Use of the Internet in the Diffusion of GIS for General Practices in Victoria, Australia

Francisco J. ESCOBAR <f.escobar@engineering.unimelb.edu.au>
Ian P. WILLIAMSON
Julie GREEN
Elizabeth WATERS
University of Melbourne
Australia

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Abstract

This paper describes the delivery of a Geographic Information System (GIS) product through the Internet for primary health care services provided at general medical practices in the State of Victoria, Australia. The paper details a collaborative research project, the principal aim of which was to develop a methodology for creating a GIS as a decision support system, for more effective use of information about population and health services at a given location. The methodology employed is based on the ability of a GIS to establish interrelationships between a combination of health, geographic, and demographic data.

An overview of GIS as a technology that allows geospatial data to be analyzed, displayed, and queried is given. The results of the project can be demonstrated through a live presentation, detailing specific and generic reasons for the choice of the Internet as the preferred delivery mechanism. The paper concludes with the identification of important issues related to the research and use of the World Wide Web for Geographic Information Systems and Health.

Contents

Introduction

This paper describes the delivery of a Geographic Information System (GIS) product through the Internet for primary health care services provided at general medical practices in one rural and one metropolitan area in the State of Victoria, Australia. It begins with a brief description of the rise in the use of the Internet in the health sector. The paper details a collaborative pilot project whose principal aim was to develop a methodology for creating a GIS as a decision support system with the potential for more effective use of information about a population and its health services at a given location. The context of the general practice setting is also provided.

The methodology of the research project is based on the features of a GIS to establish interrelationships between a combination of health, geographic and demographic data. As the results of the research are intended for use by the two general practice divisions participating in the research, the methodology is aligned to their needs with an emphasis on future directions and service delivery.

Since a Geographic Information System is a technology which allows geospatial data to be analyzed, queried and displayed in map form, it is increasingly considered an important analytic tool for the advancement of the health and the well-being of the world's population (Bertrand & Mock, 1995). In preparing the options for the presentation of the GIS prototype to the two pilot communities, consideration was given to communication technologies which offer the opportunity to link health care providers with their colleagues regionally, nationally and internationally. The rapid increase in the multiple uses of the Internet in the health sector provides the opportunity to capitalize on the outcomes of this research project. As health care providers and policy makers in the health sector are required to make greater use of available evidence in their decision-making processes, the Internet is well placed to disseminate research findings (Silagy, 1996).

The application of GIS to the health sector is concerned with the quantitative study of disease distributions and with patterns of health care and service planning, where the health services or health issues are geographically defined (Garter & Bailey, 1996). GIS to date has been used within health services and epidemiological research to analyze the possible relationships between disadvantage and the uptake of health services, access to emergency services and analysis for possible associations between environmental or ecological variations in incidence of disease and clustering effects.

This project has developed a GIS for Divisions of General Practice to facilitate better understanding of the health needs and health status of their population groups. The information infrastructure is used to support decision making related to their service, education and research planning. The intention is for the GIS to be a complementary information tool and to assist in monitoring health outcomes.

The Research Team for this project involves of the Department of Geomatics, University of Melbourne, the Center for Community Child Health & Ambulatory Pediatrics (University of Melbourne) Royal Children's Hospital, and the National Key Center for Social Applications of GIS, University of Adelaide.

Background to the research project

Divisions of general practice

Since 1993, general medical practices in Australia have been organized into "Divisions" or groups of doctors within a particular geographic location. This is to enable general practitioners to work with each other and with the wider health care system, to improve the quality and continuity of health care at the local level, and to collaborate more effectively with preventive health care (Commonwealth Dept. Health & Family Services, 1996). As Divisions are increasingly being perceived as an organizational vehicle to improve the health of the Australian population, the Commonwealth Divisions of General Practice Program provides funding for general practitioners to become involved in cooperative activities. A key feature of current reforms is for funding to be provided according to Outcomes Based Funding, whereby Divisions receive a proportion of their income according to their ability to demonstrate improvement in the health outcomes of their populations. A GIS containing baseline and current data has the potential to assist in this regard.

