broad plan for the capacity development process was developed, to include a timeframe, resources required and projected costs.

The key activities undertaken were:

- Establish Steering Committee including project proponents and other key players;
- Conduct internal and external analyses to assess existing capacity and potential for future development: review relevant documents; develop questions; conduct focus groups; interview key informants;
- Summarize the current situation including systems, data, personnel and training capacity;
- Identify and validate key requirements (goal setting and defining objectives);
- Develop a draft strategic plan including positioning in the region's overall Strategic Plan;
- Validate the draft plan with key decision makers;
- Develop the business plan;
- Confirm support for the Strategic Plan from Senior Executive within Eastern Health and from collaborating partners; and
- Achieve commitment from partners to ensure sustainability.

Use of Standards

The strategic and business planning process did not require direct utilization of the CGDI; however it did promote the CGDI by articulating the benefits that Eastern Health would achieve through adopting CGDI standards and accessing CGDI content. Eastern Health intends on adopting geospatial standards during the capacity building phase.

The adopting of the CGDI will allow Eastern Health and its partners to access and share geospatial data and other information directly from a variety of authoritative sources through the use of common standards.

Public health data related to socioeconomic status, the environment, and risk behaviours could be contributed to the CGDI. Contributing this data would ensure that information is operational with other data sources.

National Significance

Eastern Health, as part of the Newfoundland and Labrador health services system, was starting from a less-developed state regarding GIS capacity and applications than is found in several other provinces. However, by starting at the strategic planning phase, they have placed themselves in a position to take maximum advantage of limited funding that will be available to address health-related GIS development needs.

This project reflects planning for applications that relate to:

- Timely identification of the geographic distribution of diseases
- Analysing spatial and temporal trends
- Mapping population groups at risk
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets
- Assessing resource allocation
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology

Specific User Focus

The plan addresses the needs of a broad range of users both within Eastern Health and other relevant organizations. It recognizes that user training and support will need to be provided if the organization wishes to be successful in the incorporation of GIS applications.

Universal Applicability

The Eastern Health experience will be relevant background for organizations taking initial steps to introduce geomatics activities into their work.

Key Results and Lessons Learned

New linkages were made and existing linkages strengthened through this strategic planning process with expertise in GIS, information technology, health information, and public health becoming more integrated. Various potential sources of external funding have been identified. However, the support of Eastern Health's executive team in the form of matching funds and in-kind contributions was critical to moving this plan forward and ensuring its long term sustainability.

Areas that need further dialogue were highlighted including governance, privacy and access to provincial information systems.

Stakeholder consultations should be performed more frequently, in order to maximize input from all sides.

Senior Management from Eastern Health is supportive of this initiative, nevertheless ongoing financial challenges and competing priorities will remain an obstacle to development. This will require continued efforts on our behalf to promote the development and implementation of GIS.

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CG-2 – Developing a Shared Strategic and Business Plan for the Calgary Consortium

Developing a Shared Strategic and Business Plan for the Calgary Consortium

Project Id:	40731(CG-2)
Project Category:	Comprehensive Geomatics Programs
Project Sponsor:	Calgary Health Region
Collaborators:	City of Calgary
	United Way of Calgary
	Calgary Board of Education
	Community Partnership Enhancement Fund (CPEF)
	Golder Associates Ltd. Consultant
Contact:	Dr. David Strong
	Deputy Medical Officer of Health
	10101 Southport Road SW,
	Calgary Alberta, T2W 3N2
	Telephone number: 403-943-0272
	Fax number: 403-943-0226
	Email address: david.strong@calgaryhealthregion.ca

Project Description

Purpose

To facilitate the creation of a shared strategic and business geomatics plan for the Calgary Consortium aimed at strengthening public health surveillance.

The specific goals that were identified for this project are as follows:

- To identify geospatial framework (alignment layers, land feature/form layers, conceptual layers) and thematic datasets that are required to meet the shared business objectives of the partner organizations;
- To develop a strategy and plan for ensuring that the required thematic datasets possessed by the Consortium members are configured to meet CGDI standards, and to develop a sustainable process for ensuring compliance to these standards;
- To develop a sustainable business model for the Consortium for accessing the required framework data from public and private sector geospatial data suppliers;
- To develop a shared and sustainable business model for incorporating a CGDI-compliant web mapping service(s) and applications that would allow Consortium members to share geospatial datasets and to display thematic data over a web environment to internal and external end-users.

Intended Benefits

The consortium's members considered it desirable to identify all the geospatial priorities and develop an integrated business plan that addresses those priorities rather than individual business units adopting disparate solutions that may not be compliant with CGDI standards.

In 5 years it is hoped that the Calgary Consortium has evolved such that the CGDI has been exploited to its fullest potential, that the barriers currently in place with respect to incorporating spatial analysis into public health and environmental health protection have been removed, and that the partners are contributors to, as well as consumers of CGDI resources.

Effected Stakeholders

To assess end-users needs, a number of interview sessions were conducted with United Way, City of Calgary, Calgary Board of Education and Calgary Health Region groups.

Primary Users

The main users of the geospatial outputs addressed in this project are the program managers and frontline service delivery professionals working for the CHR, the City of Calgary, the Calgary Board of Education, United Way of Calgary and its affiliated agencies, and the public living within the boundaries of the CHR.

Secondary

First Nations Communities

University of Calgary

Approach and Methodology

Phase 1 – User needs interviews and documentation reviews to establish the current geomatics capacity in the partner organizations. This was aimed at discovering relevant information including:

- Inventory of current spatial data holdings including a description of how the data sets are acquired, the restrictions on their use (e.g., licensing, ownership), and their degree of compliance with CGDI standards;
- Inventory of current geomatics human resource capacity, i.e., users as well as technical support;
- Description of current technologies used within each partner organization to disseminate spatial data and maps to internal users;
- Description of technologies used to disseminate spatial data and maps to external users;
- Assessment of the positioning of spatial analysis within business intelligence frameworks;

- Assessment of the options for accessing framework datasets from federal, provincial, academic and private Data Custodians/owners; and
- Assessment of the constraints imposed by existing health information privacy legislation with respect to the sharing of spatial data over web service architecture.

Phase 2 – Development of a multi-year business plan. The consultant facilitated the creation of a costed multi-year business plan with the project leads and the technical experts from each of the partner organizations. The aim was to ensure that the strategic priorities identified in Phase 1 would be integrated into the Information Management strategic plans of each organization.

Use of Standards

A primary goal of this initiative is to move the partner organizations towards incorporating CGDI standards into their respective geomatics strategies. The rationale is that the adoption of open source standards furthers the public health and environmental health objectives of the partner organizations.

It is recommended in the Business Plan to create a metadata standard which will be used by all of the partners in the Calgary Consortium. This will involve the adoption of the ISO Metadata Standard (ISO 19115) which is the standard used by GeoConnections. The GIS Strategic Plan and GIS Business plan also highlight the need for development and implementation of a Spatial Data Warehouse (SDW) that will contain the core set of CHR spatial data, as well as access relevant data from the City of Calgary, CBE, and other partners. This would form part of the sustainable business model which will incorporate future IT and GIS expansion. Once the SDW is developed and implemented, the detailed design phase for Social and Health Atlas would focus on the selection of core software engines with consideration to existing CGDI standards, user interface design, and performance considerations.

Those involved in this project concluded that, even if it was financially and technologically practical, it is simply impossible to gather all of the aforementioned data together into a single location and in a similar format. The goal is then to make all of the data available to the vast number of users in a context of what is referred to as interoperability.

There are many benefits of connecting users within a specific community such as in public health:

- Shared vision/risks/benefits
- Diversification of business lines, services and products
- Developing best practices and partnerships
- Own what you must and access what you need
- Speed the integration of geo-technologies with mainstream and enterprise IM/IT applications

National Significance

This project demonstrates that it is feasible for several users within the same geographical area, but with a limited amount of commonality in service mandates, to collaborate on geomatics initiatives. Due to a common set of geospatial information that serves their interests. Also, there are savings to be realized from such collaboration by the avoidance of duplication of technology, software and specialized human resources.

Public health agencies benefit as well by strengthening relationships with organizations that can assist them in their disease surveillance, outbreak response, environmental monitoring and health education activities. They can also, potentially, discover sources of expertise that can be called upon to assist them in their geomatics activities.

Example of Application Types

This project reflects the future development of applications that relates to:

Timely identification of the geographic distribution of diseases

Analysing spatial and temporal trends

Mapping population groups at risk

Assessing effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets

Assessing resource allocation

Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology

This project is an excellent example of how a common vision and a collaborative effort can result in a plan that serves the needs of a variety of municipal/regional organizations that have common needs and a willingness to share information and technology.

Key Results and Lessons Learned

There are challenges that need to be overcome in the creation of a health and social atlas for the CHR. These have been identified by the GeoConnections program and are very typical in public health challenges in the application of geomatics technologies (after Wesch, 2006):

- Developing awareness and understanding of geospatial analysis, and undertaking geomatics projects
- Lack of training and capacity – in both human and financial resources – for geospatial analysis
- Ensuring work is complimentary to and informed by other initiatives (e.g. Canada Health Infoway, Pan-Canadian Public Health Surveillance project)
- Building tools that allow for the secure sharing of geospatial information between organizations and across multiple jurisdictions

- Breaking down barriers to data sharing

It is recommended that training be an on-going process to maintain the institutional knowledge of GIS technology, standards to support the continuous improvement around the use of GIS within the CHR as well as the project partners.

Ultimately, CHR will need to fully embrace the spatial or geographic domain and recognize its strategic value to the organization, as well as the project partners. Geography and spatial awareness are significant to CHR and a few groups have started to make extensive but mostly independent use of the technology. In terms of spatial information being both valued and truly embraced as a corporate/enterprise asset and managed accordingly, there is still much progress to be made.

Some key questions to ponder in moving forward are:

- How important is GIS to your organization?
- How "spatially informed" is your organization (outside of current users)?
- Does your organization truly value the spatial data investment made to date?
- Who is minding the spatial data "store" and who ultimately owns the GIS initiative?

Answering these questions will certainly help to move GIS from the current state of a project-by-project or group effort to a strategic corporate information asset and resource.

Process

The Business Plan explains that the successful execution of a GIS Strategic Plan requires a number of steps which need to be addressed in a logical sequence to make sense and provide the greatest value and direction. These steps are as follows:

Creation of a metadata standard for the consortium

Development and implementation of a Spatial Data Warehouse in the public health agency

Creation of a detailed design for the geomatics application.

