Exploring the Demographic and Socioeconomic Determinants of Health along the US-Mexico Border: An Online Interactive Application

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Abstract

This paper demonstrates the usefulness of an interactive online geographic information system (GIS) tool—a demographic data viewer—used for the exploration of the determinants of health along the United States-Mexico border region. This tool facilitates access to and analysis of data for users with no GIS experience. The application, DDViewer 3.0, is an innovative Java-based interactive mapping application, freely accessible through the World Wide Web. It integrates many types of demographic and socioeconomic data and visualizes interdisciplinary spatial data online in real time. Users may create customized maps and undertake simple statistical analysis. Thus, DDViewer can play an important role in the dialogue between many different stakeholders in a public health system whose issues span large, heterogeneous, bi-national communities the way they do along the US-Mexico border.

Keywords: social demography, socioeconomic characteristics, health, US-Mexico border, data visualization

Introduction

When public health issues span large, heterogeneous communities as they do along the United States-Mexico border, policymakers and researchers need analytical tools that are neutral, simple, and versatile. This paper showcases the Demographic Data Viewer (DDViewer), an interactive online tool for exploring mortality and its socioeconomic and demographic determinants. DDViewer allows users with no geographic information system (GIS) experience to create customized maps and generate descriptive statistics for any region of interest within the United States.

DDViewer 3.0

DDViewer is an interactive mapping tool that currently makes available 225 demographic and socioeconomic variables from the 1990 US Census at the state, county, and tract level (1). The database is being extended to include US birth and death statistics at the county and state levels, Mexican socioeconomic and demographic data, and birth and death statistics for Mexico. At the time that this paper was written, only demographic and socioeconomic data from the counties on the US side were prepared for use. Future online applications will encompass data for the counties on both sides of the US-Mexico border.

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DDViewer 3.0 is an innovative Java-based interactive mapping application, accessible through the World Wide Web. At present, it is an excellent data exploration tool. In the future, it will integrate additional analytic capabilities. It was developed by the Center for International Earth Science Information Network (CIESIN) at Columbia University in 1996. In 1997, a version using Java technology was released. Both Java and non-Java versions are available to meet the computer requirements of users with varying technological capabilities. Access to DDViewer is available through CIESIN's homepage (www.ciesin.org) or directly at its own universal resource locator (URL), http://plue.sedac.ciesin.org/plue/ddviewer/.

Applying DDViewer

DDViewer visualizes interdisciplinary spatial data online in real time. Using a map and listbox graphical user interface, users may select regions and socioeconomic and demographic variables of interest. Figure 1 shows that the states along the US-Mexico border can be selected by clicking on each state. Alternatively, an entire area may be chosen via the listbox. This feature is very flexible. Regions need not be contiguous and can be added or deleted easily. Once a state has been selected, lower levels—counties or census tract—may be selected.

The next step is to select variables. There are six categories from which to choose: population, income, education, employment, housing, and a miscellaneous category. Figure 2 shows a sample of the variables in the population category. Once variables are

