Problems and Solutions in the Integration of Population Data with Other Disparate Data Sets

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Abstract

When creating databases that cross disciplines, units of analysis are often compromised. This paper examines three different approaches to data integration, each of which considers the problems of varying and seemingly incompatible analytic units. We highlight the following issues associated with building, maintaining, and using the database: federally and commercially dictated data restrictions, confidentiality, database documentation and metadata, foreign-language translation, and cross-national variable compatibility.

The three approaches differ in scope (national to global), scale (first to fourth-level administrative boundaries), and thematic breadth (single variable to multivariate). These approaches include the creation of 1) a gridded global database of population (Gridded Population of the World), 2) a tool to visualize and export data across contiguous national boundaries (U.S.-Mexico Demographic Data Viewer), and 3) a tool to generate equivalencies between U.S. geographies (Geocorr). All three approaches deal with data integration issues at the sub-national level; GPW and Geocorr also facilitate integration of data collected by administrative units with georeferenced biophysical data. The U.S.-Mexico DDViewer contains social, economic, and health behavioral data for three levels of boundaries. The approaches vary in the problems they address, but all are models highly applicable to other themes and scales.

Introduction

Cross-disciplinary analysis is a common activity in the social sciences but some population issues require even broader cross-disciplinary analysis and data integration. Problems such as human-environment interactions and climate-health relationships require multidimensional and multi-disciplinary data integration across different geographies, units of analysis and time scales. The needs of any particular study or assessment are framed by the questions at hand:

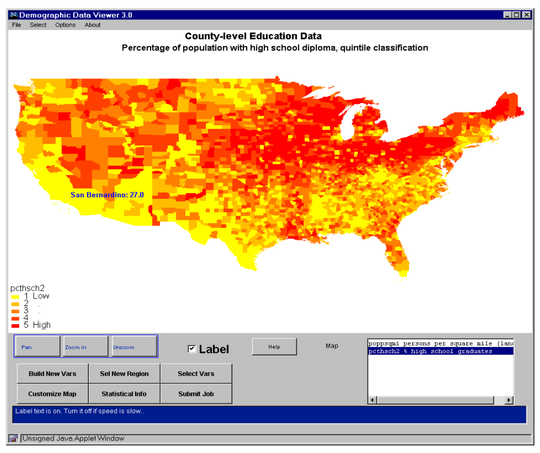
- The precise combination of data needs may change dynamically and cannot be predetermined
- Pace and requirements of data needs are increasing
- Most existing standard global data products (e.g., Digital Chart of the World, World Bank indicators) have limitations:
  - ♦small scale or poor resolution (DCW is 1:1,000,000)
  - ♦difficult to keep current
  - ♦sub-national units are rarely available
- "Alternative" (or common demographic) data sources, such as surveys, have selective coverage and confidentiality concerns.

CIESIN has used several approaches for removing barriers to data integration, for example:

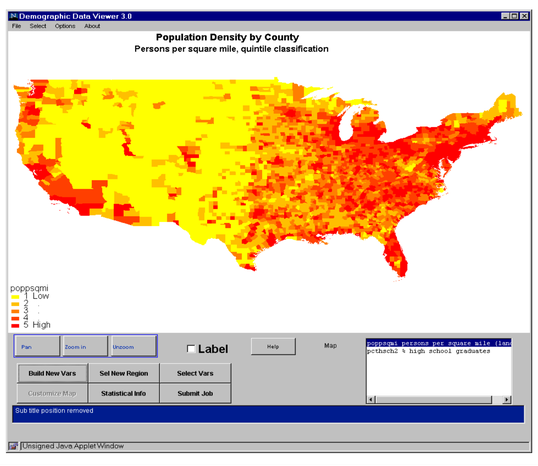
1) Start simple! Convert a single variable data set (e.g., population) from a common social science format (census) to common Earth science format (grid).
2) Move towards open GIS
3) Create tools and methods for converting geographies
   - ♦Create or customize software where existing ones fail and use geography as a discipline to foster integration.