Development of along-term hosting solution for the spatial data warehouse and the online application.

The project partners must demonstrate a strong commitment to enabling the goals of the project including the incremental adoption of CGDI standards. The adoption of many CGDI standards will be required to enable the collaborative initiatives to succeed.

Best Practices

Several western Canadian urban health regions are moving towards developing Public Health Observatories and ultimately creating a network.

The Calgary Health Region has set a priority of creating a Public Health Observatory that is modeled on the United Kingdom (UK) observatories that were established in 2000. There are nine Public Health Observatories in the UK, and what distinguishes them is their formal commitment to working collaboratively, to add value to existing health and social information, and to focus on identifying and describing health inequities. Spatial analysis and the use of mapping applications are the main tools used by the Observatories to root out health inequities. The CHR wishes to take their approach to a higher level of achievement.

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CG-3 – Strategic Plan for Health GIS Implementation in BC: A Focus on Health Surveillance

Strategic Plan for Health GIS Implementation in BC: A Focus on Health Surveillance

Project Id:	230586 (GC-3)
Project Category:	Comprehensive Geomatics Programs
Project Sponsor:	Population Health and Wellness and Knowledge Management and Technology - BC Ministry of Health
Collaborators:	Corporate Resource Information Management Division (CRIM) - Integrated Land Management Bureau (ILMB)
	Regional Health Authorities
	British Columbia Centre for Disease Control
	Health Officers' Council of BC
	BC Public Health Information Project Steering Committee
Contact:	Russell Fairburn
	BC Ministry of Health
	1515 Blanshard Street
	Victoria BC
	V8W 3C8
	Telephone number: (250) 952-1439
	Fax number: (250) 952-1713
	Email address: Russell.Fairburn@gov.bc.ca

Project Description

Purpose

The primary goal of this project was to achieve consensus among the executive level of the Ministry's administration that development of a ministry-wide health geospatial information system is a part of Ministry's strategic and sustainable business plan, and this system is essential to support a variety of the Ministry's business operations and services.

Geospatial technology had been utilized by different programs within the Ministry. Such usage was uncoordinated and had the potential to result in duplicated efforts in software purchase, development, spatial information inquiry and maintenance, and discrepancies in data or technology standards. A centralized Health GIS (HGIS) would enable consistent and sustainable uses of geospatial information technology to support services within the Ministry.

This project articulated strategic options for the implementation of Health GIS in the context of the needs of the BC health system and existing government information infrastructure.

Deliverables included definition of the needs for Health GIS in the BC Health System, documentation of high level requirements, description of existing resources and gaps and the proposal of a range of options for the incremental development and implementation.

One of the important aims of the Ministry's information management framework is to increase the use of data in support of evidence-based decision making throughout the system. Innovative approaches to information delivery, as envisioned by projects such as this will further these goals.

Intended Benefits

This plan will guide the Ministry, communicate its internal directions regarding the use of GIS, and help ensure that it is aligned with the Provincial GIS Strategy so that it may reap the benefits of leveraging the larger shared services model. The establishment and maintenance of cross-organizational partnerships is an important component of these projects, leveraging existing spatial infrastructure and thus minimizing duplicated efforts and costs.

The strategic plan for the Ministry's Health GIS system will enhance the capability to analyze and deploy health information to variety of users.

It is anticipated that the framework and foundation established by this initial planning process and the projects to follow will allow the incremental building of centralized, collaborated, and multi-purposed Ministry-wide HGIS which will enable the deployment of quality assured data and information products in support of population-based health surveillance, health system monitoring, assessment, decision support and planning in a geospatial context.

Effected Stakeholders

The users of the strategic plan will be the decision–makers in the BC Ministry of Health, the Integrated Land Management Bureau, BC Ministry of the Environment and other Ministries with related accountabilities, and the Regional Health Authorities and their associated agencies including the British Columbia Centre for Disease Control.

With this strategic planning and related projects, an increasing number of health professionals will be exposed to new GIS tools, and will become aware of the usefulness of geospatial information and technology.

The following communications objectives were established to ensure effective stakeholder involvement in the project:

- Ensure the timely release of project information to the appropriate stakeholders in order to solicit input and gain acceptance and buy-in of both the process and the final deliverables;
- Create and ensure awareness and acceptance of the objectives and scope;
- Create and maintain, two-way communication between Ministry program area staff and the key stakeholders by listening and improving the deliverables by implementing their ideas and recommendations;
- Assist the project team to obtain timely agreement on project deliverables by encouraging stakeholder participation;
- Provide a process to focus communication and to ensure that all potential stakeholders are identified and contacted;
- Educate stakeholders with respect to the project and project progress;
- Provide accurate, up-to-date information that is tailored to audience;
- Provide consistent, accurate and timely responses to project inquiries; and
- Encourage identification and support for future phases of the project.

Approach and Methodology

The Provincial GIS Strategy report was delivered in March 2007.This report is the guide for ministries already using or planning to use GIS. That report recognized that the ministries that currently benefit most from GIS are those in the Natural Resource Sector who have a long history of its application. New applications for GIS are now being found by ministries in the health and social sectors.

The BC Government is a multi-participant environment and to be successful, it holds that GIS business solutions must meet needs that are common to all users as well as the unique business needs within each ministry. The established shared service model within the BC Government is provided by the ILMB. Established GIS ministries each leverage this shared services model in a different way as defined by their business requirements; some use the complete package of standards and services while others use only select components.

The CRIM has maintained a rich geospatial data warehouse and provides standard geospatial information and services to provincial governmental agencies. The CRIM and Ministry of Health have built a close partnership through a previously GeoConnections funded health GIS project, A Spatially-Enabled Population Health Framework for Communicable Disease Surveillance. This project demonstrated the desire of both organizations to continue a partnership in geospatial information sharing, analytical services, and deployment. Some base geospatial information, such as provincial administrative and health boundaries, locations of communities, physical environmental features, and transportation networks, has been well maintained by the CRIM and will be utilized as the primary source for the Ministry's HGIS system.

The CRIM has also maintained a powerful web-GIS tool which is feasible for direct and customized applications. As a partner, the Ministry will take advantage of the existing system to develop applications specifically relevant to health.

The emerging GIS ministries, including the Ministry of Health, are in the early stages of developing their own GIS data, applications and workflows. Prior to this project, GIS technology within the Ministry of Health had been utilized by different program areas on a project-by-project basis, often uncoordinated and with duplicating effort and costs.

One of the major projects recently completed, the Aggregated Health Information Warehouse project (AHIP), developed a database and access/query mechanisms with support for spatial data. It can be used to perform both the information integration and the generation of analytic results consistently on a partially automated basis for ongoing health monitoring.

The outputs of the MOH's HGIS strategic plan project include:

- Identification of user requirements;
- Current trends and use of health GIS in government at national and international level;
- Summary of health GIS applications that are currently implemented in the MOH, health authorities, and other organizations across the province;
- The uniqueness and added values that a health GIS can bring to the MOH's goals, missions and services;
- Applications that should be developed;
- Technical requirements to implement HGIS;
- Resources, both human and technological, to support HGIS;
- Data requirements and sources for the HGIS;
- Data transfer mechanisms, data storage options, data standards (adoption or development), and data documentation (metadata), as well as data sharing, privacy and security;
- Training requirements for implementing HGIS;
- Comparison between required investments and available resources; and
- Overall financial commitments for 1, 3, and 5 years.

Use of Standards

The Ministry of Health understands that sustainability, interoperability, and common standards are three fundamental requirements for the development of any geospatial information system. With the services and resources provided by CGDI. CGDI can be used to assist the Ministry in meeting its goals in the following manner:

- Adoption of CGDI endorsed standards in the areas of geospatial data manipulation (metadata for geospatial data), resources publication, discovery, data visualization, access, and description;
- Review, analysis and selection of appropriate existing national framework CGDI base layers;
- Identification and development of health geospatial data products and specifications;
- Public sharing via CGDI of health geospatial data products;
- Use and development of metadata and associated metadata management methodologies;

- Adoption of CGDI technical standards to facilitate maximal integration between projects, jurisdictions and disciplines; and
- Sharing the results projects for wider use across jurisdictions and disciplines.

National Significance

As the Ministry adhered to CGDI and other recognized standards, there is an expectation that information and models developed through this project and through the eventual operational use of an HGIS will be of interest and value to other organizations and jurisdictions.

The involvement of medical professionals in the development of HGIS expands the applicability of GIS in health and human services areas and as a result the HGIS strategic planning and the projects guided by this plan will benefit CGDI by promoting GIS uses in these areas and providing precedents for their application in a health context.

In relation to the opportunity to expand the use of GIS to the health sector, there are issues related to the application of GIS to health that are unique. For instance, privacy issues in data modeling and disease surveillance represent a major challenge to the wide use of GIS, unless suitable models and policies are developed. The Ministry of Health hopes to provide some protocols to address such challenges.

This provincial plan relates to:

- Timely identification of the geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation;
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology; and
- Identifying best practices by comparing resource inputs to population health outcomes.

Specific User Focus

The process involved a comprehensive user needs assessment across a variety of organizations with a decision-making role in the BC health system. There is recognition of the key importance of user training and support to ensure realization of the potential benefits of GIS applications.

Universal Applicability

While broader in scope than public health, this project provides a template that other provincial and territorial governments with substantial existing geomatics infrastructure could use to cost-effectively meet the GIS needs of departments/ministries and other health organizations.

Special Challenge Addressed

During development of the Strategic Plan, challenges were faced and overcome with regard to effectively engaging business areas who have limited exposure to geospatial capabilities. This required education of the business areas to raise their level of geospatial awareness.

Key Results and Lessons Learned

Learning included realizing the shifting emphasis from developing a new GIS capability and potentially new system to spatially enabling existing health data and leveraging existing capability (including data, infrastructure, tools, processes, etc.) through partnership and collaboration with other provincial agencies.

CG-4 – Defining the Strategic and Business plans for an On-line Mapping portal To Monitor Neighbourhood Level Population Health Using CGDI

Defining the Strategic and Business plans for An On-line Mapping portal To Monitor Neighbourhood Level Population Health Using CGDI

Project Id:	174449 (CG-4)
Project Category:	Comprehensive Geomatics Programs
	Determinants of Health
Project Sponsor:	Social Planning Council of Ottawa (SPCO)
Collaborators:	Social Planning Network of Ontario
	Child and Youth Health Network for Eastern Ontario
Contact	Dianne Urquhart
	Executive Director
	Social Planning Council of Ottawa
	280 Metcalfe Street, Suite 501, Ottawa, Ont. K2P 1R7
	Telephone number: 613-236-9300 ext. 303
	Email address: dianneu@spcottawa.on.ca

Project Description

Purpose

The goal of the project was to create a strategic plan and a business plan for a collaborative, viable, multi-year implementation of a sustainable solution to meet the overall goal of increasing the capability of the SPCO and key collaborators to use geomatics to understand and improve population health.