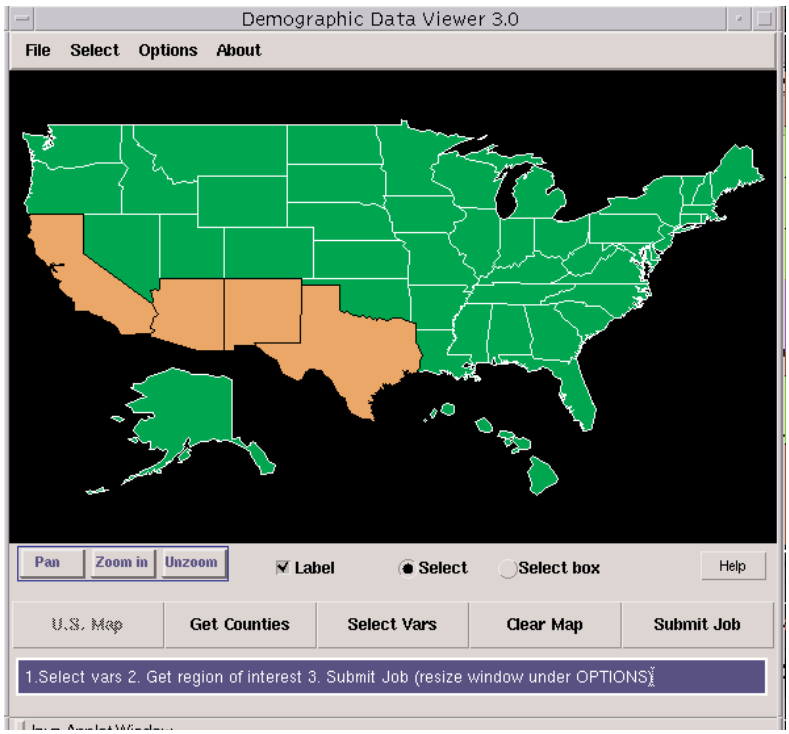

Figure 1 DDViewer display of selected states along the US-Mexico border.

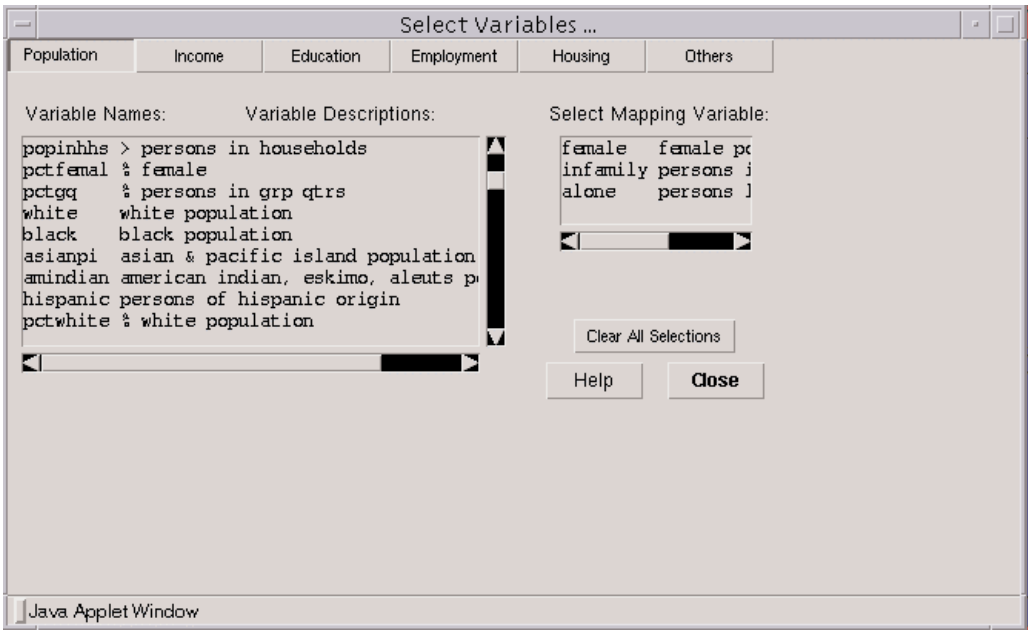

Figure 2 Sample of variables in the DDViewer population category.

selected, it is possible to construct new variables as a function of the original ones. Of course, the time it takes to process the selection depends on the size of the geographic area and number of units of interest, as well as the number of attributes. However, it is typically quick. To produce a county-level map of the distribution of the Hispanic population of the United States, for example, takes less than five minutes. Once the boundary and attribute data have been selected, all data processing takes place within the user's desktop client, and processing tends to be quite rapid. Each time a new region or additional variable is selected, CIESIN's server again transmits data directly to the user's computer.

