Visualizing the Health Resources of Taiwan: the application of Web-GIS

Po-Huang Chiang
Chi-Pang Wen
Yaw-Tang Shih
Correspondence: chiangp@nhri.org.tw

Abstract

To understand the health resources allocation and to discover the health disparity issues in Taiwan, we developed a web-based GIS application system in National Health Research Institutes (NHRI) which provides flexible way to investigate the health resources locally. We use the Area Resource File (ARF) of the township level of Taiwan from the government website and officially reports. The Area Resource file contains the data from 369 townships or 25 counties since 1996. It includes demographic, medical services and health outcomes information. We create shape file for health resource areas and to disseminate the underlying data and maps over Internet by using ArcIMS from ESRI。

The results of interactive ARF system provide significant information discovery. It not only allows researchers to study the health resource allocation locally, but also allows them to examine the health and environmental disparity issues through the system.

Keyword：
geographic information system、Internet、Web-GIS、Area Resource File、public health informatics

Introduction

To fast improve our understanding of health factors and mechanisms that affect our health is a fundamental necessity for planning appropriate health policy and preventive interventions. The elucidation of health issues is beset by well design health research with adequate health data. The research design tries to combines health demographic, services and outcome information integration by using Geographic Information System and creates effective information presentation system to deliver the powerful policy solution available for building sustainable, flexible infrastructures to power the real-time health policy research task. Research teams can discover and share information assets as well as seamlessly present those information assets throughout the health community. .

The Health Data Team at Center for Health Policy Research (CHPR) and Development, National Health Research Institutes (NHRI) conducts research in the field of health policy by providing innovative evidence-based information and systems and is dedicated to the generation of new knowledge about the nature of health information problems, the development of new information resources and health policy analysis technique and tools to support evidence-based health research [1], and the evaluation of various innovations in overcoming health information problems.

This study tries to combine health Area Resource File (ARF) of Taiwan which was collected from the government website and officially reports and create new healthcare information presentation system for policy analysis. Geographic Information System (GIS) was chosen since it provides a powerful, logical, and intuitive means to store, manipulate, and retrieve data [2-3]. It provides the ability to visualize in a map form, only those features or objects that meet specific selection criteria. Through web GIS technology, you can visually identify features and a geographic representation in an instant. Interest in Web GIS application in health fields has grown considerably over the past few years. Recent advances in the application of web GIS technology have improved, and will continue to revolutionize the spatial analysis of diseases, environmental contamination, and social/demographic information. Many articles focus on primary care [4-7], monitoring [8], surveillance[9-10] , eliminate health disparity [11] , surveying [12] and health resources searching [13] The growing availability of health, demographic, and environmental databases containing local, regional, national, and international information are propelling major advances in the use of GIS and computer mapping.

Materials and Methods

The county and township specific Area Resource File (ARF) from the project of "International Collaborative Network for Health Policy Research" has been collected available public and secondary data sets for all researchers at the CHPR since 2003. The mission is to integrate different data sources and construct a comprehensive data base for research use. Types of data sets collected by the data team were

including government statistics report, vital statistics, national insurance claims data and survey or Census information. (Figure 1), (Table 1).

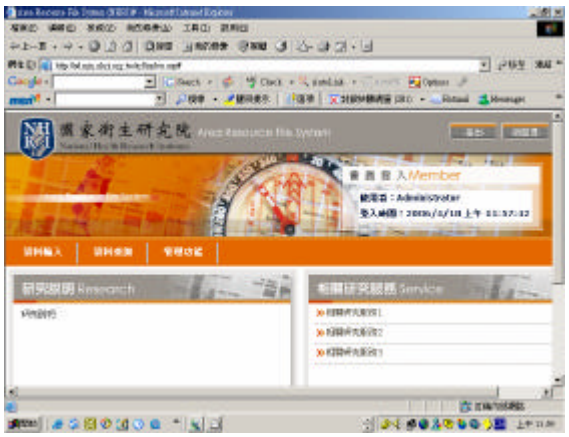

Figure 1. ARF system

Table 1: Contents of ARF

Summary reports	Statistics Abstract/Statistics Book for 25 counties
	Social Indicators, R.O.C
	DOH statistics reports and others
Population statistics	
Mortality data	
National Health Insurance claims data	
2002 KAP (Knowledge, Attitude, Practice) survey	
2005 National Health Interview Survey	
Others	

