CO-188

VISUALIZING HEALTH CARE ACCESSIBILITY: AN ONLINE ATLAS OF MEDICAL SERVICES IN MICHIGAN, USA

GOLDSBERRY K., SOCIA K.
Michigan State University, EAST LANSING, MI, UNITED STATES

BACKGROUND

Access to health care is an important issue in the United States. For many different reasons, millions of Americans lack ready access to the medical services they need. This paper examines ways to cartographically identify disparities in geographic health care access. However, accessibility is a slippery term as Peter Gould famously pointed out, its one of those terms everyone uses until faced with the problem of defining it and measuring it. As a result, beyond being stated as a vague goal in urban planning and/or public policy, accessibility is rarely translated into performance measures by which people can identify at-risk areas.

Due to recent advances in technologies, applications involving interactive and animated mapping are becoming more popular. The capabilities and potential benefits of incorporating such technology into the revision of the Michigan Department of Community Health (MDCH) Licensed Health Facility Atlas was a logical next step in the development of the atlas. MDCH has been working collaboratively with the Michigan State University Department of Geography to create an annual health facility atlas. The atlas is designed for people working in the healthcare industry and those overseeing the facilities. MDCH annually surveys and collects an abundance of data about the health facilities around the State of Michigan each year. However, this data is stored in a database and only available on request. Meetings with the MDCH program coordinators revealed a need to visualize the data and provide better public access to it.

In recent years a paper atlas was created and made available online in a PDF format. This medium however did allow for the integration of the annual survey data. The development of an online, interactive atlas allows us to incorporate the annual survey data, as well as affords multiple views of the data with different search options. In the following sections, we describe the development and design processes that lead to the creation of the Michigan Department of Community Health interactive health facility atlas.

Previous versions of the atlas were designed for print and online PDF viewing, with the atlas divided into chapters by facility type. While this method provided a visual representation of the spatial locations of facilities, it did not afford any additional data exploration opportunities for the user. This format also made editing a cumbersome and inefficient multi-step process. With an abundance of information that could be linked with each facility, interactive maps afford the possibility to link a facility to more than just its spatial location.

The interactive atlas was designed to provide detailed information about the locations and services offered at each facility. The objective was to create an interactive atlas application that could visualize the data and provide easy access to information about health facilities across the state of Michigan. This interactive atlas is the first version of the application and provides a framework with which to incorporate additional features in future years.

OBJECTIVES

Accessibility is a critical component medical geography. However, different accessibility measurement strategies result in very different pictures of access. The goals of this research are to 1) implement multiple accessibility models to help visualize health care disparities at a regional scale, 2) compare the resulting pictures of access, and 3) identify which, if any zones in Michigan are most at-risk in terms of health care access, and 4) create an online atlas capable of organizing and publishing our results.

METHODS

Each year the Michigan Department of Community Health (MDCH) conducts an annual survey of health care facilities in Michigan. Every licensed health care facility in the state is obligated to complete the comprehensive survey, which requires them to report their operational status as well as which services they offer. We integrated the resulting database with GIS to model accessibility to health care in Michigan. The database indicates two categories of geographic information: 1) the geographic locations of every hospital, nursing home, psychiatric facility, and surgical center in the state, and 2) which individual services are offered at each facility. Each of these categories of information enables a different kind of accessibility analysis. First, we can model access in terms of the cost of traveling to the different kinds of facilities (e.g. which areas are within a 30-minute drive to a hospital). Secondly, we can also model

accessibility to individual types of services (e.g. which areas are within a 30-minute drive to a magnetic resonance imaging (MRI) service). Thirdly, we can overlay the individual service outputs to visualize cumulative metrics that summarize the depth of care accessible from any location in the state. We conducted each of the above analyses using three common accessibility measures: container measures, weighted measures, and cumulative distance measures.

The development of the interactive atlas began in January 2010, with this first edition released to the public in October 2010. Assistant Professors, Dr. Kirk Goldsberry of Michigan State University and Dr. Sarah Battersby of the University of South Carolina and a Graduate cartography student developed the atlas application. The Michigan Department of Community Health Certificate of Need program provided funding for the project. The design and development of the atlas involved the use of multiple software programs which include: Adobe Illustrator CS3, Adobe Flash CS3, Adobe Dreamweaver CS3, ActionScript 3.0, ArcMap 9.3., and Microsoft Excel 2007. MDCH provided the 2009 facility data in an Excel spreadsheet format. Framework data for the base maps was retrieved from the Michigan Center for Geographic Data (http://www.mcgi.state.mi.us/mgdl/). The interactive atlas can be found on Michigan State University's Medical Geography website at http://health.geo.msu.edu/atlas.html.

The design of the interactive health facility atlas began with creating base maps in ArcMap. MDCH divides the state into eight Health Service Areas with each containing five different types of facilities. These divisions help create the chapters of the atlas. Maps were generated in ArcMap for each Health Service Area, ten major cities in the state of Michigan and two statewide maps. Nineteen base maps with framework data were created and then exported to Adobe Illustrator for further design. It took one graduate student approximately 2 months to design the base maps with cities, roads and natural features. Since each base map file was too large to directly import into Flash, the maps were saved as JPEG's and then placed in Flash.