The objectives of this specific project were:

- To implement a planning process which enhances commitment and capacity among collaborators to utilize geomatics, particularly the portal to be developed;
- To ensure the necessary partnerships are firmly negotiated which will ensure viability of the portal and its use under the confirmed leadership of the SPCO;
- To explore the possible technologies to deliver the portal, and establish the preferred strategy;
- To increase knowledge and understanding among collaborators of the opportunities provided by the CGDI and ensure the portal utilizes CGDI standards and services;
- To identify the capacity to build and training needs of all parties to ensure long term viability and credibility of the portal, as well as utilization of the geo-referenced data and maps for decision making (i.e. knowledge mobilization support);

- To establish a common agreement among collaborators of the resources needed for the portal, the process to coordinate existing resources and the strategy for securing sustainable resourcing over the long term;
- To ensure the implementation of the strategic and business plans will enhance the business practices of the social planning councils involved; and
- To develop a communications plan respecting the initiative and the lessons learned.

Intended Benefits

In 2002, the SPCO Board of Directors undertook a strategic planning process for the organization, which identified the development of an on-line data, research and mapping portal as the primary programmatic element in a significant restructuring process for the organization. This strategy was seen as a means by which SPCO could more effectively meet its mandate.

Effected Stakeholders

Primary Users

There are two main groups of end users, both working within the thematic area of population health surveillance.

The first group is the partners within the Child and Youth Health Network of Eastern Ontario. The Network includes over 80 members from across the Champlain Local Health Integration Network (LHIN) catchment area engaged in primary and population health, including government representatives, health planners, and providers of health services, community health centres and community based agencies. The Network has great difficulty accessing timely, neighbourhood level data appropriate for its decision making needs. In addition to the general challenges faced by the voluntary sector in accessing timely, authoritative and cost effective data, population health practitioners face particular challenges. The most significant of these are:

- The framework of population health, within which they work, refers to the health of a population, not individuals, as measured by health status indicators and as influenced by social, economic and physical environments, personal health practices, individual capacity and coping skills, human biology, early childhood development, and health services;
- Population health focuses not just on the determinants of health, but on the interrelatedness of conditions and factors that influence the health of populations. It seeks to identify systematic variations in their patterns of occurrence, and applies the resulting knowledge to develop and implement policies and actions to improve health. Data which can support decision making must comprehend this analytical framework. Much of the data available with respect to the determinants of health is limited to visualizing the geographic distribution of populations with a particular characteristic (e.g. incidence of low income); and
- Outcome evaluations in this framework are very complex, particularly with respect to the effect of interventions.

The second group is the social planning councils (SPCs) within the Social Planning Network of Ontario (SPNO), particularly the 13 SPCs currently within the "Geographic and Numeric System" consortium (GANIS). These users include the staff and Boards of the SPCs, and their community partners including community-based groups addressing population health, municipal governments and funding agencies, Provincial ministries, LHINs, and community based health services for vulnerable populations.

The SPCs and their respective user communities use data and geomatics as a spatial decision support tool to understand trends, populations and a spatial analysis of issues. SPCs in each community are actively engaged in activities to address core determinants of health including:

- Income and social status;
- Social support networks /social exclusion / social capital;
- Education;
- Working conditions;
- Healthy child development; and
- Culture.

Approach and Methodology

The project used the strategic and business planning methodology called "The Development Wheel". In this model, the planning focuses simultaneously on three streams: organizational development, partnerships and strategic networking and enterprise development. The methodology was modified such that the "enterprise development" stream consisted of geomatics planning.

An important part of the planning was to define clearly the mechanisms to ensure success – particularly the specifics of the technical infrastructure, partnerships and governance, protocols and security for data use and sharing, maximum integration of and compliance with CGDI, specific information products, training, specific supports to ensure mobilization of the data and knowledge for decision making and resourcing.

Use of Standards

The strategic and business plans, have integrated the following elements of the CGDI, which will be utilized as the portal is implemented:

- Ability to bring in data discoverable through various data;
- Data management systems and protocols will be consistent with CGDI standards and specifications to the greatest degree possible;
- The portal will integrate WMS, WFS, GML, SLD and filter encoding to increase efficiency; and
- Encouragement of partners to use the training and information sharing provided through CGDI.

The Strategic and Business Planning project was the first formal step in a multi-year transformation by the SPCO into using all four components of the CGDI. Early in the project

SPCO developed a service memo on existing data and services within the CGDI which SPCO, SPNO members and members of the CYHNEO could use right away. In particular, the SPCs started to use web feature services and information regarding distributed data including CGDI compliant Geodata Discovery Services for metadata search and Geodata Resource Registries.

SPCO's second major step will be the development and deployment of a new application, specifically the on-line portal to monitor neighbourhood population health. The portal will be developed as a WMS-based tool which can enhance the services of the CGDI. It will maximize use of CGDI policies, standards and protocols. CGDI services will provide complementary data layers to the mapping portal. End users will have the options of selecting data from different sources to meet their needs. SPC has already identified some CGDI services available to the community from the City of Ottawa, ESRI, Natural Resources Canada and the Atlas of Canada that would be integrated into the mapping portal. The application design will make full use of technologies, services and data as developed through CGDI. The application will use CGDI technology (i.e., WMS, WFS – serving GML, WCS, SLD, Filter Encoding and Catalogue services), data (e.g., Atlas of Canada, GeoGratis and others) and services (i.e., CGDI developer's network) within the limits of MapServer or MapGuide open source.

With the deployment of the portal, the SPCO and its collaborators, would be able to

- Share maps (static or interactive) through web applications; and
- Share data between applications using OGC web services.

National Significance

These projects, by addressing the social determinants of health and the needs of voluntary human services organizations, are quite unique. The application currently under development should be beneficial on a county-wide scale.

These projects combined reflect an application that relates to:

- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

The projects comprehensively address target users needs by focusing on the types of information they need as well as the importance of ease of use, training and support.

Key Results and Lessons Learned

Several lessons were learned that will inform future developments in the voluntary sector:

- Development of a sustainable business model in the voluntary sector is complex. No other model existed within the voluntary sector. The particular challenges were the financing structure involving partners and difficulty finding a consultant with all the skills necessary for the business plan given the innovative nature of the project.
- End users' lack of familiarity with the technology creates significant challenges. The voluntary sector lags well behind other sectors with respect to technical literacy.
- Many social planning councils were not ready for a social enterprise model of sustainable web geomatics infrastructure.
- Development of the data framework is time consuming. For the portal to be attractive to users, the offering was expanded for non-census data to be available within the portal. The primary importance of relevant data for rural areas, at a small geography, further complicated the process of identifying cost effective data.

Two policy challenges were encountered:

First, much of the data to be used in this initiative is proprietary and licensed with a fee attached. To address this challenge the data framework was carefully developed to identify reliable data which could be provided to partners without violating license agreements. Additional data will be available to select partners who are part of existing data consortia. Second, much of the additional data users want to access is proprietary and strictly controlled to a small group of primary health stakeholders or authorized researchers. With no way to influence the access to this data, a core function was negotiated in the technological solution so that users could bring in their own data. In this way, health partners who are authorized to access these sets of data could bring them into the system themselves, and work with their data, without facilitating broader access.

The major technical challenge was to find a technology solution which could serve dozens of stakeholders, each with different needs, but still be cost effective. The consultants proposed a flexible model that allows for considerable user defined content.

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U-1 – Infectious Disease Simulation Tool – A Geospatial Decision Support System

Infectious Disease Simulation Tool – A Geospatial Decision Support System

Project Id:	209833 (U-1)
Project Category:	User-centered
Project Sponsor:	Peel Public Health
Collaborators:	Infonaut Inc.
	SAS Canada
	University of Waterloo, Faculty of Mathematics
Contact	Dr. Eileen de Villa
	Associate Medical Officer of Health
	Peel Public Health
	44 Peel Centre Drive
	Brampton, Ontario
	L6T 4B5
	Telephone number: 905-791-7800 Ext. 2856
	Fax number: 905-789-1604
	Email address: eileen.devilla@peelregion.ca

Project Description

Purpose

The project involved the development and implementation of a needs assessment of key users for a proposed Infectious Disease Simulation Tool. Among the key objectives of this project were: to identify the information needs of the key users of the proposed decision support tool; to identify the demand for such a product and its usefulness within the user groups; to identify user-friendly platforms for routine use of the proposed tool and; to identify the different diseases and/or scenarios for which the tool will be helpful.

Intended Benefits

The proposed Infectious Disease Simulation Tool would allow decision makers to visualize the dynamics of infectious disease outbreaks over time and space. With this type of tool, it is anticipated that public health officials and other decision makers will be able to create a more effective local infectious disease outbreak planning process.

Being able to model and visualize a range of simulation scenarios will lead to more informed decision-making, and will ultimately lead to better decisions, a more prepared community, and a safer public.

The end-user will be able to produce planning reports based on underlying populations and infrastructure in the areas affected. Relevant information for Public Health Units and Municipalities that would be modeled in the simulations include:

- Possible deaths, hospitalizations, and outpatient visits (by area affected)
- Impact on emergency room visits over time (by hospital site or area affected)
- Possible days lost from work due to caring for family member, or illness.
- Readiness and response
- Evaluate response times
- Quantify the costs
- Contrast effective and non-effective intervention strategies

Effected Stakeholders

Primary Users

Public Health – Medical Officer of Health (and Public Health Staff including Emergency Planners, Epidemiologists, Infection Control Specialists and Others)

Municipalities – Municipal Operations Centre/Municipal Control Group, Emergency Site Managers, Public Information Officer, Director of Public Works, Director of Emergency Medical Services, Community Emergency Management Coordinator, Municipal Planners, Emergency Services (Police, Fire, Ambulance), Others

Hospitals & Long-Term Care Homes – Emergency Site Managers, Infection Control, Planners, Emergency Room Surge Capacity Managers, Others

Secondary / Tertiary Users

- Medical Officers of Health (MOH) teleconferences, meetings, organizations and e-mail list servers
- Regional Infection Control Networks (RICNs)
- Surveillance networks
- Infection Control Professional Groups (spanning acute, long term, and allied healthcare) such as Toronto Professionals in Infection Control (TPIC), Community Hospital Infection Control Association (CHICA)
- Halton-Peel Emergency Service Network (HPESN)
- Ministry of Health and Long-Term Care (MOHLTC)
- University Epidemiology programs, including those with GIS involvement
- Provincial and federal governments

Approach and Methodology

The proposed application will provide a computer graphic simulation of an outbreak designed for a non-technical user to interpret and understand. The intention is for the end-user to be able to enter the probability of transmission rates and other infectious disease parameters (depending on the infectious agent), community-specific information, environmental considerations and public health interventions. These are all factors that are known to influence the movement of an infectious disease through a population. The opportunity for the end-user to vary these parameters based on local demographics (and other considerations) will make this a very flexible system for simulation based planning. Development of interactive outbreak modeling capabilities with web-based GIS technology will allow GIS to play an even more critical role in planning activities for infectious disease outbreaks.