There are 118 Divisions of General Practice in Australia. This research project was concerned with the metropolitan North West Melbourne Division with membership of almost 300 general practitioners (GPs) and the rural East Gippsland Division of approximately 70 GPs, in the State of Victoria. The East Gippsland division is situated between approximately 200-500 km southeast of the state capital of Melbourne (Fig. 1).

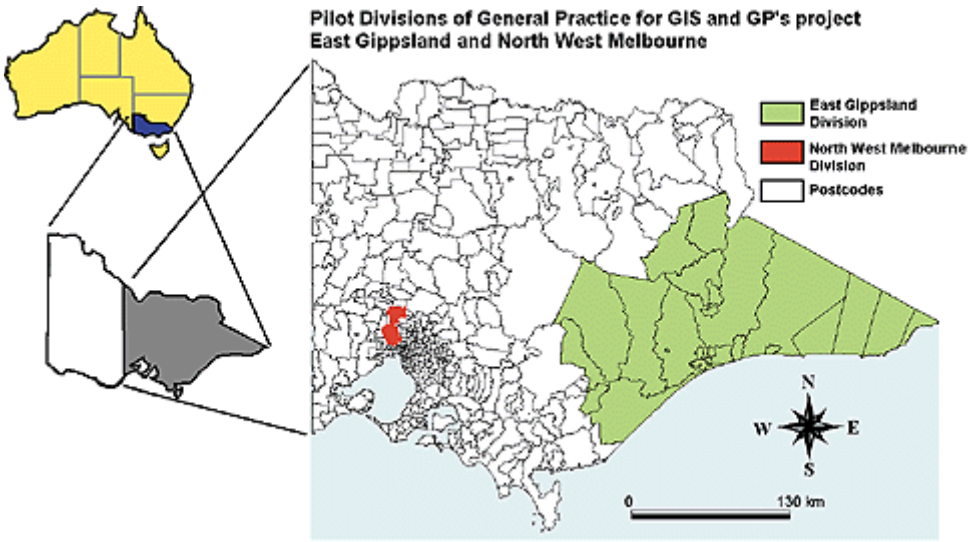

Figure 1. Location of the two pilot Divisions of General Practice. The smaller post code areas are representative of urban areas. Large post codes are common in rural areas

Project methodology

As GIS is still a relatively new technology for the health sector, the initial requirements of the project were to inform and educate the key stakeholders from the health sector involved with this project, namely state and national health departments and the pilot Divisions of General Practice themselves, about the capabilities and limitations of GIS.

The information needs of the two Divisions were then established, relative to the scope of the project and the useful application of the final GIS product. Relevant data was obtained from routinely collected federal, state, regional and local databases, where available. This was primarily demographic and health data, that had geospatial variables. Victoria's digital map bases were obtained from Land Victoria and

demographic data from Australian Bureau of Statistics (ABS). Priority was given to data which was aligned to the health priorities of the two Divisions, such as the immunization uptake rates for children under five years according to the national immunization schedule. Gaps in data availability were partially redressed through questionnaires administered to each general practice location. These questionnaires collected information on the size of the practice, other services which may be co-located, peak service times, and other relevant data such as distance patients travel to see their doctor.

Figure 2 shows the model adopted to integrate the data bases that were selected for the pilot GIS. The data bases have been grouped into routinely and specifically collected data. The model is also based on the thematic character of each data set , that is, whether it is geospatial, health or demographic data. All these data bases have been integrated into the system through common GIS operations such as tabular linking and address geocoding. The geospatial data sets needed for the implementation of the system are in the left column. These include address data bases, for the purpose of address matching operations, road network data base for routing and distance analysis, and the administrative boundaries that contain the thematic information related to demographic data and Divisions. This column also includes general practice location and other relevant health service locations, specifically collected for this project. These include Maternal and Child Health Centers, immunization venues, chemists and the hospital.. The column on the right includes hospital in-patient data (Victorian In-patient Minimum Data) and immunization data of children under the age of five years (Australian Children Immunization Register).