The next step involved designing the atlas interface with Flash. The interface needed to be simple, easy to navigate and accommodate the vast of amount of data in a variety forms. The main elements of the interface include the map area and information panel with two tabs as well as a navigation bar along the top of the atlas.

One of the major benefits of the interactive atlas is the ability to dynamically update facility information. The application utilizes an xml (Extensible Mark-up language) to structure and store the facility data in a format that Adobe Flash can read. Before the interactive atlas changes or additions to facilities in the PDF version required the designer to edit the map in Illustrator, save it as a PDF and then add it to one large PDF document to upload to the web. Now, simple changes such a name or address can be quickly edited in the .xml file and re-uploaded to the web.

One of the goals of this project was to make updating the atlas a quick and simple task. This goal was achieved by using xml data to dynamically place the facility locations on the maps. In order to do this, we used ArcMap and ActionScript to convert from a geographic coordinate system to screen coordinates. This involved a multi-step process to transform the data. The original data was in an excel spreadsheet containing addresses, services and latitude and longitude coordinates for each facility. This data was then imported and converted to shapefiles in ArcMap. Since the base maps were in the Michigan GeoRef state projection, the latitude and longitude coordinates needed to be converted to Michigan GeoRef coordinates. Next, the new attribute table for each facility type was then exported back into excel for further data transformation.

The next step of data processing consisted of creating an xml schema for the ActionScript to read. We used Dreamweaver to set-up and create an xml schema to match the label format of the Excel spreadsheet. After generating an xml template, the xml file was opened in Excel where the rest of the data could then be added.

With the data in dynamic text format that will work with Flash and ActionScript, we then began building the actual application interface and navigation. The first steps involved adding illustrator files created for the Atlas background, tabs, and pages and the base map JPEG's. We then wrote ActionScript code to load the xml documents and placed the facilities in their correct screen coordinate locations. Buttons and links to external files were then added to create a functional atlas.

The atlas is structured so that a user sees a table of contents first, allowing them to choose a specific map area of interest. The table of contents is organized by Health Service Areas, major cities and statewide maps. After choosing a map, the user still has the ability to view other maps from a navigation bar near the top of the atlas. The navigation bar essentially displays the path to the currently displayed map as well as provides links to other related maps.

When the selected map loads, the user has the option to view the facilities by type or by a specific service. Facility types include hospitals and nursing homes while the services include categories such as Emergency Departments, MRI services or transplants. The two different viewing modes are set-up as digital tabs, that when selected, change the search option and the display of the information panel. The default is set with the view by facility tab active and with hospitals set as the default symbol.

The information panel displays five radio buttons that correspond to the facility types and allow the user to view each type of facility separately on the map. Selecting the hospital radio button will display all the hospitals located within the selected map area. The user can then hover over the hospital symbols and click on one to display more information. Hovering over a symbol magnifies it and when it is clicked a drop shadow is applied that makes the selected symbol stand out among the rest. Clicking another symbol deactivates the previously clicked symbol and then magnifies the new symbol.

When a user clicks on a symbol, the xml data associated with the selected facility loads into the information panel. Information about the facility's address, I.D. number and a link to a PDF document appear. In addition, on the right side of the information panel a list of facility services are displayed. The list of services is shown in gray, and when the user selects a facility the services offered at that facility become highlighted. This mode allows the user to essentially view different types of facilities and the kinds of services they provide.

The second tab on the information panel allows the user to view facilities according to services. Rather than viewing only hospitals or nursing homes, this search option returns all the possible types of facilities that offer the selected service. For example, selecting the Inpatient Hospital Beds service displays all the facilities in the selected map area that offer that service. The symbols also function the same way in this mode as in the View by Facility mode and the basic address, I.D. number and PDF link appear as well. The tabs are structured the same way, where the location and services information is in the same location on each tab.

RESULTS

The results reveal the geographic distribution of health care opportunities across Michigan with unprecedented clarity. Although these results only begin to help us understand the complex interactions between geography, the built environment, and health care, we believe that they represent key step towards informing American health care policy with sophisticated GIS analyses. Furthermore, epidemiologists and medical geographers can also use the results to investigate whether or not proximity to health care services influences incidence of certain health care outcomes.

CONCLUSION

This online, interactive atlas far surpasses the functionality and capabilities of the previous versions of the atlas and affords many opportunities for expansion and integration of more information. The first phase has been a great success and received warm feedback from users, which we hope to incorporate in the future editions. We hope this Atlas project will continue to expand over the years by incorporating additional datasets and facility information. We also plan to improve the functionality by incorporating mouseover information boxes to the map symbols, as well as add the ability to toggle between base layers, such as census data and natural features.

We believe that health care accessibility is an important yet misunderstood issue in the US. We also contend the combined abilities of accessibility modeling, GIS, cartographic design, and web publishing present an exciting new opportunity to help people understand the geography of health care with newfound richness.