U.S.-Mexico Demographic Data Viewer (DDViewer)

The U.S.-Mexico DDViewer is a free, on-line interactive application that allows thematic mapping of matched variables in the U.S. and Mexico at three levels: region, state and county/municipio. The application is currently being tested and will be released to the public in the spring of 2000. A sample of the U.S. version of the DDViewer is shown below. Matched variable types in the U.S.-Mexico version include:



The DDViewer is a quick and intuitive way to make maps of social and demographic variables. Using multiple windows, simple comparison and scoping exercises are possible. Here, county level data for the U.S. have been used to display education data (above) and population density (below). As it is a java applet, all that is required to run DDViewer is Internet access and a java-compliant web broswer.



- Population and age breakdowns
- Birth rates
- Age-specific mortality data
- Household characteristics
- Education

The viewer allows the user to download the attribute data along with geographic identifiers. In this way, users can perform statistical analysis or combine the attributes with their own data in a GIS.

The integration of micro and multi-level data across national boundaries presents special problems:

- Maintain consistency in or convert thematic variables (e.g. education)
- Select or create a seamless and consistent boundary between countries
- Create variables, tools and documentation in two or more languages
- Obtain adquate and consistent metadata
- Maintain confidentiality (e.g., cause of death data, survey data).

Next Steps:

- Additional data layers
  - ♦Environmental data (e.g., pollutant releases)
  - ♦Health data
- Extend variables to a time series (1980-1995)
- Add functionality to allow spatial analysis.

The U.S. version of DDViewer can be accessed via the web at: http://plue.sedac.ciesin.org/plue/ddviewer/

Once ready, the U.S.-Mexico version will be accessible from CIESIN's web page at: http://www.ciesin.org

Conclusion

These examples are only a starting point for data integration efforts. Future integration efforts will focus on leveraging spatial data technologies to provide additional functionality and customized data access. Where traditional integration methods fail, as shown here, geography can be used to foster dialogue and integration.

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Gridded Population of the World (GPW)

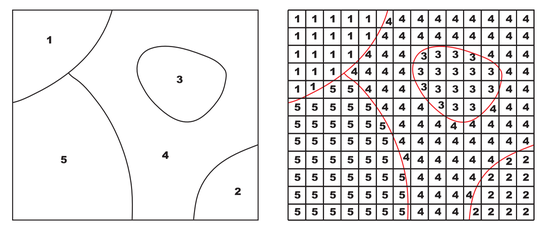
Demographic information is often provided on a national basis, but global environmental studies usually require data that are referenced by latitude and longitude rather than by political or administrative units. To create GPW, sub-national administrative boundary data (levels 1 to 4) and population data from over 200 countries were obtained from government and commercial sources. These data were gridded to arrive at population estimates for each grid cell in GPW. (See the figures below for more details on the gridding used for GPW.) While there are restrictions on the source data used in creating GPW, the derivative grids can be freely distributed.

GPW provides the ability to integrate natural or other variables which are stored in a grid or otherwise georefernced. It has many potential uses, including hazard vulnerability assessment, climate model refinement, and studies of human-induced stress on natural systems.

Next Steps:

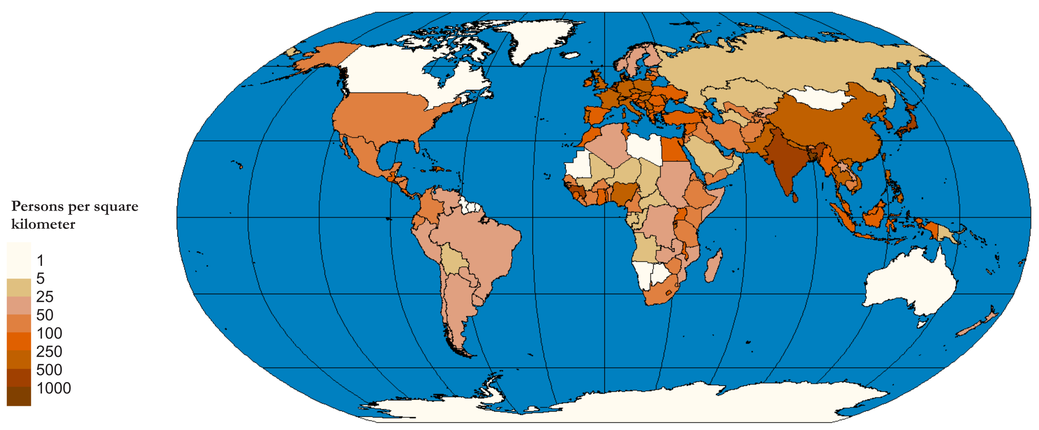
- Creating new single-variable data sets:
  - ♦Age distribution
  - ♦Income and/or poverty
  - ♦Human settlements/urban areas
  - ♦Nutrition
  - ♦Land use
  - ♦Energy Consumption
- Facilitating environmental assessments:
  - ♦Hazard vulnerability
  - ♦Climate
  - ♦Urbanization
  - ♦Health
  - ♦Agriculture
  - ♦Water resources.