Users can manipulate and customize their maps. For example, they may add titles and legends, alter the colors, zoom in on smaller regions, and select the manner in which the variables are displayed. To illustrate these capabilities, this paper includes a series of county-level maps generated by DDViewer showing the distribution of the Hispanic population of the United States. This variable was chosen because theory suggests that mortality and other health outcomes are dependent on access to health care, and that access to health care depends in part on the ethnic composition of an area (2).

Results

The first map, Figure 3, displays the distribution of the Hispanic population as quintiles (five categories that each contain one-fifth of the total population), though quartiles (four even categories) are the standard display unit of DDViewer and of the breakdown in which the descriptive statistics are given (see Figure 4). At the 25th percentile (i.e., one-quarter of the counties in the United States), the county-level population is 0.4% Hispanic. Even at the 75th percentile, only 2.4% of the county population is Hispanic.

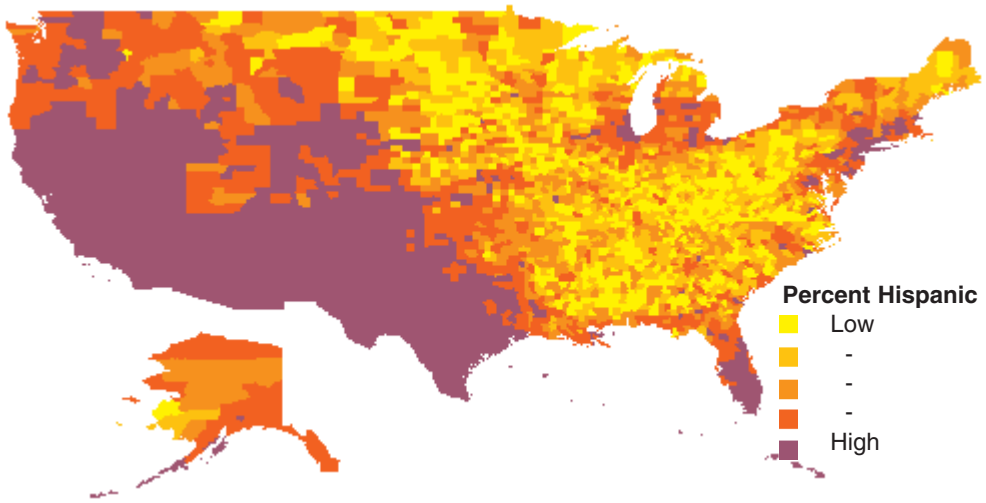

Figure 3 County-level distribution of US Hispanic population, 1990. Percentages displayed as quintiles.