The information needs of the key users were identified through user interviews, a survey and a Joint Application Design (JAD) session and are clearly represented in the report and embedded in the proposed approach. Additional user groups have been identified and were mapped to 'user roles' for the proposed tool. User and project priorities have been captured and are presented in the report.

A user-friendly platform and development approach have been identified and presented in the approach that aligns with user needs and the level of GIS technical capacity within the health unit.

Geospatial surveillance was identified as an additional key user need outside the scope of the simulation tool. It was communicated at the final presentation to the MOH that Peel Public Health staff would like to pursue development of the simulation tool through a GeoConnections GDSS project based on the user needs identified in the UNA Report, and that they would pursue opportunities to develop a GIS-based surveillance system simultaneously. Opportunities to integrate components of these projects and their underlying data will be sought, particularly through the use of CGDI standards and technologies.

Use of Standards

The application was built to use CGDI data and services and be compatible with open standards such as web map service, styled layer descriptor, web feature service, filter encoding, geography mark-up language, and CGDI compatible Web Map Services. Such integration enables the organization to integrate data from CGDI with internal spatial and non-spatial data.

Data generated through the project is published using CGDI standards including CGDI metadata standards. These data sets include population risk patterns, hospital catchment areas, emergency sites, outputs from planning scenarios and other spatially-enabled data.

National Significance

This project reflects an application that relates to:

- Modelling infectious disease outbreaks;
- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

This was a comprehensive user needs assessment. It identified the specific needs of a broad variety of users. The design is user friendly and user training and support needs were specified.

Universal Applicability

While simulation models are useful, they are not as beneficial as active disease surveillance applications. The latter may also include modelling capability.

Special Challenge Addressed

The specific diseases, scenarios and actual roles for which the proposed tool would be useful were mostly agreed upon by users; however, there was some disagreement amongst the users whether a simulation environment represents the most effective application of the GIS technology in the health unit. Many potential users within the organization expressed a need for a geospatial surveillance system; some even expressed the view that development of a geospatial surveillance system would be of greater value and utility than the proposed geospatial decision support tool.

There is limited organizational capacity for GIS Systems

- Need to build internal capacity (training, infrastructure);
- Outsource / partner with external organizations;
- Embed 'GIS knowledge' within systems;
- Tools must be easy to use and easy to learn; and
- Overall impact on the organization must be low.

Key Results and Lessons Learned

In terms of the project content itself, it was learned through the course of research and analysis that the development of sophisticated predictive models may take up to a year or more. It was therefore surmised that in order to make a follow-up GDSS project feasible within an acceptable timeframe for both GeoConnections and the other project participants, that the development of a descriptive or 'toy' model of a geospatial decision support tool is more appropriate.

In projects undertaken with Public Health staff responsible for Communicable Disease investigations, there is always the possibility that an outbreak or an urgent event requiring immediate response will require a reassessment of timelines and deviation from the initial plan. This was identified in the initial risks outlined in the proposal for the UNA. A lesson learned from this project would be to include additional slack in the project timeline in order to account for any unforeseen delays. The lesson learned in terms of the schedule would be to commit resources to the project, where and if possible, that will not be affected by an outbreak event.

Lessons learned from the final phase of the project include the fact that when conducting any needs assessment, the final outcome may be different from the originally anticipated outcome. This proves that the UNA process actually does work and adds value to the project/process.

Time frame available impacts on the type of model that can be developed:

Short time-frame (6 months) – feasible for GeoConnections project
- Descriptive or 'toy' model;
- Multivariate, spatiotemporal spread;
- Enhance organizational learning, understanding and knowledge application.

Longer time-frame (1 – 2 years)
- Predictive model; Bayesian;
- Incorporate social networking & mixing behaviours.

A two-pronged approach is suggested wherein a simpler model is developed for initial tool development while exploring more sophisticated predictive models. Historical data is required to build models of any scope – and availability will help guide scope.

U-3 – GIS Capacity Building and User Needs Assessment Project

GIS Capacity Building and User Needs Assessment Project

Project Id:	458752 (U-3)
Project Category:	User-centered
Project Sponsor:	The Vancouver Island Health Authority (VIHA)
Collaborators:	Sooke Region Community Health
	Interior Health Authority (IHA)
	Vancouver Coastal Health Authority (VCHA)
	British Columbia Centre for Disease Control (BCCDC)
	The University of Victoria's Spatial Sciences Research Lab
	BC Health Authority GIS Working Group
	Refractions Research - Contractor
Contact	Fiona Lawson
	Population Health Analyst
	415 – 1900 Richmond Avenue
	Victoria, British Columbia
	V8R 4R2
	Telephone number: (250) 519-7076
	Fax number: (250) 592-0576
	Email address: Fiona.Lawson@viha.ca

Project Description

Purpose

The purpose of this project was to increase GIS capacity in VIHA through training and the acquisition of software, as well as to conduct a user needs assessment that will guide the future development of a geospatial decision support system. This project also served to increase awareness and support for an enterprise-wide geospatial decision support system, and more generally for the continued development of GIS capacity within the Public and Population Health Observatory (PPHO) and VIHA.

The goals of the User Needs Assessment were as follows:

- To identify potential users of a VIHA geospatial decision support system;
- To describe the tasks the users currently perform, with an emphasis on spatial data;
- To describe the ways the users could use a VIHA geospatial decision support system;

- To improve understanding of the requirements and design specifications for a geospatial decision support system that will support VIHA users' and partners' business needs;
- To quantify and develop design specifications to address the precise questions which will be posed by users, including reports that will be required to answer their questions;
- To prioritize services, systems and tools requirements;
- To identify the expectations of the users;
- To identify any problems and/or limitations that users are currently experiencing; and
- To review existing tools and applications already in use by VIHA.

The main objective of this project was to increase GIS awareness and GIS capacity within VIHA. The very successful GIS and Health Workshop, together with the GIS courses and the User Needs Assessment interviews achieved this very important objective. This project was able to broaden the profile of GIS within VIHA to a point where almost all of VIHA's managers, directors and executive directors have at least a basic understanding of what GIS is and how it can be applied to the field of health. By meeting this objective, the PPHO has been able to build support for the on-going implementation of GIS into VIHA's everyday operations, analysis, planning and research. For example, during this project, VIHA signed an MOU with GeoBC to join the provincial ELA (Enterprise Licence Agreement) with ESRI Canada. This will make it far easier for VIHA to build up its GIS capacity as the organization continues to adopt this new technology.

Intended Benefits

The project addressed Population Health Surveillance by improving VIHA's ability to monitor health status, respond to health problems, and support planning, implementation, and evaluation of health services and programs through the use of GIS. This project also addressed the priority issue of Emergency Management by funding the purchase of ArcGIS Server Workgroup. This software will allow PPHO to further develop its pilot emergency web atlas (VEMGIS) and bring it in-house. Furthermore, once VIHA moves both the VEMGIS and the Community Health Atlas (CHA) in-house, the training funded by this project will provide VIHA staff with the software and skills necessary to further develop these sites and build others.

As a result of this project, VIHA and communities within VIHA realized a number of tangible and intangible benefits. These benefits include:

- More effective and efficient business processes and decision making in support of the planning and provision of health services and functions through increased data query, reporting and map production capabilities.
- Increased awareness about geospatial concepts and collaborative requirements within the authority.
- Increased awareness and support for the development of GIS in VIHA.
- Increased awareness of what GIS is and how it can be used in the health care and public health care fields.
- Reduction or elimination of spatial and locational data redundancy among departments.

- Increased organization and integration of spatially related/oriented information.
- More efficient management of limited VIHA resources and improved customer service.
- Increased ability to provide GIS services to the community at large.
- Increased ability to create and share geographic information and products easily and quickly between departments and agencies throughout the enterprise, as well as with communities within VIHA.
- Operational cost savings through increased analysis capabilities, improved decision making and more efficient coordination of resources.2
- Increased integration of business processes across the organization.
- Increased utilization and inclusion of GIS in all of VIHA's business processes.
- Increased GIS capacity throughout VIHA and therefore, an increased ability to sustain the use of GIS in VIHA.
- Increased short-term and long-term success of the PPHO and VIHA as a whole.
- Increased ability to take advantage of opportunities within the CGDI for the use of relevant applications, services and data.

This project provided the software and training necessary to fulfill some of VIHA's long-term goals. For example, it will allow the PPHO to proceed with building a geospatial decision support system without having to worry about the full cost of purchasing the software and acquiring the training needed to run it. By minimizing this initial start-up cost, VIHA will be able to put more funding towards the application design and development.

Effected Stakeholders

This project focused mainly on VIHA's staff. Representatives from other health authorities and agencies within British Columbia were involved as collaborators, making the effects of this project province-wide.

A critical component of VIHA's GIS program is developing the internal skills and capabilities to create and maintain the system. Developing internal skills will reduce reliance on outside consultants/vendors and increase VIHA's ability to direct GIS development within the organization in a timely fashion. This requires a comprehensive training program for all levels of staff. Therefore, this project focused not only on further developing the skills of VIHA employees currently using GIS on a regular basis but also aimed to increase the GIS knowledge and skills of VIHA managers and directors. There was some custom training dedicated to increasing the GIS capacity of VIHA's GIS staff and the BC Health Authority GIS Working Group.

A half-day workshop was held for VIHA managers and directors on GIS and Health. The workshop included information on what GIS is, how it can be used in the Primary Health Care and Public Health fields (including examples of how other regional health organizations are using GIS) and how GIS can be used to support the specific goals and mandates of VIHA's departments. The key questions addressed in this workshop included:

- How can GIS augment the current approaches used?
- How can GIS provide new perspectives of existing data?

