

Small-Area Indicators for Urban Housing, Environment and Child Health in India and Nigeria

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Purpose

The purpose of this project was to develop instructional modules relevant to child and maternal health in cities in developing countries. These modules combine some of the commonly used geographic information systems functions of ArcView with some spatial analysis functions that are used to analyze the geographic distribution of indices of child and maternal health within urban metropolitan areas of cities in developing countries.

We collaborated with the National Institute of Urban Affairs, New Delhi, India and the Department of Geography, The University of Ibadan, Nigeria to develop a web-based training program on the application of geographic information systems to urban housing, environment and vital statistics data for the purpose of establishing relationships between indicators of housing and the environment and child health for small areas of cities in developing countries.

Results

Our web site www.uiowa.edu/~gishlth (discussed further below) contains six instructional modules. Each module describes the overall purpose of the GIS functions to be learnt, specific instructions to implement the function either using the user's own data or one of the data sets provided by the web module, and an illustration of the results and a discussion of the interpretation of the results.

The modules use new materials developed to train students to do practical GIS analyses using geographic framework data, individual records of health events

and urban housing data. Students learn to compute and display density distributions of infant mortality either in Des Moines, Iowa, or using an alternative data set provided, a typical city in a developing country. They also learn to compute measures of geographic access to urban services and to compute indicators of expected changes to access if alternative policies for improving urban services are followed, (Richards et al. 1999, Rushton 2000, Rushton and West 1999).

The literature on infant mortality in developed and developing countries has established that areas of high rates are usually localized within metropolitan areas and that intra-metropolitan differences are greater than inter-metropolitan differences. In developed countries these differences have become clearer as techniques were developed for adding small-area geocodes to urban housing characteristics, environmental data, and to vital statistics records of births, birth characteristics and infant deaths. At the same time, the 1990s have seen rapid development of methods of smoothing point-based health data and establishing reliable rates of disease in circumstances where population data is sparse (Anselin 2000, Bithell 1990, Rushton and Lolonis 1996, Wall and Devine 2000).

Our collaborators in New Delhi, India and Ibadan, Nigeria found that vital statistics data within their respective cities were commonly collected from establishments where assisted births take place (hospitals and maternity wards for births) and places for registering deaths.

Although these places of registration generally served the people living within their neighborhoods, they do not account for all births and deaths in their areas, and they also contain births and deaths from other areas. The result is that detailed geographic relationships between births and infant deaths for small areas cannot easily be established. The final report for the Ibadan, Nigeria, collaborator, Dr. Ayeni is an appendix to this report and appears as a PDF file under the Reports section on the home page. The final report for the New Delhi, India, collaborator, Dr. Tewari, has not yet been received. It will be placed on the web site when it is received. Dr. Tewari, however, has sent us much of his original data materials and information on the characteristics of vital statistics records in New Delhi. Using this material we developed synthetic data sets for use in many of the GIS instructional modules. New buttons “Data Sets” on the homepage tell users of the system that two different datasets are now available and that they can choose whichever of the datasets is closest to that of the area in which they are working. Here is the text of that section:

“The laboratory exercises have descriptions of the purpose of the exercise and instructions for using GIS to accomplish the purpose. These are applicable to both U.S. conditions and to developing country conditions. In several of the exercises, however, two different datasets are supplied and the user should choose whichever data set is closest to replicating the data in their own application setting. One data set is for a U.S. area and the other is for a developing country city.”

In describing the synthetic data sets, the new “Data sets” button describes this data in this way:

“In learning situations it is often advantageous to use synthetic data. Synthetic data is data generated by simulation methods to conform to known characteristics. Because real (i.e. observed) data on infant births and deaths are expected to have inherent variability when measured for small geographic areas the synthetic data is generated to mimic this expected variability.

The reports on infant mortality in New Delhi and Ibadan document the difficulty of acquiring data from vital statistics records that is suitable for examining small-area variation in rates of infant mortality. In the case of New Delhi there are difficulties in assigning birth and death records from the official registers to digitized residential locations. Although this problem is potentially solvable by the development of suitable address-matching algorithms and datasets that record the locations of addresses, this problem has not yet been solved for New Delhi. In the case of Ibadan, Nigeria, research assistants with intimate knowledge of the address records of the city manually assigned vital statistics records to the 122 recognized geographic zones in the city. Records of births and deaths in Ibadan covered a smaller proportion of the total population, however, than in New Delhi. Hence population coverage was a greater problem in Ibadan than in New Delhi.

In generating this synthetic data we first obtained the birth and death

rates for Delhi from the *Annual Report of Health Department, Bureau of Health Intelligence, Health Department, Municipal Corporation of Delhi*. We assumed that the infant death rates for slum areas are 30 percent higher than other areas. Using the crude birth rates and the populations of slum and non-slum areas, we projected the number of births in these areas. Using the simulated infant death rates we projected the number of deaths in these areas. The lab exercises (labs 3 and 4) use this data to compute maps of expected infant mortality rates in New Delhi.

The co-ordinates of the major slums were determined from the shape file of Delhi. The projected births and deaths in slums were randomly allocated to areas confined by slum boundaries. Other births and deaths similarly were allocated to areas outside the slum boundaries.

The specific parameters used to generate the synthetic data are described in the labs in which this data is used.”

The instructional materials are on our updated web site at www.uiowa.edu/~gishlth. This site will continue to be revised as the recently received materials from New Delhi and Ibadan are incorporated in it.

Relevant Techniques, Training Modules and Data Sets

The training modules on our web site cover the following GIS-based techniques for computing, spatially analyzing and displaying health-related indicators at a small-area level.

1. Alternative approaches for geocoding vital statistics data and methods for assessing the geometric accuracy and attribute completeness levels of the geocoding.
2. Mapping types appropriate to the above data characteristics. Measures of uncertainty associated with the levels and geographic entities mapped.
3. Methods for computing density estimates for vital statistics and reportable disease data, where available, (Bithell 1990). Important examples include small-area infant mortality rates, birth rates, fertility rates, age-adjusted death rates, (Rushton and Lolonis 1996; Rushton et al. 1996, Talbot et al. 1999). Methods for visualizing the above computations (ArcView scripts) and for displaying them on geospatial data fields to assist in communicating and interpreting them to the public as well as other concerned agencies.
4. Methods for computing statistical significance given the typically small number of observations in small areas reflecting the common rarity of events per unit of population in such areas, (Gatrell et al. 1996; Gelman and Price 1999; Lolonis and Rushton 1996).

5. Methods for computing geographic access to health services and visualizing the results (Armstrong et al. 1992; Densham 1994; Rushton, 1999).

The Indian materials appear to be more complete in their coverage but less easy to geocode to particular localities than the materials from Nigeria. In both cases, however, the difficulties were great though, in the long run, with the further development of basic geographic framework data (national spatial data infrastructure), improvements can be expected.

Indian and Nigerian Participants

For India data sets for the training modules have been generated based on materials sent by staff at the National Institute of Urban Affairs, for selected small areas (poor communities) in New Delhi. The training modules integrated with the spatial databases of poor communities are targeted towards all those agencies and community groups concerned with the planning, delivery and management of basic services and urban poverty alleviation in the country.

In Nigeria, the city of Ibadan was our study area. More details of this site are contained in Dr. Ayeni's final project report which can be seen under the "Reports" button on our web site.

Discussion

It is clear from this collaborative project that the geographic elements of the materials needed to monitor the health of neighborhoods within developing country cities present considerable difficulties to anyone wishing to use GIS methods in health surveillance in these cities. The results of our collaboration show that the raw health records generally exist although the extent of coverage of the population was different between Nigeria and India.

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