The server for the implemented system is located at the Department of Geomatics, University of Melbourne. In the future, if this methodology is extended to the Divisional sector or health sector more widely, health administration agencies will need to consider the issue of providing a server with the required storage capacity.

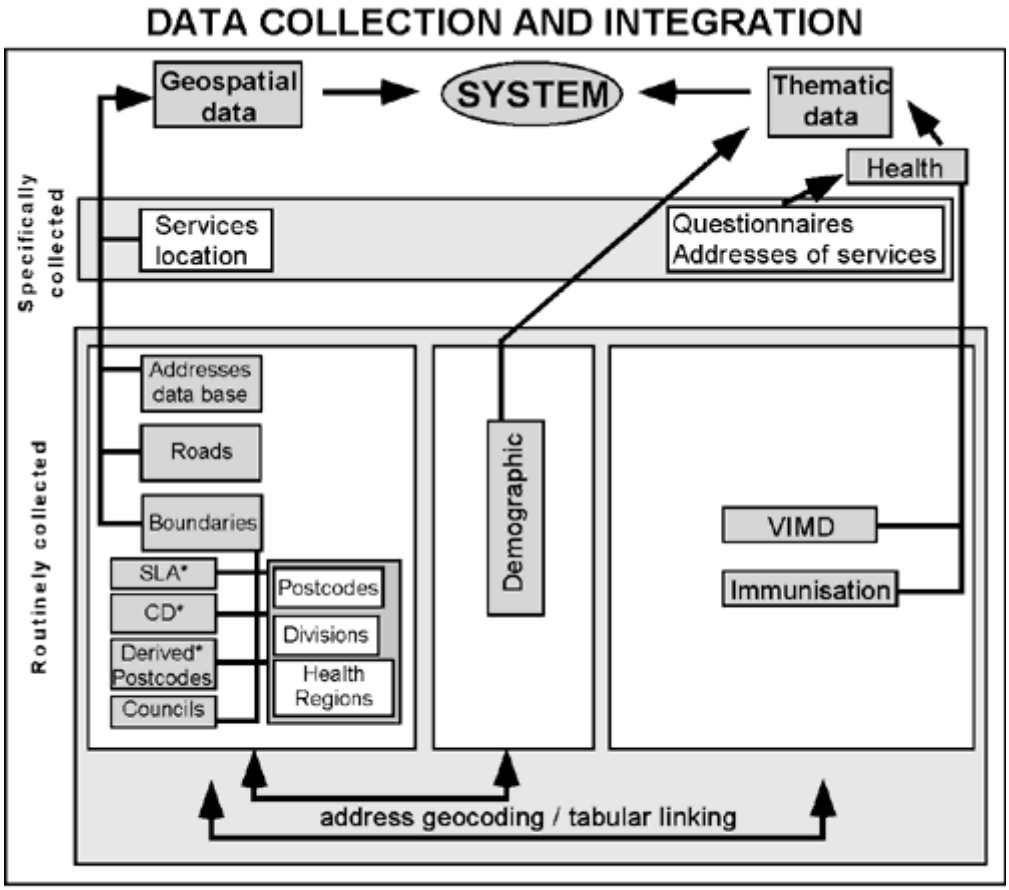

Figure 2. Model adopted for the integration of data sets.

** SLA (Statistical Local Area), CD (Collector District) and Derived Postcodes are administrative boundaries used by the Australian Bureau of Statistics*

A literature review was undertaken of the international application of GIS within the health sector, particularly focusing on the application of GIS to practical primary care settings. Progress and preliminary outcomes of the project were disseminated and discussed within state and national forums, with key information management organizations and individuals, and with the relevant health department officials. The project team established contact with other projects related to GIS and Health within Victoria, Australia, and internationally, to ensure that the methodology underpinning the decisions to include data sources was valid and reliable.