Workshop participants included representatives from the following VIHA departments and external organizations:

- Public and Population Health Observatory (PPHO), VIHA
- Community Care Facilities Licensing (CCFL), VIHA
- Planning and Community Engagement, VIHA
- Tobacco Control, VIHA
- Health Protection and Environmental Services (HPES), VIHA
- Emergency Management, VIHA
- Clinical Prevention and Health Promotion, VIHA
- Primary Health Care, Population and Family Health, VIHA
- Primary Health Care & Chronic Disease Management, VIHA
- Performance Monitoring and Improvement, VIHA
- Seniors, End of Life & Spiritual Health, VIHA
- Sooke Region Community Health Initiative (CHI)
- Interior Health Authority (IHA)
- Vancouver Coastal Health Authority (VCHA)
- BC Centre for Disease Control (BCCDC)

An important part of this project was improving the GIS skills of VIHA staff that use GIS on a day-to-day basis. VIHA's GIS staff attended commercial off-the-shelf (COTS) ESRI product training.

Another critical component of this project involved custom training for both VIHA staff that use GIS on a day-to-day basis and for the BC Health Authority GIS Working Group. As well as VIHA members of this newly created GIS user group, this custom training included at least one GIS analyst from the following organizations:

- Interior Health Authority
- Vancouver Coastal Health Authority
- Fraser Health Authority
- Provincial Health Services Authority

The BC Health Authority GIS Working Group identified topics for group training sessions including the following:

- Best practices for geocoding addresses
- Best practices for conducting drive-time analyses and distance analyses
- How to utilize and share spatial information through the CGDI

The real impact of this project will occur once VIHA implements the recommendations of the UNA consultants and builds a web application that meets the high priority needs of VIHA's departments and programs. This browser based web application will allow many more of VIHA's staff to integrate GIS analysis into their everyday activities and in turn, will improve their decision making processes.

Approach and Methodology

The project was conducted in four phases.

Phase One:

1. A project kick-off meeting introduced members of the Refractions' team to the project committee at PPHO. Refractions used this opportunity to ascertain any outstanding project requirements from PPHO, discuss finer aspects of the proposed methodology for developing and conducting the user needs assessment, and define target format/content for project deliverables.

2. Review current status of GIS in VIHA Refractions, with the help of the PPHO, examined the existing tools already in use by VIHA including PPHO's Community Health Atlas. Refractions also reviewed all relevant background documentation provided to them by PPHO.

3. Refractions conducted a workshop with PPHO to review their preliminary methodology against the overall objectives of the project. Refractions worked with PPHO to identify and profile the different types of potential users and incorporate these in their methodology.

4. Develop a framework and methodology for the user needs assessment project. Feedback from the previous workshop drove a first version of Refraction's methodological framework for the user needs assessment project.

Phase Two: Refractions developed a user needs assessment process to ascertain the functional requirements of a geospatial decision support system so that the technical, business and system needs of the end-user communities are met. The process involved interviews of all key user types. Interview forms were standardized for the sake of objectively meeting project requirements across segmented user-groups, but flexible enough to accommodate free-form responses from individual users.

Phase Three: Preceded by a mail-out of interview packages, the Refractions project team undertook pre-scheduled consultations with potential users and stakeholders that PPHO had identified.

Phase Four: This last project stage involved an analysis of Refractions' observations from the user consultations. They used the patterns and trends in these analyses to derive a comprehensive set of recommendations for the geospatial decision support system design. Recommendations were presented in a final report document accompanied by an oral presentation to the PPHO project team and other stakeholders. All deliverable material from this project was given to the PPHO in both hard copy and electronic format.

Information and knowledge gained from this project was shared with other health authorities in BC and across Canada at their request. For instance, the PPHO was able to provide advice on the project process including information on how to apply for GeoConnections funding opportunities. The PPHO was also able to share with other health authorities the report on the use of GIS for health-related research and analyses developed by the University of Victoria as part of the GIS and Health Workshop.

Following the Capacity Building and User Needs Assessment Project, VIHA will proceed by seeking further GeoConnections funding, specifically Category 3 – Decision-support applications. The need to develop a web-based geospatial decision support system within VIHA was outlined in VIHA's GIS Implementation Plan. VIHA may also apply for Category 8 – Regional Atlases funding from GeoConnections.

Use of Standards

Because this project did not involve the production of any GIS data, tools, or applications no CGDI content, standards or technology were used. However, VIHA's GIS staff did learn more about CGDI content, standards and technology during the courses and workshops that took place during this project.

This project will give VIHA and its community partners the capacity to use the CGDI.

PPHO acquired a shared network drive dedicated solely to the storage and distribution of geographical information throughout the health authority. The PPHO is using this opportunity to develop GIS standards (i.e., naming conventions, metadata standards, etc.) to ensure this drive is well organized, well documented and standardized. As part of this initiative, VIHA will create and publish metadata using the ISO standard for layers created by VIHA (e.g., VIHA facilities and community data).

National Significance

This project reflects a process that is intended to lead to an application that relates to:

- Timely identification of the geographic distribution of diseases;
- Analysing spatial and temporal trends;
- Mapping population groups at risk;
- Identifying changes in the determinants of health that will have downstream effects on population health, enabling attention to be focused on the most important risk factors and population groups at greatest risk;
- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

This project had a strong user focus. It comprehensively addressed the identification of user information needs. There was consideration given to the different needs of various user categories. Significant emphasis was placed on user training and support.

Universal Applicability

This project is a very good example for other organizations to follow to ensure both the information and technical needs of users are met.

Key Results and Lessons Learned

The mission of the BC Health Authority GIS Working Group is to promote collaborative GIS initiatives between British Columbia's Health Authorities and their affiliated organizations, allowing for more effective resource allocation and ultimately working towards the use of spatial data for enhanced decision making. This group also seeks to improve the GIS capacity of BC's government health organizations and to act as a connection between external agencies and the Ministry of Health.

Although this group is fairly new, the following activities have been identified as possible strategic priorities:

- Consolidate data acquisition activities and data sharing agreements
- Investigate opportunities to share the cost of data, training and software
- Organize group training sessions on topics of interest to increase GIS capacity of government health organizations in BC
- Use the Canadian Geospatial Data Infrastructure (CGDI) to publish common datasets
- Develop best practices (e.g., standards) for common GIS methodologies and metadata to ensure interoperability between government health organizations
- Develop a method to distribute work throughout the region to ensure efforts are not duplicated
- Set up a SharePoint or Wiki site to share relevant resources (grey papers, white papers, website links, etc.)

HHR-1 – Ontario Health Service Provider Maps (OHSPM)

Ontario Health Service Provider Maps (OHSPM)

Project Id:	52540 (HHR-1)
Project Category:	Health Human Resources
Project Sponsor:	Ontario Ministry of Health and Long-Term Care (MOHLTC)
Collaborators:	Land Information Ontario (LIO)
	Local Health Integration Networks (LHIN)
Contact	Peggy Barwell
	Manager, Development and Maintenance
	Health Care Programs I&IT Branch
	Health Services I&IT Cluster
	Ontario Ministry of Health and Long-Term Care
	Telephone number: 416-326-1493
	Email address: Peggy.Barwell@ontario.ca

Project Description

Purpose

The application has two main purposes:

- To provide the health service providers with the ability to view, monitor and update their own contact information using web GIS technology and to make that information immediately available for use by LHINs and MOHLTC; and
- To improve the underlying infrastructure from being a standalone system and database (downloading "changed" data from other databases) to a broader corporate implementation based on CGDI standards (WMS and WFS) and integration with LIO base data, thereby creating opportunities to integrate other LIO data holdings and potentially other data suppliers in the future.

The application puts the control and quality of the health service provider data directly in the hands of the source of the information. The application provides those that have the ability and knowledge of changes (health service providers) to change their administration data, including location, at source while making that information immediately available to the wider user group. If their address changes, the application would convert the information into the geospatial information and allow the information manager to confirm the location using one of several geocoding methodologies provided through Land Information Ontario (LIO). This ensures the quality and interoperability of the information so other organizations can integrate these datasets for their needs.

Health service providers have access to their own information as well as the authoritative source for information related to other service providers in their area or peers within other geographical locations, to which they don't currently have access and which can be time consuming to gather. This application allows for time to be spent on analysis and use of information rather than recreating the burden of collection process multiple times throughout the health system. The corporate nature of the application enables central access to the data resulting in opportunities for the creation of maps and other information products as well as being available for other spatial analysis purposes by LHINs and ministry staff. This information becomes an authoritative source of health service provider information (e.g. location, address, CEO contact, administration office contact etc.) that can be used by other ministry databases.

Intended Benefits

The application provides the following benefits to LHINs, the MOHLTC, and health service providers.

- A single, "one-stop" information resource detailing information on health services and health service providers within a specific boundary (e.g. a LHIN geographic area or municipality).
- LHINs and the MOHLTC will have a spatially-enabled analytical tool for visualization and planning health services.
- Health service providers will maintain their information in a dynamic, real-time environment. This will relieve the current burden on the LHINs and/or ministry of the need to contact the health service providers to get updated information, and reduce the error of data entry, thereby substantially improving the current process (customer service).
- Information will be collected, maintained, and served-up in a standardized format and against standardized "base data" (e.g. roads and water), thereby increasing the reliability and interoperability of this data with other future needs.
- Collaborative effort for creating, maintaining and using this information between LHINs, the MOHLTC and Health Service Providers.
- Integration of the LIO base data into this application will ensure current base data is available for use and that the data collected is referenced against a common base standard.
- Use of LIO geocoding service to ensure that geospatial coordinate information is updated when address data is changed.
- Capture of this data will position the MOHLTC and LHINs to allow for more detailed geospatial analytics and location-based decision support that will be needed in planning for the future health system in the province of Ontario.
- The proliferation and promulgation of CGDI standards is supported in an application widely used by one of the largest ministry's in Canada, and by the broader health care community in Ontario.
- Using CGDI approved standards, as well as interoperability standards, will be a principle of this application. Using these standards provides the infrastructure required for future feature enhancements.
- The establishment of a core infrastructure provides a foundation for future functionality and data enhancements for this application as well as prepares for other opportunities to build upon this infrastructure in the MOHLTC for other business needs. The use of GIS enabled applications within the LHINs and MOHLTC is typically reserved for a "select" group of business areas. This application will be

the stepping stone in establishing GIS capabilities within the mainstream of the business.