We used the ESRI ArcIMS 9 for our development. Its architecture and functionality have been engineered specifically to publish maps, data, and metadata on the Web. The software is designed so that it is easy to create maps, develop Web pages that communicate with the maps, and administer a Web mapping site [14]. ArcIMS is a client-server distributed system. On the client side, these custom viewers, HTML Viewer and Java Viewer allow visitors accessing Web site to view high-quality, interactive maps that feature tools including seamless pan, dynamic zoom, MapTips, and keyboard shortcuts. The Server side includes ArcIMS Spatial Server, ArcIMS Application Server, ArcIMS Application Server Connector and ArcIMS Manager, provide the capability to publish a map onto Internet. The ArcIMS Application Server runs as a background process and handles the load distribution of incoming requests. It also catalogs which services are running on which ArcIMS Spatial Servers. Using this information, the Application Server dispatches an incoming request to the appropriate Spatial Server. Application Server Connector is used to connect between Web Server and ArcIMS Application Server which provides different kinds of format, including Servlet Connector, Cold Fusion Connector, Java Connector and ActiveX Connector. ArcIMS Manager consists Author, Design and Adminidtrator which can provide the ability to create and manage your application. ArcXML is the protocol for communicating with the ArcIMS Spatial Server. An ArcIMS Spatial Server is the backbone of ArcIMS and provides the functional capabilities for accessing and bundling maps and data into the appropriate format before sending the data back to a client. The ArcIMS software is also designed to be distributed across a network and to be scalable as the demand for maps increases. ArcIMS has a multi-tier architecture consisting of presentation, business logic, and data tiers. In addition, ArcIMS has a set of applications for managing a Web mapping site. Overview of the ArcIMS architecture sees Figure 2.

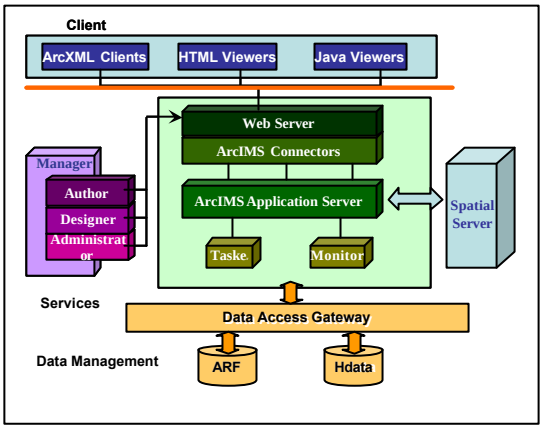

Figure 2. Architecture of ArcIMS

Results

The Health Resources Internet Mapping system is initiated by select the County and Township level boundary. The data layer has Demographic, Health/Medical Services and Health Outcome for area information presentation layers (Figure 3). Detail selection can be chosen through select toolbar (Figure 4). The GIS map layer control the active and visible layer to perform an identify and other analytical operation (Figure 5). It also provides facilities and transportation (point) information (ex. Hospital, Public Services, and Station etc.) (Figure 6a, 6b). Several customized tools buttons are located in the menu bare above the interactive map.

Figure 3

Figure 4.

Figure 5.

Figure 6a

Figure 6b

ArcXML is the communicating bridge between client and server side. Data and map can be visualize through the interactive system. In this study, we use HTML for easy access for user across the Internet. (Figure 7a, 7b, 7c)

viewer.htm - 記事本

```
<SCRIPT TYPE="text/javascript" LANGUAGE="JavaScript">

        var cmdString = document.location.search;
        var cmdString2 = cmdString.toUpperCase();
        var pos = cmdString2.indexOf("TITLE=");
        var startpos = 0;
        var endpos = 0;
        var theTitle = "Area Resource File (2000~2002年)";
        var reloadTimer;
        var connectorType = "Servlet";
        if (pos!=-1) {
                startpos = pos + 6;
                endpos = cmdString.indexOf("&",startpos);
                if (endpos==-1) endpos = cmdString.length;
                theTitle = cmdString.substring(startpos,endpos);
                theTitle = replacePlus(theTitle);
                theTitle = unescape(theTitle);

        }
        document.writeln("<TITLE>" + theTitle + "</TITLE>");

        function doIt() {
                MapFrame.useJava=false;
                MapFrame.checkParams();
                //ToolFrame.document.location="toolbar.htm";
        }
        function replacePlus(inText) {
             var re = /\+/g;
              inText = inText.replace(re," ");
             return inText;
        }

        function reloadApp() {
                        //document.location = "default.htm";
                        window.clearTimeout(reloadTimer);
```