In Australia, and worldwide, the amount of morbidity data that is comprehensively and reliably collected at a population level, which also includes geospatial variables such as address, post code, or statistical local area, is minimal. In particular, information at the local level was limited to individual GPs, ancillary health related services, and national population-based immunization registers. Whilst data collected on hospital admission rates can be useful to making informed decisions regarding the geographical origin of hospital patients, their use for monitoring health at a geographically local level can, however, have spurious interpretations where services are limited and where population density is low, as is the case of the rural areas.

The final stages of this project involve providing training to the Divisions on the use of geospatial data, basic mapping skills and introduction of the preferred software prior to the introduction of the prototype. Mechanisms for monitoring and evaluating the use of the GIS are currently being determined.

GIS: the basic concepts

As the health sector is a relative newcomer in using GIS, an overview of the concept of Geographic Information Systems has been included for clarity.

GIS is a technology which allows geospatial data to be analyzed, displayed and queried. Most simply, GIS can be defined as an intelligent map. The early applications of this technology, during the 1970's and 1980's, were related with monitoring natural resources and the management of big geospatial data bases, mostly cadastral records. In the 1980's and more so in the 1990's, Geographic Information Systems have been adopted in a multiple range of social applications. Consequently, in the '90's, health is one of the most rapidly expanding areas utilizing a broad range of its spatial applications.

There are many definitions of GIS, nearly as many as there are authors in the field. Some of these definitions are focussed on the nature of the information managed in these systems. This is the case with the definition given by Serbian and Mark (1986): "GIS is a computerized data base that includes spatial information." Other definitions emphasize the capabilities and functions of these systems: "GIS is a system composed by hardware, software and procedures made to facilitate the management, manipulation, analysis, modeling and visualization of spatial referenced data in order to solve complex problems of planning and management" (NCGIA, 1990). Figure 3 shows the components of a GIS, according to this latter definition. It is important to clarify that GIS is not just software installed onto a hard disk or a collection of maps, but that it is a complete system of software, hardware, spatial and thematic data, analysis tools and staff to operate it. Without all these elements, it is not a GIS.

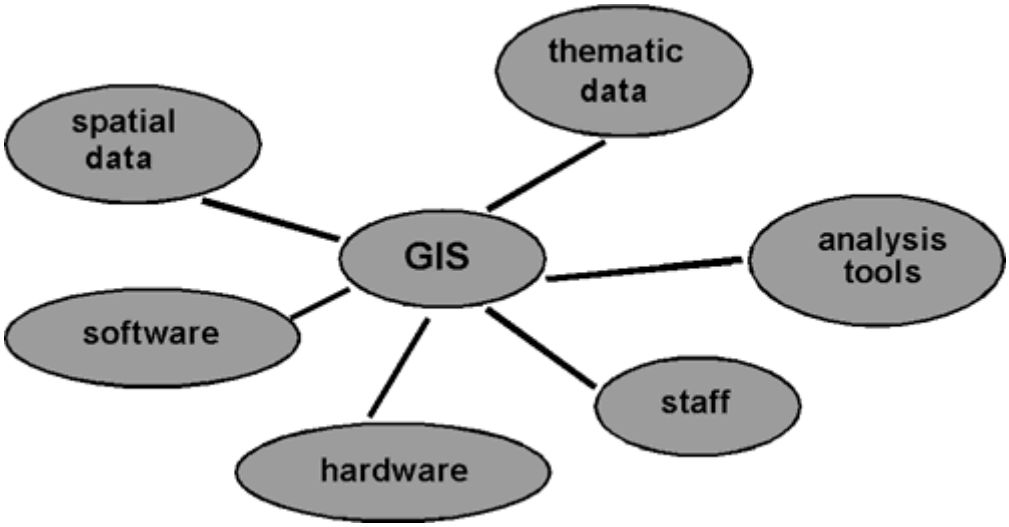

Figure 3. The GIS components

GIS technology has evolved from the combination of computer assisted drawing and conventional database management technology. Figure 4 shows the links established in

the GIS environment between these two aspects of the technology. Each of the attributes listed in the left column are linked to the geospatial database through a common identifier.