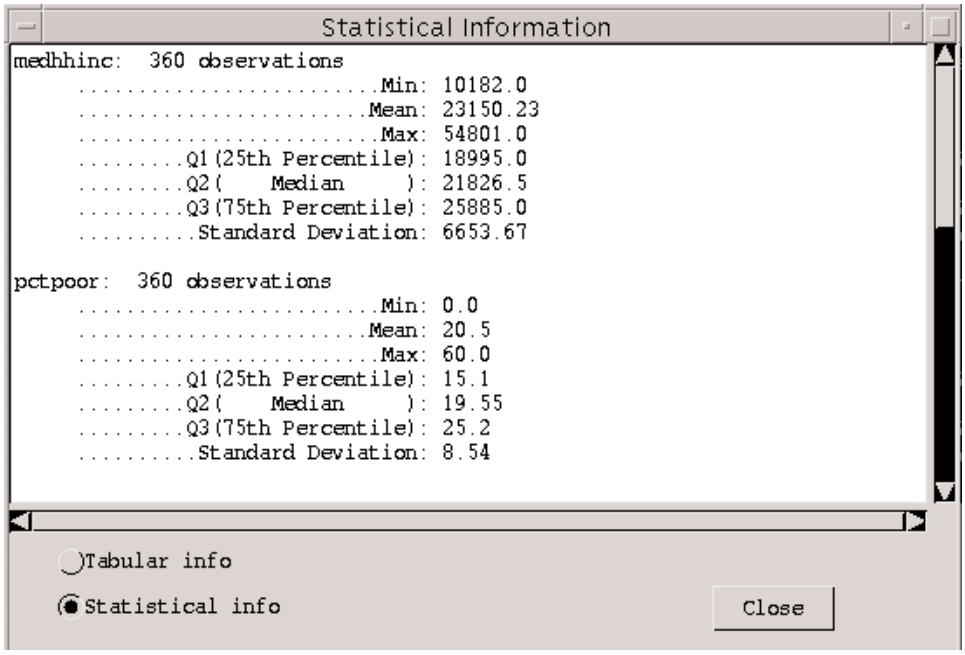

Figure 4 Descriptive statistics of quartiles.

The quintile breakdowns shown in Figure 3 would not be substantially different from those drawn for quartiles.

Although the color schema of the map in Figure 3 is accurate in indicating which areas of the United States have relatively small or large Hispanic populations, it does not describe the absolute distribution. The next map, Figure 5, shows the proportion of

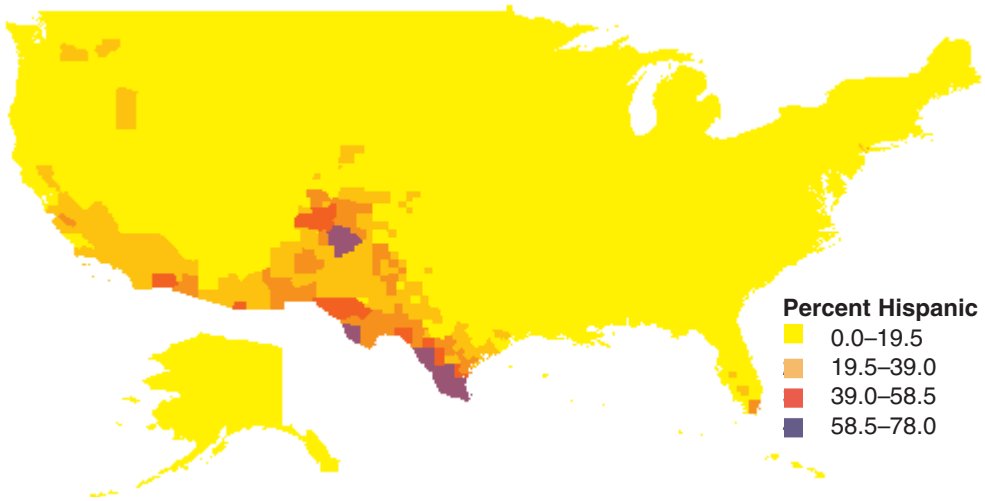

Figure 5 US Hispanic population, county level, 1990. Distribution displayed as five equal intervals.

Hispanic population to total population for each county in terms of five even intervals of the values of the distribution. It indicates that the vast majority of US counties have Hispanic populations of less than 20%. A few, mostly in Texas along the US-Mexico border, have Hispanic populations of 79% or greater.

Figure 6 plots specific proportions of the US Hispanic population based on customized distribution intervals. For example, the provision of Spanish language health services might be based on some critical proportion of the total population being Hispanic. Health planners could decide on the threshold level and then categorize areas in terms of having or not having a sufficient Hispanic population to warrant this service. The red in Figure 6 highlights areas where the Hispanic population is between 20 and 50%. The purple identifies counties with majority Hispanic populations.