Figure 7a Front page viewer script

viewer.htm - 記事本

```
<SCRIPT TYPE="text/javascript" LANGUAGE="JavaScript">

        var cmdString = document.location.search;
        var cmdString2 = cmdString.toUpperCase();
        var pos = cmdString2.indexOf("TITLE=");
        var startpos = 0;
        var endpos = 0;
        var theTitle = "Area Resource File (2000~2002年)";
        var reloadTimer;
        var connectorType = "Servlet";
        if (pos!=-1) {
                startpos = pos + 6;
                endpos = cmdString.indexOf("&",startpos);
                if (endpos==-1) endpos = cmdString.length;
                theTitle = cmdString.substring(startpos,endpos);
                theTitle = replacePlus(theTitle);
                theTitle = unescape(theTitle);

        }
        document.writeln("<TITLE>" + theTitle + "</TITLE>");

        function doIt() {
                MapFrame.useJava=false;
                MapFrame.checkParams();
                //ToolFrame.document.location="toolbar.htm";
        }
        function replacePlus(inText) {
             var re = /\+/g;
              inText = inText.replace(re," ");
             return inText;
        }

        function reloadApp() {
                        //document.location = "default.htm";
                        window.clearTimeout(reloadTimer);
```

Figure 7b HTML script

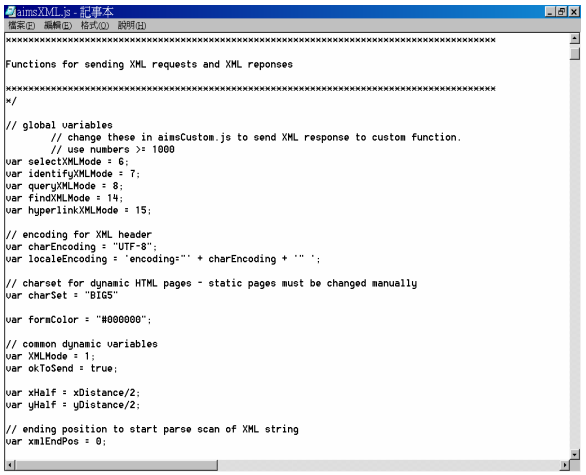

Figure 7c Java script

Discussion and Conclusions

The Web GIS provides a suite of tools for examining the health outcome related to location and distribution of service providers with respect to health and demographic characteristics and other GIS reference layers (e.g., administrative and political boundaries). The data visualization available through this project enables the public, healthcare providers, and policy makers to better understand the distribution of services, and improves the ability of decision-makers to understand the implications of economic, social and demographic factors on the distribution of services.

The system was not able to demonstrate the analysis capability in health disparity issues yet due to the sources for data entry was unavailability and lack of township level data. Some Inconsistency of elements among counties and years was also found in different data sources. The continuous effort for better data quality of ARF was needed. Improved understanding the health issues will come from an abundant and complete health database, then better health care and safety medical service can be reached.

The Health Data Team at Center for Health Policy Research and Development, National Health Research Institutes (NHRI) conducts research in the field of health policy by providing innovative evidence-based information and systems and is dedicated to the generation of new knowledge about the nature of health information problems, the development of new information resources and health policy analysis technique and tools to support evidence-based health research, and the evaluation of various innovations in overcoming health information problems. Other research topic like community resource accessibility can also be conducted if the township level data are available. Each sub-unit represent by its population weighted centroid (the centre of population in the area rather than the geometric centroid) and the travel time taken to each community resource (for example, a hospital) along the road network can be calculated using the network functionality in ArcInfo GIS. There are so many potential applications for us to explore and benefit the community.

With this integrate new design of healthy community at their disposal, researchers will be able to search for existing health care information, identify needed population, develop new economic welfare policy research questions and seamlessly integrate information assets throughout the policy research society. Through the establishment of information alternation platform, the health ARF, National Health Insurance Database, along with other health survey and government census data, provides a unique opportunity to examine health issues and the health industry as a whole. Health researchers and managers can focus not only on health care utilization and expenditure but also on social and economical issues. Medial practitioners can identify associations between health events and drugs or devices.