- Advancement of GIS delivery to a broader corporate level and the opportunity for wide spread acceptance and growth of the technologies.
- Improvement to quality and integrity of underlying data, thus the reliability of applications.
- Foster collaboration within and across organizations.
- Provision for an opportunity to serve data to other users within the Ontario government ministries that also need this data, and for opportunities to integrate their data with the MOHLTC and LHINs.

In addition, the application provides benefits to LIO and the Health Services I&IT Cluster (HSC). Specifically:

- LIO has been successful in the "traditional" communities that are familiar with land based analysis and GIS. However, it has been more challenging "selling" this need to other business areas. Having the Health community start to use GIS and geospatial data for planning and analysis shows the potential and power of GIS to other "non-traditional" potential clients.
- The HSC had limited GIS knowledge or capacity to service their clients with this powerful analysis and planning tool. This project used the knowledge of the consulting firm hired to transfer those skills to key HSC staff to ensure this application is maintained and to allow for future expansion that is anticipated.

Effected Stakeholders

User Categories

The main users of this application are the CEOs, planning managers and other staff within the LHINs, strategic planners and analysts in the MOHLTC, and health service providers; the health service providers and LHINs will be the main contributors of the data. Although not the main users, it is envisioned that health and population researchers will be indirect users. All users will be able to use the application in support of decisions reflective of the collective vision for Medicare reform and the LHIN mandate.

Responding to Users Needs:

The concept of the application was developed in response to needs and issues identified through various mechanisms, and therefore, is a user driven application. The concept of this application was developed based on input from:

User feedback

As part of the implementation of the LHIN Health Atlas application, user feedback was received verbally (in various demonstrations and presentations) and through the Internet feedback process. In addition, user feedback was received during some in-class training of the application. This feedback highlighted the need to expand the GIS capabilities from just an atlas installation to a more robust application that allowed for key information to be maintained. A great portion of the feedback highlighted errors in the health service provider contact and location information and therefore identified the need to update the information instead of just sending feedback via e-mail. Having contact information that is static and maintained by manual methods was identified as a key area of concern.

Preliminary requirements analysis by a consulting firm

As part of a process to understand future needs of the LHINs, a consulting firm was hired to interview, identify and prioritize the future requirements of data and the types of uses the LHINs would have for the data. One key need that was identified was the ability to "Estimate capacity of services within a LHIN". Capacity is a measure of an organization's ability to provide clients with the services demanded in the amount requested and in a timely manner; often stated as "the maximum rate of production".

Presentation to LHIN CEOs

When the MOHLTC decided to create the original Letter of Intent for the GeoConnections project, the concept of this application was brought forward to the LHIN CEO forum, the endorsement for which was received.

Health Results Team – Information Management

The Health Results Team – Information Management stream (HRT-IM) is a group of information and information management subject matter experts that were hired as part of the transformation of the MOHLTC. They have been working with MOHLTC and LHINs in setting direction for the future. One of the key objectives of this team is to identify authoritative sources of data and work with the various organizations to reduce the burden of data collection. With the manual processes for maintaining the data, the reporting challenges in getting access to the data, and the lack of currency of the data, they identified the data on a health provider as one of the more challenging databases, and the need to have one "source of the truth".

Approach and Methodology

This leveraged the experience and acceptance of an existing GIS tool, the LHIN Health Atlas, which has been implemented for use by the LHINs and MOHLTC. This tool was developed as a prototype to promote the potential value of GIS to visually illustrate information for planning and information purposes. The LHIN Health Atlas has gained wide acceptance and is therefore continuing to expand and utilize GIS for other purposes that have been deemed beneficial to both the MOHLTC and LHINs.

Use of Standards

The application makes use of various CGDI endorsed standards, services and technologies. As part of the MOHLTC relationship with LIO, the approach in creating this application was to utilize, as much as possible, the data, services and technologies available from LIO.

LIO provides CGDI-compliant spatial data, Geocoding web services and other data sources:

Base map

- Ontario Road Network
- Parks and Recreation
- Lakes and rivers
- Point of Interest
- Municipality boundary
- Geocoding services
- Postal code (FSA & LDU)
- LHIN boundary

National Significance

This application is indirectly relevant to all of the health goals domains – i.e. determinants of health (e.g. socio-economic status, genetics, environment); risky behaviours (e.g. physical activity, diet, smoking); and preventable illnesses (e.g. preventable injuries, diabetes). It provides, for example, the capacity for comparing the distribution of human resources to population needs, enables the re-balancing of human resources to reflect needs and allows for measuring the impact of accessibility to human resources on health indicators.

This project reflects an application that relates to:

- Assessing the effectiveness of public health programs by measuring and illustrating their impacts and reporting on progress toward goals, objectives and targets;
- Assessing resource allocation; and
- Assisting the efficiency of public health staff by supporting them with appropriate geomatics-based work planning technology.

Specific User Focus

The application was developed to empower health services staff to maintain an up-to-date accurate record of their contact and location characteristics, most importantly location of workplace. Such information assists managers with staff deployment decisions.

Universal Applicability

This is the only GeoConnections public health project to date that deals specifically with health human resources information. Such information is beneficial to all users of public health geomatics applications.

Lessons Learned

- When a new technology is being contemplated, engaging expert assistance as early as possible will move the process along faster;
- Ensure that business/client has committed sufficient staff for the project when charter is being drafted;

- Obtain clear agreement about who can direct resources involved in development who may come from outside the lead organization;
- Allocation of time to test services from other providers is required and time for resolution of critical issues should be build in the project plan in case it is needed. Commitment from other service provider is needed to resolve any issues in timely manner;
- Allow time in project plan for analysis and update of source data. Obtain signed agreements regarding authoritative data sources early in project;
- As part of the project plan, engage communications and dedicated client/business resources in developing a plan for stakeholder engagement;
- Assign dedicated communication staff to the project to provide advice on how to market a new application; and
- Develop a plan on how and when to market a new application.

It is recommended that the CGDI be improved in the following areas:

- Spatial data quality – especially the Ontario Road Network dataset which still has a lot of flaws and inaccuracy, which has caused many troubles to use and to manage;
- Quality, reliability, and scalability of the CGDI web services – some challenges were faced in consuming some web services due to the quality, reliability, and scalability, e.g. we have experienced inaccuracy, downtimes and slow responses from the LIO Geocoding web services as an example.

APPENDIX C – ANNOTATED BIBLIOGRAPHY

Title	Author	Date
A Developers' Guide to the CGDI: Developing and publishing geographic information, data and associated services	GeoConnections Secretariat	Aug-04
A Developers' Guide to the CGDI: Developing and publishing geographic information, data and associated services		
A GIS based Study of Urban Contextual Health Potential	M. Sawada, I. McDowell and M. Driedger University of Ottawa	Unknown
A GIS based Study of Urban Contextual Health Potential. This multidisciplinary research bridges the disciplines of Geomatics, Epidemiology and Health Geography by creating the first epidemiologically relevant spatial database of urban contextual health potential. Both physical and social contextual health determinants will be characterized through the development of innovative mapping methodologies. This new approach and resulting spatial database will establish the degree to which the urban environment influences health at the individual and aggregate level.		
Building a Business Case for Geospatial Information Technology: A Practitioner's Guide to Financial Strategic Analysis	Geospatial Information & Technology Association (GITA)	Mar-07
The American Water Works Association Research Foundation, GeoConnections Canada, the Geospatial Information Technology Association (GITA), and the Federal Geographic Data Committee (FGDC) funded this study to develop and document a formal methodology for the preparation of business cases for geographic information technology within a water utility, as well as compatible other utility sectors such as telecommunications, transportation agencies, and municipal-wide geospatial projects. The research includes a literature search, a survey with numerous water utility participants, and the development of a workbook and digital templates to assist other utilities in building their business cases for GIT projects. Case studies included provide real-life examples that apply the workbook's methodology and templates.		
Canadian Geospatial Data Infrastructure: Gaps and Opportunities in Public Health	New Brunswick Lung Association	Mar-06
The New Brunswick Lung Association is pleased to present this report assessing gaps and opportunities for development of CGDI-nested public health infrastructure and applications. The report is divided into six Sections. Each section contains our research and concludes with recommendations. This report will assist GeoConnections and Public Health Authorities across Canada for the improved application of mapping technology in support of public health decision-making.		
Charting the Course: A Pan-Canadian Consultation on Population and Public Health Priorities	CIHI - Canadian Institute for Health Information	May-02
In the fall of 2001, the Canadian Institutes of Health Research, Institute of Population and Public Health (IPPH) and the Canadian Institute for Health Information, Canadian Population Health Initiative (CPHI) carried out a series of consultation sessions in 10 cities across Canada. The aim of these joint consultations was to obtain stakeholder input and inform the priority-setting processes of IPPH and CPHI.		

Environmental Health Systematic Review	Centre de recherche en géomatique, Université Laval	Nov-07
Environmental Health Systematic Review: How the new analytical geomatics technologies can help environmental health professionals and decision-makers to make further use of mapping than what is offered traditionally by geographic information systems (GIS) and web mapping.		
Environmental Scan: Public Health Performance Indicators	Health Canada, Calgary Health Region	Apr-09
Report on public health indicators.		
Evaluation of the Health Information Roadmap Initiative - Executive Summary	IBM Business Consulting Services	Oct-03
Numerous reports and commissions conducted over the last few years demonstrate that Canadians are more concerned than ever about the sustainability of the health care system. Many believe that health information is the key to unlocking the solutions to the pressures facing the health care system and to overcoming the barriers to improving population health status. In 1999, the Roadmap Initiative was created to improve the accessibility and quality of health information for use by health care professionals and the general public. The four-year initiative known as “Roadmap” was launched with $95 million in funding from the Government of Canada and the support of provincial/territorial deputy ministers of health. The initiative brought together the three major players in the provision of national health information – the Canadian Institute for Health Information (CIHI), Statistics Canada (STC) and Health Canada to forge a common agenda. CIHI was given fiduciary responsibility for the funding and a mandate to meet specific Roadmap objectives.		
Federal, Provincial and Territorial Cooperative Activities 2004-2007	Geomatica, Canadian Institute of Geomatics	2007
2007 Geomatica Publication of Federal, Provincial and Territorial Cooperative Activities 2004-2007		
Geomatics and Public Health	CGDI, GeoConnections Secretariat	Apr-08
Applying location-based tools to public health practice in the 21ST century.		
Improving the Health of Canadians	CIHI - Canadian Institute for Health Information	Feb-04
Improving the Health of Canadians is the first in a biennial report series produced by the Canadian Population Health Initiative. It examines what we know about factors that affect the health of Canadians, ways to improve our health and the implications of policy choices on health. It builds on earlier reports on the health of Canadians from the Federal, Provincial and Territorial Advisory Committee on Population Health. This Summary Report provides an overview of the full report. We encourage you to refer to the detailed research findings and data that underlie this document. Graphs, tables and full references are available in Improving the Health of Canadians, which can be accessed free of charge at www.cihi.ca.		
Integrated Approaches to Community Awareness - Defining Regional Atlas	GeoConnections Secretariat, Canadian Geospatial Data Infrastructure (CGDI)	Apr-07