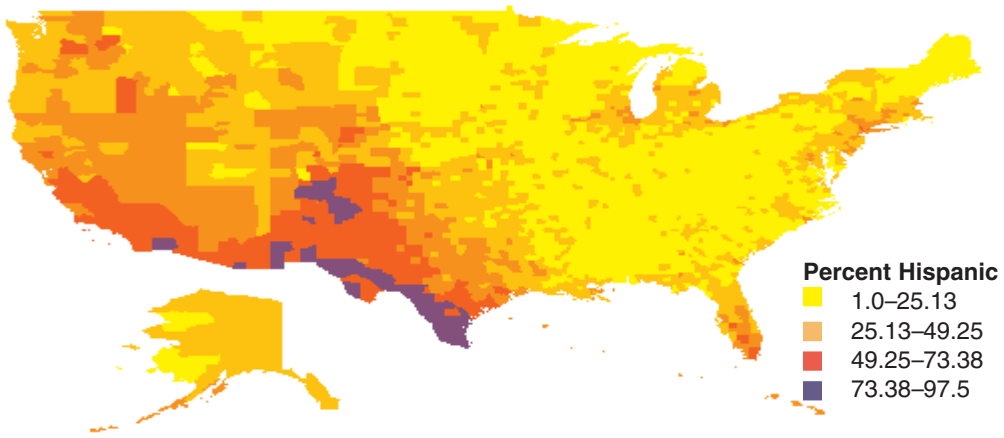

Figure 6 US Hispanic population, county level, 1990. Based on customized distribution intervals.

In addition, health planners might be interested in knowing whether certain counties are relatively underserved because they are predominantly Hispanic. Ideally, one would want to correlate and overlay data of different types, such as the proportion of the population that is Hispanic with the level of health care service provisions. Such developments are currently underway and will facilitate creating useful GIS for many areas of interest. It is important to note that the three maps presented here can be created in only a matter of minutes.

Now for a quick look at the border states, in particular, and some of the other capabilities of DDViewer. The map in Figure 7 shows the Hispanic population of the counties in California, Arizona, New Mexico, and Texas. The county border lines are visible. Figure 8, showing median household income, displays an inverse pattern to that of the Hispanic distribution. Figure 9 shows that the proportion of persons whose education ended at the elementary level corresponds to the Hispanic distribution and is inverse to the pattern of median household income. Figures 10 and 11 describe the extent of poverty in the region. While there are variations within most of the states, the stronger variation is seen from east to west.

The data for these counties can quickly and easily be downloaded into other software and additional analysis can be done. Figure 12 presents the correlation coefficients for these variables. As suspected, they confirm the visual conclusion. All relationships are statistically significant.

Additional Considerations

Users may query the map by pointing to (i.e., placing their mouse on) any polygon to identify underlying values or polygon labels—that is, place names—right on their computer screens. They may retrieve a data listing, as shown in Figure 13. It is also easy to create and re-code derivative variables. The descriptive data can be downloaded simply by cutting and pasting. It can then be read into any other software package for

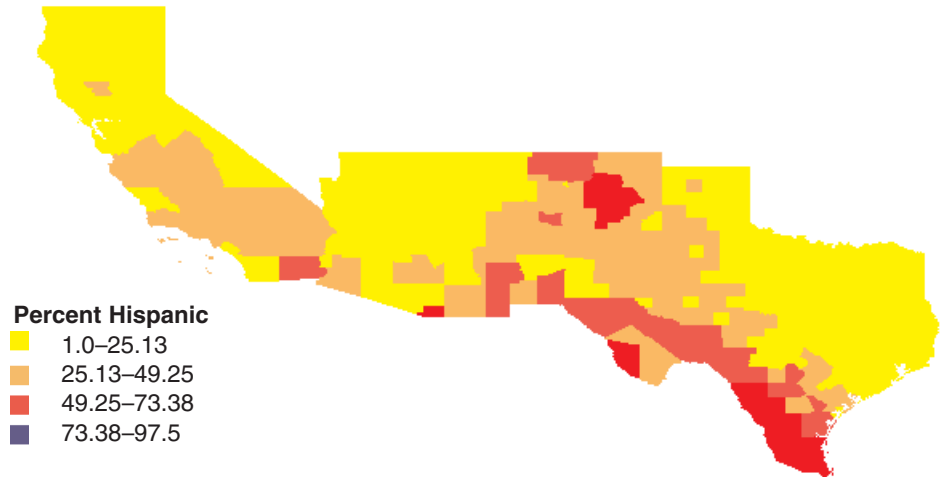

Figure 7 Percentage of Hispanic population for border states AZ, CA, NM, and TX; county level, 1990.