The elucidation of health issues is beset by well design health research with adequate and accurate health data. Our goal of national health is hindered by lack of secure and effective information sharing systems and the clearness of the premise and provisions. The area of health informatics is being revolutionized by new technological advancement in data exchange and internet development. Improved understanding of health issues will be a direct result from an abundant and complete health database. Well-designed health research along with adequate and accurate health data will assist improving our health care delivery system and the overall health of Taiwan.

Acknowledgement

This project is administered by the Centre for Health Policy Research and Development, NHRI. Part of the research reported in this paper was supported by a Department Of Health grant of National Health Information Infrastructure (NHII) to NHRI. We would also like to thank Dr. Der-Ming Liou, National Yang-Ming University, Ms. Shu-Fang Shih, Ms. Shu-I Chiu, Miss Hsiao-Lei Chen, Miss Hsiao-Hui Chen and Mr. Ta-Chien Chan, Center for Health Policy Research and Development, NHRI, for their support to this study.

References

1. Waters E, Doyle J. "Evidence-based public health: Cochrane update." J Public Health Med. 2003; 25:72–5.
2. Croner CM. "Public health, GIS, and the Internet. Annu Rev Public Health." 2003; 24:57–82.
3. Richards TB, Croner CM, Rushton G, Brown CK, Fowler L. "Geographic information systems and public health: mapping the future. Public Health." Rep. 1999; 114:359–73.
4. Luo W, Wang F, Douglass C., "Temporal Changes of Access to Primary Health Care in Illinois (1990–2000) and Policy Implications", Journal of Medical Systems 2004; 28:287-99.
5. Margarethe Theseira, "Using Internet GIS technology for sharing health and health related data for West Midlands Region", Health & Place 2002; 8:37-46.
6. David C, Goodman DC, Mick SS, Bott D, Stukel T, Chang C, Marth N, Poage J, Carretta HJ. "Primary Care Service Areas: A New Tool for The Evaluation of Primary Care Services." Health Services Research. 2003; 38:287–309.
7. Higgs G, Richards W. "The use of geographical information systems in examining variations in sociodemographic profiles of dental practice catchments: a case study of a Swansea practice." Prim Dent Care. 2002; 9:63–9.
8. Dimitrios Ptochos, Dimitrios Panopoulos, Kostas Metaxiotis, Dimitrios Askounis, John Psarras. "Using internet GIS technology for early warning, response and controlling the quality of the public health sector." International Journal of Electronic Healthcare (IJEH), Vol. 1, No. 1, 2004.
9. Maged N Kamel Boulos. "Towards evidence-based, GIS-driven national spatial health information infrastructure and surveillance services in the United Kingdom" Int J Health Geogr. 2004; 3: 1.
10. Boulos MN. "Towards evidence-based, GIS-driven national spatial health information infrastructure and surveillance services in the United Kingdom." Int J Health Geogr. 2004;**3**:1
11. Christopher L. Fulcher, Catherine E. Kaukinen. "Visualizing the Infrastructure of US Healthcare Using Internet GIS: A Community Health Informatics Approach for Reducing Health Disparities." MEDINFO 2004. Amsterdam: IOS Press.
12. Smith DP, Gould MI, Higgs G. "(Re) surveying the uses of Geographical Information Systems in Health Authorities." 1991–2001. Area. 2003; 35:74–83.
13. **網際網路醫療資源地理資訊查詢系統**. Available from URL: http://203.65.100.159/dohgis/ (Accessed: August 19, 2006)
14. An ESRI white paper, May 2005. ArcIMS 9 Architecture and functionality. Available from URL: http://www.esri.com/library/whitepapers/pdfs/arcims9-architecture.pdf. (Accessed: August 19,2006)
15. **張邨生**, "ESRI ArcGIS **地理資訊系統簡介**", **國土資訊系統通訊**:49 Available from URL: http://ngis.moi.gov.tw/TheFiles/journal/49/008.htm . (Accessed: August 19,2006)
16. **蔡博文**, "GIS **作業平台功能簡介**" , **國土資訊系統網站**. Available from URL: http://ngis .moi.gov.tw/trainfrom/10202_1.aspx?class_seq=6 . (Accessed: August 19,2006)