This document states what GeoConnections defines as the characteristics of a regional atlas, as well as indicating the role regional atlases will play within the Canadian Geospatial Infrastructure (CGDI).		
Learning from SARS: Renewal of Public Health in Canada	Health Canada and National Advisory Committee on SARS	Oct-03
A report of the National Advisory Committee on SARS and Public Health		
National Health Expenditure Trends 1975-2005	CIHI - Canadian Institute for Health Information	Nov-05
National Health Expenditure Trends (1975–2005) is CIHI's ninth annual health expenditure trends publication and provides detailed, updated information on health expenditure in Canada.		
Provincial / Territorial Health Expenditure 2005	CIHI - Canadian Institute for Health Information	Jun-05
After the cutbacks of the early to mid-1990s, money was re-injected into the Canadian health care system. In order to provide an overview of where each jurisdiction has chosen to allocate most of its money, this report tracks the levels and changes in provincial and territorial government health expenditures by age group and sex for the major categories of expenditures (*hospitals*, *other institutions*, *physicians*, *other professionals* and *prescribed drugs*), for each province and territory and for the period of 1997 to 2002 (2002 is the latest year for which data are available). Also, the report assesses the specific aging effect on future provincial and territorial government health spending and updates future health expenditure growth numbers that were originally produced in 2000 for the *National Health Expenditure Trends Report*.		
Public Health Community Status	GeoConnections Secretariat	Nov-08
GeoConnections is supporting the Public Health community on two priority issues: Population Health Surveillance and Health Emergency and Inter-Emergency. In addressing these issues, GeoConnections is helping public health organizations to utilize geospatially referenced health status and health determinant information to make correlations, and identify priorities and strategies necessary to improve and protect health and the factors that influence it. In addition, public health organizations are being enabled to build capacity by expanding their knowledge and use of geospatial information and tools, which help to provide a mechanism to undertake analysis as well as to facilitate information exchange amongst their partners and stakeholders.		
Public Health Goals for Canada	Canadian Public Health Association	Apr-05
Public health has been described as the science and art of promoting health, preventing disease, prolonging life and improving quality of life through the organized efforts of society. It combines sciences, skills, and beliefs directed to the maintenance and improvement of the health of all people through collective action. The programs, services, and institutions involved tend to emphasize two things: the prevention of disease, and the health needs of the population as a whole.		
Roadmap Initiative - Launching the Process: The Final Year	Canadian Institute for Health Information and Statistics Canada	May-03

This document, prepared jointly by the Canadian Institute for Health Information (CIHI) and Statistics Canada, highlights major activities, deliverables and accomplishments in the fourth, and final, year of the original Health Information Roadmap Initiative.		
Survey of Geographic Information Decision-makers - 2006, Executive Summary	Environics Research Group	Oct-06
The findings from this research indicate that GeoConnections has successfully laid much of the required groundwork in the promotion of the CGDI as a geospatial information hub for organizations operating in the four theme areas. Many decision-makers in the four themes were aware of GeoConnections prior to being involved in the survey, and there is a wide range of areas where they see the CGDI being applicable for their organization. However, there is an ongoing need to promote the CGDI to organizations in these areas, as well as the need for continuing education efforts among decision-makers regarding the potential of the CGDI to have a positive impact on their organizations.		
The Dissemination of Government Geographic Data in Canada: Guide to Best Practices	GeoConnections Secretariat	2008
Version 2 of the Guide to Best Practices sets out a revised integrated framework for the four types of government geographic data licensing models most commonly used in Canada - the unrestricted use model, the end-user model, the reseller model and the value-added reseller model. It provides a rationale for appropriate uses, explains how each model builds on common structures, demonstrates their inter-relationships and provides clear guidance to assist licensing practitioners in selecting the most appropriate model and licence agreement. Recommended approaches to fundamental concepts such as ownership of intellectual property, liability, duration and termination are discussed in detail for the benefit of licensing practitioners, and are guided by data dissemination policy directives currently in force across federal departments and agencies.		
The Federal Response to Hurricane Katrina: Lessons Learned	The US Department of Homeland Security and Counterterrorism	Feb-06
Lessons learned from the federal response to hurricane Katrina.		
The Future of Public Health in Canada: Developing a Public Health System for the 21st Century	CIHI - Canadian Institute for Health Information, CIHR - Canadian Institutes of Health Research	Jun-03
The public health system exists to safeguard and improve the health of Canadians. Great progress has been made in the past century, but many challenges remain. The dawn of a new century is an opportune time to strategically and explicitly build the infrastructure for a strong public health system that will adequately serve all Canadians.		
Understanding Users' Needs and User-Centered Design	GeoConnections Secretariat	Oct-07
The purpose of this guide is to assist organizations in understanding approaches for user-needs assessments and user-centered design, which are required for some projects that GeoConnections funds.		
Web-based Spatial Analysis for Public Health Surveillance, a Case Study	David Buckeridge, NRCan	Mar-07
Web-based Spatial Analysis for Public Health Surveillance, a Case Study		

Web-based Spatial Analysis for Public Health Surveillance; Guideline for System Development Case Studies	David Buckeridge, NRCan	Mar-07
Guideline for Workshop case studies.		
WHO Public Health Mapping	World Health Organization, Department of Communicable Disease Surveillance and Response	2003
The WHO Public HealthMapping Programme provides a range of services and products tailored to support decision-makers in the use of GIS and mapping for surveillance, planning management and monitoring of public health programmes. Current programme partners include Roll Back Malaria, UNAIDS, Lymphatic Filariasis, leprosy, Guinea worm, onchocerciasis, non communicable diseases, Integrated Management of Childhood Illnesses.		

APPENDIX D – SURVEY RESULTS

A web-based survey was conducted in which 289 invitations were issued and 68 responses were received. The survey asked questions concerning the level of knowledge and use of geomatics within the organization, how it is used, organizational structure, benefits derived, development methodologies, implementation issues, who are the leading lights, need for collaboration and standards, and issues with knowledge and data sharing.

Survey response rates were the highest from Ontario and British Columbia. They were negligible from the territories, the Atlantic Provinces and the Prairie Provinces.

The results of each question are shown below.

Is your organization:	**Response Percent**
Public health delivery organization	22.0%
Public health research organization	3.4%
Academic institution	5.1%
Private sector	8.5%
NGO	6.8%
Municipal government department	3.4%
Provincial government department	11.9%
Federal government department	20.3%
Other	18.6%

The types of organizations targeted for the survey were confirmed in the results.

To what extent do you use geomatics in your public health research activities?	**Response Percent**
On most projects	80.0%
Occasionally	20.0%
Never	0.0%

All of the survey responses indicated that they had used geomatics on most of the projects they work on or at least have used geomatics occasionally.

What resources do you have available for this work? Check all that apply.	Response Percent
Staff with geomatics expertise	80.0%
Relevant technology	80.0%
Relevant data	100.0%
Relevant applications	60.0%
Other	0.0%

Most (80% or more) of the participants had either human and/or physical resources available to support their geomatics work.

How could you be more involved?	Response Percent
Training users in the use of applications	25.0%
Operating a user helpdesk	0.0%
Undertaking contracted analysis and research	75.0%
Developing new applications	50.0%
Other	0.0%

At least half of the responses saw additional analysis, research and developing new applications as the best way they could continue to contribute.

What is your organization's level of knowledge of the use of geomatics within public health?	Response Percent
High	31.0%
Moderate	50.0%
Low	19.0%
What level of priority does your organization's management attach to geomatics to support the public health sector?	**Response Percent**
High	36.2%
Moderate	43.1%
Low	20.7%

Approximately 80% of the responses indicate that their organization has at least a moderate level of knowledge on the use of public health geomatics and gives geomatics a moderate level of priority to supporting the public health sector.

What level of progress is being made in your organization in the implementation of geomatics to support the public health sector?	Response Percent
High	31.0%
Moderate	50.0%
Low	19.0%

Over 80% of the respondents indicated that moderate or high level of progress is being made in their organization regarding the implementation of geomatics.

What rationale was used to promote geomatics to the decision makers in your organization?	Response Percent
Improve ability to plan services	70.2%
Improve efficiency and effectiveness	63.2%
Increase capacity to present key information to decision-makers	84.2%
Facilitate accountability reporting	26.3%
Other	17.5%

There was a wide variety of rationale used to promote geomatics to decisions makers within their respective organizations. Improving the ability to plan services and increase the capacity to present key information to decision makers ranked the highest. One response indicated the rationale to be the ability to work with partners outside of the health system using geomatics. This suggests that geography (i.e. maps) allowed for a common language to communicate ideas.

How do you presently use geomatics?	Response Percent
Disease mapping and surveillance	68.4%
Emergency preparedness	42.1%
Decision support	59.6%
Determinants of health analysis	64.9%
Resource management	33.3%
Community health planning	40.4%
Operational planning	29.8%
Needs forecasting	31.6%
Other	28.1%

Geomatics has a wide range of use amongst the respondents. Additional to these use categories were for purposes of ccommunications, risk assessment, municipal utilities, infrastructure, crime analysis, etc.

What are the envisioned uses for geomatics in your organization?	Response Percent
Disease mapping and surveillance	75.4%
Emergency preparedness	63.2%
Decision support	73.7%
Determinants of health analysis	78.9%
Resource management	43.9%
Community health planning	66.7%
Operational planning	54.4%
Needs forecasting	61.4%
Other	19.3%

Respondents felt that using geomatics for planning activities offers the greatest potential relative to existing geomatics use. This can be seen by comparing the responses of this question with the previous question which shows the largest difference can be seen in the following three areas: community health planning (+26%); operational planning (+24%); and needs forecasting (+30%).

Also worth noting is that every area for geomatics use listed, except for disease mapping and surveillance, showed a increase of 10% or greater in terms of potential use relative to current use.

What is the main source of geomatics capacity for your organization?	Response Percent
Internal geomatics division / department / team	42.6%
External geomatics division / department / team	5.6%
Public health subject matter experts who possess geomatics skills	25.9%
Contracted geomatics resources	9.3%
Other	16.7%

A relatively high portion of the respondents indicated that they were supported by an internal geomatics group followed by public health subject matter experts with geomatics skills.