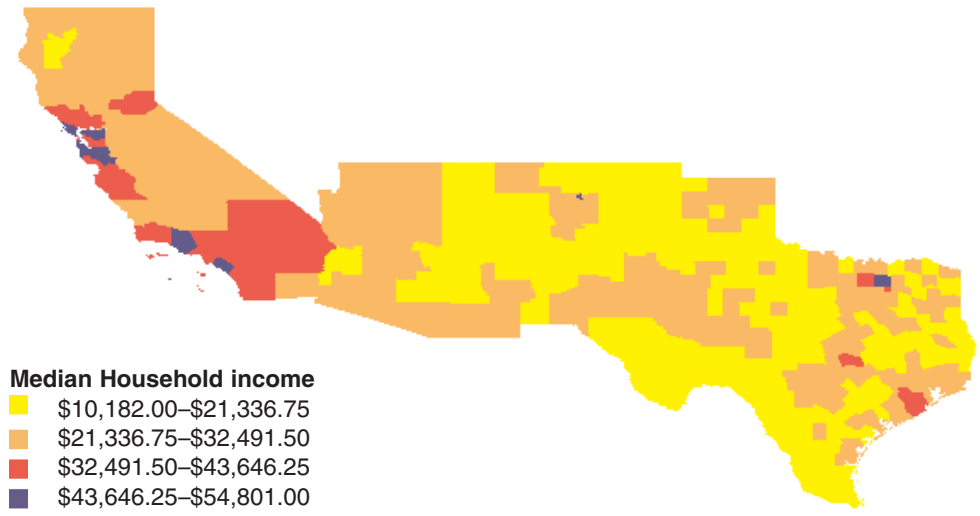

Figure 8 Median household income for border states AZ, CA, NM, and TX; county level, 1990.

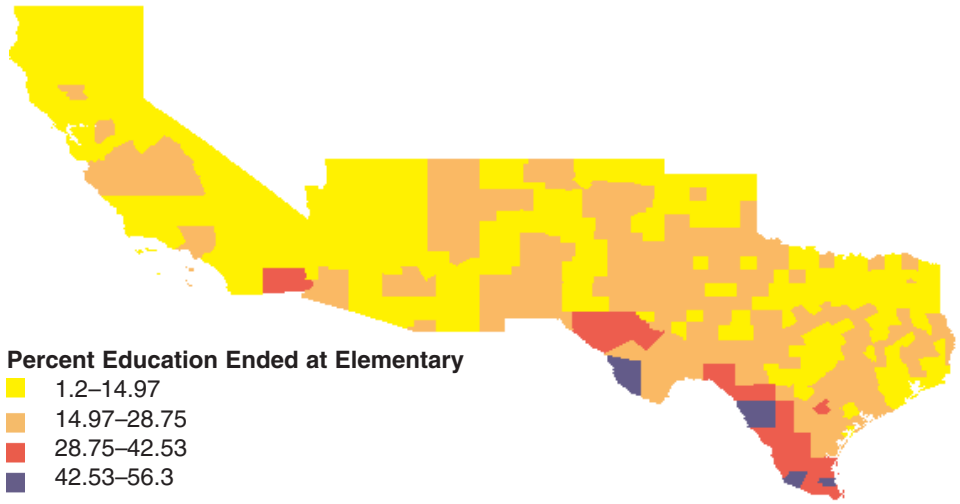

Figure 9 Percentage of persons whose education ended at the elementary level in border states AZ, CA, NM, and TX; county level, 1990.

further analysis. If a user is interested in data for a very large number of counties or tracts, such as the entire country, the data can be downloaded through another tool, the Demographic Data Cartogram, DDCarto, also available from CIESIN's homepage. The direct URL for DDCarto is http://plue.seda.ciesin.org/plue/ddcarto.