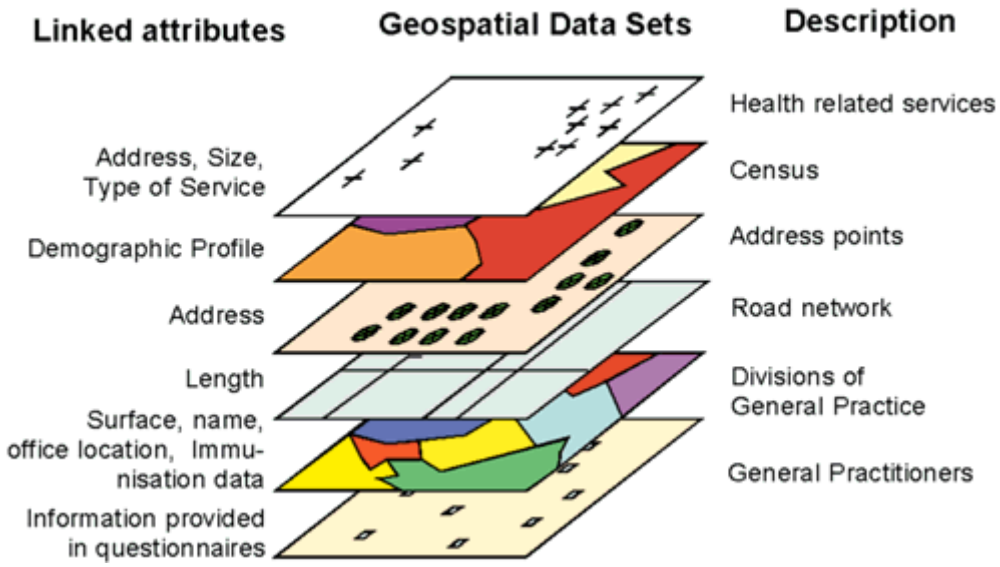

Figure 4. The concept of layers and linked attributes.

The use of the Internet in the health sector

As the Internet continues to grow in popularity, so does the scope of its health-related applications. The ever increasing numbers of health related Web sites are intended for the purposes of providing professional education, community service needs, and patient discussion groups, just to mention a few of its uses, and are repositories of specialized knowledge.

Health care providers are increasingly communicating with one another and distributing the results and medical details via the Internet. The use of the Internet as a marketing tool in other industries is well-documented (Bertazzon & Waters, 1996), and we are now witnessing widespread marketing and advertising of health-related products and services via the Internet (Sonnenberg, 1997).

Health researchers and planners are among those attempting to maximize the benefits of the Internet. Recognition has been given to the need for information systems to provide access to detailed, current, action-oriented information to successfully tackle public health problems (Friede & Ory, 1993) and for this information to be made available at the local, state, national and international level. The emphasis of this research project is not on the delivery of health services *per se* through the Internet, but on the use of this tool to improve the planning and delivery of health services.

Mechanisms are more commonly found which place population health information detailing mortality, hospital discharges, and notifiable diseases for example, at the fingertips of public health officials, providing a foundation for information based on public health policy and planning. HealthWIZ, for example, is a national social health data base of major data collections of population census data, hospital, cancer and mortality data available to the Australian public. Its developer, Prometheus Information,

released the first version of HealthWIZ On-line (http://www.hcn.net.au/) in February 1998 with a combination of cost-free data, and restricted data for subscribers. Another notable Web site which provides information on links to most of the health Web sites in Australia is http://www.moreton.com.au/ana/ausweb.htm.