Other sources for geomatics capacity consisted of individuals with GIS expertise or both GIS and public health subject matter expertise.

How does your organization benefit from the use of geomatics in your regular activities?	Response Percent
Setting priorities	49.0%
Assigning staff	17.6%
Supporting budget submissions	19.6%
Informing stakeholders	80.4%
Other	23.5%

Based on the responses there is a common thread of using geomatics to inform stakeholders. Other uses are not consistent however setting priorities through geomatics analysis is the next highest use indicated.

What are the implications of geomatics projects on the stakeholders?	Response Percent
Enhanced information analysis	92.5%
Better resource planning	58.5%
Sound decision making	77.4%
Enhanced reporting capabilities	66.0%
Work simplification / higher productivity	26.4%

Better results	49.1%
Other	9.4%

Excluding for simplifying work and increasing productivity, most of the respondents indicated that geomatics address all of the other characteristics.

How do you measure the success of your geomatics projects?	Response Percent
Monitoring utilization	54.7%
Evaluating results	45.3%
Other	32.1%

Many of the textual responses confirmed that a wide variety of means were being used to measure the success of geomatics projects. However, a large portion of the responses indicated they were conducting no measurements of success.

Are you aware of the federal government's GeoConnections program for supporting geomatics within the public health sector?	Response Percent
Yes	83.3%
No	16.7%
Have you taken advantage of that program?	**Response Percent**
Yes	59.3%
No	40.7%

Although a minority of the respondents indicate that they were not aware of the GeoConnections program in the first question above, considering that all of the respondents had used geomatics at least occasionally indicates that knowledge of GeoConnections, the CGDI, as well as the guiding principles and standards it supports must continue to be shared within the public health geomatics community. Moreover, a smaller proportion of respondents took advantage of the program.

Whose needs do your geomatics applications address?	Response Percent
Medical officers of health	64.2%
Epidemiologists	75.5%
Public health nurses	43.4%
Environmental health officers	62.3%
Nutritionists	24.5%
Health educators	30.2%
Managers	67.9%
Planners	64.2%
Private practice physicians	5.7%
Health care institutions	26.4%
Schools	22.6%

Employers	11.3%
General public	62.3%
None	0.0%
Other stakeholders	20.8%

A variety of stakeholders are served by public health geomatics.

What techniques do you use to determine user requirements?	**Response Percent**
Involve the stakeholders from the start	71.2%
Perform user needs analysis	61.5%
Analyze requirements using a process mapping methodology	19.2%
Use prototyping for discovery, observation and validation of user needs	26.9%
Have all key stakeholders review the requirements once they are compiled	36.5%
Strategic planning processes	48.1%
Annual work plan development	44.2%
Staff surveys	13.5%
Staff goal setting and performance reviews	7.7%
Other	11.5%
How do you facilitate user feedback or ascertain additional requirements?	**Response Percent**
Document review	49.1%
Unsolicited user feedback (verbal/letters/e-mails)	58.5%
On-line feedback form	7.5%
User survey	26.4%
Evaluation forms	22.6%
Issue-specific focus groups	24.5%
Unsolicited praise (received verbally or in writing)	32.1%
Do not seek user feedback	13.2%
Other	17.0%
How do you encourage your users to use geomatics applications?	**Response Percent**
Education during the development process	55.1%
Training sessions after implementation	59.2%
On-line tutorials	24.5%
Other	32.7%

Based on the comments received it is seems that some of the respondents do not have an appreciation for the importance of following a process / methodology to acquire requirements for geomatics solutions. Moreover, some may stand to gain from taking a more proactive approach to eliciting feedback rather than receiving anecdotes; good or otherwise.

What challenges do you face when implementing geomatics projects?	Response Percent
Lack of knowledge / awareness of potential uses for geomatics applications	73.6%
Lack of available applications for adoption	28.3%
Lack of application development capability	41.5%
Lack of capacity to absorb applications into the work environment	49.1%
Data issues (privacy, access, quality, frequency of up-dates, etc.)	77.4%
Cost	73.6%
Other	15.1%

By far the most significant challenges reported by respondents is a lack of geomatics awareness (i.e. understanding how geomatics could be used), issues with data, and cost.

How did you go about solving the implementation issue(s) from previous question?	Response Percent
Research / investigation	47.1%
Strategic / business planning / user needs assessment	54.9%
Establishing policies	21.6%
Seeking external funding	49.0%
Training	39.2%
Engaging consultants	33.3%
Other	29.4%

The common term through the comments provided is collaboration. Through connecting and networking, costs were shared and data issues managed.

Which type(s) of geomatics software do you use in your public health geomatics projects?	Response Percent
Open Source Software (OSS)	3.9%
Commercial, off-the-shelf (COTS) software	37.3%
Custom development	3.9%
A combination of OSS, COTS and/or custom development	41.2%
Other	13.7%

Amongst the respondents, most were heavily either users of COTS or a combination of COTS, Open Source and custom development. This is in line with expectations since GIS is a toolbox that at times benefits from customization to meet specific needs. Some are forced not to use COTS (cost prohibitive) or OSS (internal policy).

What software development methodology is used on your geomatics projects?	Response Percent
SDLC (Software Development Life Cycle)	4.2%
RUP (Rational Unified Process)	2.1%
Iterative Software Development	8.3%
Agile Software Development	4.2%
No formal methodology is used	66.7%
Other	14.6%

The response of most surveyed indicated that they did not use a formal software development methodology. Independently this is not overly surprising since there was no differentiation between respondents who performed custom software development in their geomatics projects and those that were using GIS COTS or open source tools "as is" to perform spatial analysis and create maps, results, etc.

Can you point to any best practices used by your organization or others on public health geomatics projects?	Response Percent
Yes	25.5%
No	74.5%

Most responses indicated no best practices being considered by their organizations.

What is the importance of interoperability in general and CGDI (Canadian Geospatial Data Infrastructure) in particular to your organization?	Response Percent
Very important	26.9%
Important	53.8%
Not important	19.2%

Approximately ¼ (26.9%) of the survey responses indicated that interoperability and the CGDI were very important to the organization. This suggests that opportunities for additional collaboration at the technical level and use of CGDI standards are likely to exist. Enabling CGDI standards can help to address some of the technical feasibility of data storage, maintenance, and sharing.

Who do you see as leaders in the use of geomatics in supporting public health?	Response Percent
Organizations:	97.5%
Individuals:	52.5%

Some of the organizations considered by most as leaders included: PHAC, GeoConnections, Saskatoon Public Health, BC Ministry of Health, Toronto Public Health, Sault Ste. Marie Innovation Centre - Community Geomatics Centre; and Cancer Care Ontario.

Should a national organization have the primary responsibility for providing leadership to the field of geomatics within the public health sector?	Response Percent
Yes, Public Health Agency of Canada (PHAC)	62.0%
Yes, Pan-Canadian Public Health Network	0.0%
Yes, Statistics Canada	6.0%
Yes, Canadian Institute for Health Information (CIHI)	2.0%
No	8.0%
Other	22.0%

Overwhelmingly most respondents agreed that a national organization should have the primary responsibility for providing leadership in public health geomatics and that it should be PHAC. Others thought that PHAC already leads this work and that a collaborative effort between PHAC, Statistics Canada and CIHI would best serve public health geomatics uptake.

What roles should the primary federal agency play?	Response Percent
Lead consensus-building related to priorities for the development of public health geomatics	72.5%
Develop awareness of the benefits of public health geomatics	82.4%
Facilitate the adoption of public health geomatics	90.2%
Design applications	39.2%
Develop applications	33.3%
Manage applications	17.6%
Provide technical support for users	49.0%
Fund development and adoption	74.5%
Other	17.6%

Interpreted common messages received from the survey responses for how a federal agency should serve the public health geomatics community included:

- Providing access to relevant data in a timely manner;
- Provide higher level services for coordination and consensus building, development of awareness, and technical support; and
- Assist with funding.

Another message is that designing, developing, or managing applications is not something most see as a priority for a leading federal organization.

To facilitate adoption by all users, would it help to have a standardized set of geographic information systems applications which support the public health sector?	Response Percent
Yes	81.6%
No	18.4%
Who should produce this standard set?	**Response Percent**
Public Health Agency of Canada (PHAC)	72.1%

Statistics Canada	39.5%
Canadian Institute for Health Information (CIHI)	37.2%
Other	39.5%

The responses to this question have a great deal of diversity. Some think having applications to choose from would be great. This is no surprise based on the significant majority of responses that answered affirmatively. However, a majority of the comments received indicated that applications would be difficult to standardize since there is such a variety of fundamental needs, regional requirements, data availability and standards, and user specifics. Additionally, this same group of respondents tended to think standard communication and interoperability protocols and data consistency and available would create a far greater positive impact.

Do you collaborate with other organizations and the private sector?	Response Percent
Same jurisdiction	68.6%
Neighbouring jurisdiction	43.1%
Other jurisdictions	60.8%
University	68.6%
Other research institution	39.2%
Private sector	33.3%
Other	15.7%

Results of this question indicate that collaboration is going on within organizations and with organizations of different jurisdiction. Interestingly not as much collaboration is being conducted with neighbouring jurisdictions. Other options included NGO's, First Nations, and the volunteer community.

What are your privacy and sensitivity concerns pertaining to geographic data and data sharing?	Response Percent
Protection of patient / client information	86.3%
Protection of staff identity	31.4%
Other	21.6%

The main concern is the protection of privacy for small area geographies.

How do you share geomatics knowledge with other organizations?	Response Percent
Newsletters	12.8%
User groups	40.4%
Conferences or workshops	74.5%
Professional journals	29.8%
Website postings	53.2%
Other	27.7%

What techniques do you use to address concerns and mitigate the risks of sharing?	Response Percent
Data desensitization (i.e. anonymization, obfuscation)	66.0%
Licensing (i.e. EULA)	26.0%
Non-disclosure / confidentiality agreements (i.e. MOUs)	58.0%
Legislation (i.e. Privacy Act)	44.0%
Secure access	68.0%
Other	18.0%

Providing technical solutions (e.g. secure access) and desensitizing the data are the most answers provided by respondents.

GENERAL COMMENTS

The comments provided by respondents indicated that the largest barriers to progressing the use of geomatics in public health included:

- A lack of resources, staffing, and knowledge
- Inflexibility of privacy legislation
- Access to relevant data for important public health research due to high cost and/or sensitivity even though use is for internal planning purposes only
- Lack of location history data in concert with medical history.