The basic GIS for Mexico's states, municipios, and islands has been completed. A

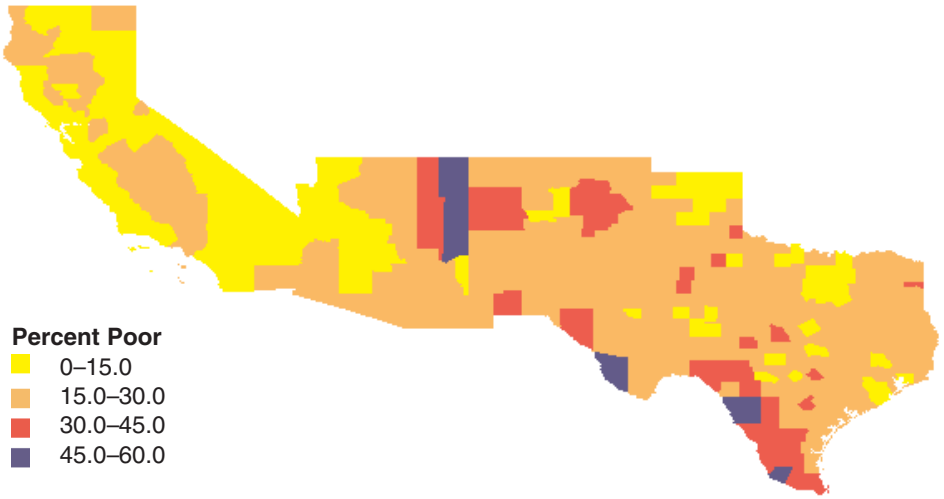

Figure 10 Percentage of persons living below the poverty line in border states AZ, CA, NM, and TX; county level, 1990.

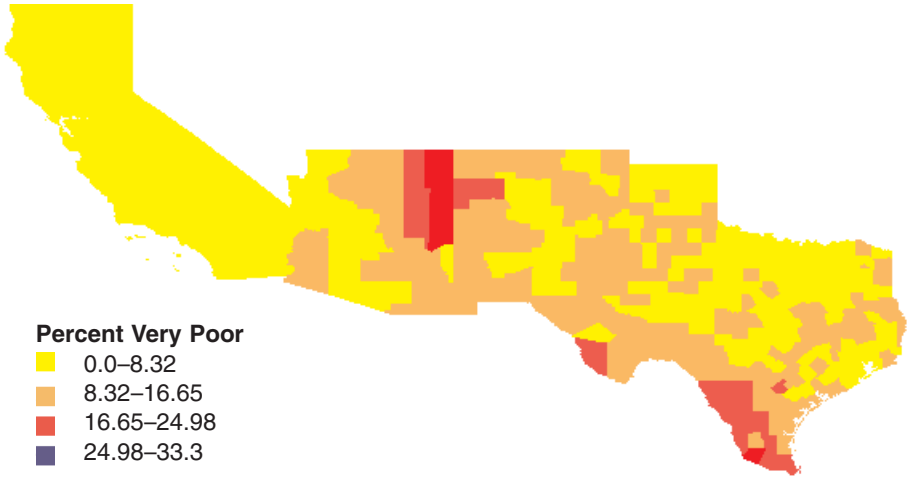

Figure 11 Percentage of persons living 50% below the poverty line in border states AZ, CA, NM, and TX; county level, 1990.

beta test version of it is available on CD-ROM. For anyone interested, copies are available from CIESIN and comments are welcome. The construction of the Mexico GIS required re-mapping the US-Mexican border so that the US and Mexican maps would align perfectly. The boundaries were taken from TIGER 95 for this correction.

Data for the Mexican states are being incorporated into DDViewer. The border states will be done first because of the special interest in border-related issues and the clear need for such information. Health data are also currently being added as part of DDViewer for both the United States and Mexico. The health data will first be introduced for the states along the US-Mexican border. The new applications will be released soon in both English and Spanish.