Gridding Vector Data: Majority Rule



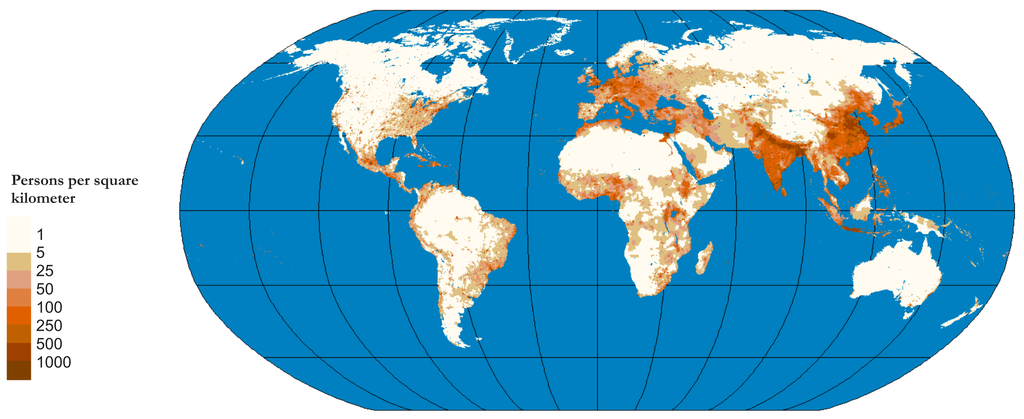
The simple majority rule depicted above is appropriate for gridding categorical data. Gridding of quantitative data requires that polygon data totals be distributed across the grid cells that the polygon covers. GPW uses proportional allocation to assign population values to cells where multiple polygons provide input. Diagram redrawn from: G.F. Bonham-Carter, 1996. *Geographic Information Systems for Geoscientists.*

Global Population Density
National Level Data, 1990



Global population data and other human-related variables are often only available at the national level. Integration of population data with national-level environmental or other variables is possible; however, the results of the integration only allow for comparison among nations. Source of data used to create the above figure: Environmental Systems Research Institute, Inc. ArcWorld CD-ROM.

Gridded Population of the World
Version 2.0: Estimated 1995 Population Density



Through gridding of population data or other human variables with the best-available data, the integration of population and other variables across national borders can allow for comparison at the sub-national level. Gridded population data also allows for integration with natural science data, which is most often referenced to spatial coordinates rather than administrative units. The map above shows estimated population densities in 1995 from the preliminary release of GPW, version 2.

Geographic Correspondence Engine (Geocorr)

Geocorr is an on-line, interactive service that allows users to select specific geographic layers in the U.S. and generate custom correlation lists. The resulting correlation list, which can be weighted by population, housing units, or land area, gives the proportion of overlap between two geographic layers. 'Geographies' accessible in Geocorr include:

- 1990 census geographies (state, county, census tract, place and block, plus 1980 county, place and tract)
- Congressional Districts (102nd and 103rd)
- 5-digit ZIP codes
- 1990 Public Use Microdata Areas (1% and 5% samples: used for the Census 'long form')
- Metropolitan Statistical Areas (MSA's)
- Hydrologic Unit Codes (watersheds)

Geocorr can enable data integration in many different types of studies. The ability to convert between units associated with socioeconomic data and biophysical units is especially useful. Geocorr can also be used as a tool to maintain confidentiality in survey data; point or small-area data inappropriate for public release can be aggregated to other units with the correlation list provided by Geocorr.

Next Steps:

- Add new layers in the U.S.:
  - ♦Ecoregions
  - ♦Land cover classification
  - ♦Transportation planning zones
  - ♦Climate regions
- Expand beyond the U.S.:
  - ♦Other national coverages
  - ♦International coverages (e.g. North America).

Geocorr can be accessed on CIESIN's web site at: http://plue.sedac.ciesin.org/plue/geocorr/