Results of GIS for GPs project

The objective of this project was to develop a GIS prototype, for the use of the two pilot Divisions on whose geographic areas the data was collected. Following the integration of different types of data in the laboratory setting, the product was presented to the two Divisions.

It is important to remember that this was a pilot project. This GIS prototype located on the World Wide Web has the capability to be expanded and is not intended to be a final product. It is an open system that can be easily updated and enlarged with additional layers or additional variables in the existing layers to perform functions required by the users.

After considering the range of methods available for distributing the GIS, the Internet was the preferred choice, specifically using the GIS software ArcExplorer, provided by ESRI (http://www.esri.com) in accordance with the Open GIS Consortium (Black, 1997). While this GIS package doesn't include the full analytical capabilities of other GIS packages, it is a good starting point to perform queries and obtain good quality displays, which are the two more common operations desired by the pilot Divisions.

Reasons for using the Internet as a general communication medium include:

- recognition of the Internet as the most powerful communication medium in the world (Black, 1997)
- the data resides on a host server, thereby reducing the need for subsequent updated data to be distributed to every user
- the Interface can be designed to suit the user's requirements
- there are no software costs incurred
- there are no sophisticated hardware requirements to run ArcExplorer

(Rudd, 1997).

Reasons for the choice of the Internet specific to this project are:

- the Divisions participating in the trial already had access to the Internet
- the use of the Internet is in line with the Victorian Government policy Strategic Plan Victoria 21, which requires all government services to be on-line by the year 2005; and
- user-friendly software, given the recent introduction of information technologies into the health sector in Australia.

The availability of the system for the Divisions permits many uses of the data to address specific planning and service issues, for example, identifying peak service periods and estimating doctor/patient ratio, or for other more strategic queries throughout a calendar year.

The implemented system can be downloaded by the Divisions from:

http://www.sli.unimelb.edu.au/gdv/gdv_health.html.

For the presentation of this paper, a live demonstration of the abilities of the database is proposed. Particular attention is paid to the uses of the general practice questionnaire and immunization related data.

As the databases have been collected in the format compatible with ArcExplorer, users will be able to download for queries, analysis and display. As one of the constraints of using the Internet for a GIS in Health is the inability to publish patient identifying data, consideration needs to be given to posting confidential information despite the availability of access codes to prevent unauthorized entry to sensitive data.

Conclusion

The GIS for GPs study was undertaken to develop a methodology for the provision of a GIS to a particular group of providers of primary health care, and has been successful in achieving its aims. Nevertheless, this research has highlighted a number of constraints in the development of a GIS for the health sector. Widespread differences in data collection methods, data quality and data access have emerged. The issues and ethics involved in the protection of the privacy of the individual requires particular consideration, as the health area is one which has the potential to ostracize individuals or population groups. As each data set has its strengths and weaknesses, caution needs to be exercised in using the GIS to ensure accurate interpretation of data and the use of scientifically valid information in appropriate ways. Other issues the research has uncovered are not exclusive to this field of research, such as updating data, custodianship, security and the speed of obtaining data through the Internet. This pilot study can serve as a starting point for further research into these specific and generic issues.

A relatively underdeveloped technological infrastructure within general practice in Victoria minimizes access to the Internet. Current trends in the uptake of computers in general practice will go some way in overcoming this constraint. The Victorian Government's Strategic Plan Victoria 21 (1997) details its intention to face the information age in the twenty-first century. Initiatives during 1998 include the Department of Human Services' (Government of Victoria) commitment to draw up a "GIS for Health Strategy," and the development of a Research Strategy for GIS and Health, which is to be developed by authors of this paper. It is hoped that this will go some way to furthering the utilization of this technology.

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