	Variable labels						
	Fipscode	*pcthisp*	*pct0_19*	*Medhhinc*	*pctpoor*	*pctveryp*	*pcthsch2*
Variable labels							
Fipscode	1.0000						
pcthisp	0.5677	1.0000					
pct0_19	0.3570	0.9205	1.0000				
medhhinc	-0.7080	-0.7154	-0.5428	1.0000			
pctpoor	0.6331	0.8641	0.7506	-0.8729	1.0000		
pctveryp	0.5453	0.7815	0.7021	-0.7806	0.9467	1.0000	
pcthsch2	-0.2161	-0.5123	-0.4054	0.3729	-0.5732	-0.5433	1.0000

Figure 12 Estimated correlation coefficients between exemplary variables.

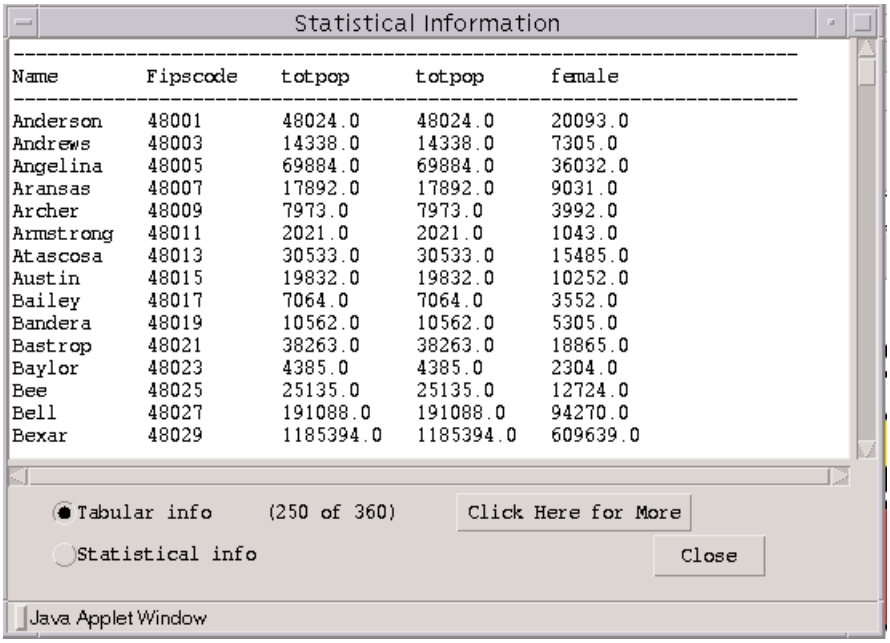

Figure 13 DDViewer data listing: selected variables by county name.

Future plans include moving beyond a strictly demographic data viewer to a spatial data viewer that allows for the integration of many more types and units of data and analysis. In addition, there are other areas for development, such as the inclusion of historical demographic data, hospital-level data, and environmental data.

Conclusion

This paper has focused on the power of DDViewer to display county-level data, but DDViewer can be an equally powerful tool at an even smaller level of analysis. On the

United States side, census-tract data provide that level of detail; however, on the Mexican side, the data are presently limited to the municipio. It is especially important to look closer at the health of the communities along the US-Mexico border. The border communities are affected by one another's general standard of living, political and administrative regimes, and shared environmental and geographic conditions. DDViewer shows how variations occur from east to west along the United States side of the border. Once the Mexican data are incorporated, differences from north to south and from east to west can be compared. The many communities that traverse the border can make use of DDViewer's data and visualization techniques without requiring extensive investment into their own GIS. Users' suggestions along with data from collaborators will determine the future developments of DDViewer in making local-level data widely accessible to researchers, policymakers, health care providers, and the general public.

Acknowledgments

Funding for this study was provided by the National Aeronautics and Space Administration (contracts #NAS5-32632 and #NAS5-98162).

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