NIEHS
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PEPH Webinar Summary | May 2012

Mapping and Environmental Public Health: Visualizing Health Disparities

PEPH Webinar Series
The Partnerships for Environmental Public Health (PEPH) Program established the PEPH Webinar series to promote interactions among PEPH grantees and to increase awareness of common issues and approaches. The webinars facilitate consideration of emerging issues. While the primary audience is grantees within the PEPH network, anyone interested in environmental public health is welcome to register.

If you have any questions about this webinar or future webinars please contact Justin Crane (cranej2@niehs.nih.gov, 919-794-4702).

Geographic risk assessment is an increasingly viable methodology for visualizing and tracking factors that feed into health disparities such as access to care or proximity to Superfund or other known sources of pollution. GIS mapping, and other less sophisticated mapping tools, are also being used for establishing patterns of disease prevalence or the effects of air, water, or chemical pollution on susceptible populations, or for identifying populations at risk for the cumulative effects of ongoing exposures and disaster events (e.g., hurricanes, tornadoes, oil spills). This webinar explored cases where mapping has been utilized to elucidate health disparities, disease prevalence, and their relation to geography and sources of pollution.

Alexander van Geen, Ph.D., is the associate director of Columbia University's Superfund Research Program (SRP). Since 2000, he has coordinated the efforts of an interdisciplinary team of earth, social, and public health scientists to reduce exposure of people in rural Bangladesh to arsenic contained in groundwater. van Geen opened the webinar by discussing the serious problem of naturally elevated arsenic (As) concentrations in groundwater pumped from millions of shallow tubewells across South and Southeast Asia. Rural communities rely on these tubewells for their drinking water. van Geen highlighted how his research team's testing of these wells in Bangladesh revealed that, although groundwater As concentration varies widely within a region, the majority of wells have higher concentrations of As than the standard of 50 parts per billion. His team discovered that the wells can be tested and labeled cheaply (about $2/test) by trained village health workers using field kits and handheld GPS devices. The results are mapped using Google Earth to show distribution and guide research. Further analysis of the data illustrated that deeper wells generally have lower As concentrations, which accounts for some of the variability within regions. The testing and labeling has helped; about 50% of people with a high As concentration well have switched to using a safe well within walking distance. However, more work needs to be done because only about half the wells have been tested and new wells continue to be installed. To protect human health in this region, the team recommends that all wells be tested (perhaps using commercial services) and that efforts to raise awareness about the risks associated with drinking As contaminated water be increased.

Steven Chillrud, Ph.D., is a Lamont Research Professor at Lamont-Doherty Earth Observatory and director of the Exposure Assessment Facility Core of Columbia University's NIEHS Center for Environmental Health in Northern Manhattan. His research focuses on the role of particles in the transport, behavior and fate of chemical contaminants. Chillrud discussed his research team's findings about intercity variations in airborne particulate matter and the associated negative health outcomes. The TEACH study of the later 1990s used monitoring and mapping technologies to demonstrate the way spatial and temporal variability of air pollution affects personal exposures. The study revealed some interesting data about variability of air pollution, with the finding that the students carrying the sampling device in their backpacks had a different distribution of exposure than the other samples (urban fixed site, home indoors and home outdoors). By plotting the geospatial distribution of the students' home locations versus personal exposure level, they discovered that all the students who lived far from school had high steel dust exposure which lead them to predict that the subway was the source of the metal exposures. Some sampling in the subway confirmed that the dust from the steel wheels was the source of the exposure for those students. Next, Chillrud discussed the NYC Neighborhood Asthma

and Allergy Study that investigated children with asthma in neighborhoods with high and low prevalence asthma. The levels of black carbon (a measure of incomplete combustion byproducts) were higher in the neighborhoods that had a higher prevalence of asthma. They investigated the traffic density but also looked at recently released mapping data of apartment buildings that burn residual fuel oil, which is dirtier and leads to incomplete combustion. They used ArcGIS to map their data and found a positive association between the buildings burning residual fuel oil and traffic density and the higher levels of black carbon. This data helps defend Mayor Bloomberg's recent legislation to phase-out use of residual fuel oil by 2030. He closed by saying that more could be done by eventually moving to natural gas or ultra low sulfur fuel oil.

Meredith Golden is a senior research associate with Columbia University Earth Institute CIESIN. As part of the Columbia SRP Research Translation Core, she coordinates outreach, translation, and geospatial approaches for Superfund research and activities. Golden works collaboratively with **Tricia Chai-Onn**, a geographic information specialist with the Center for International Earth Science Information Network (CIESIN) at the Columbia University Earth Institute. At Columbia, Chai-Onn uses her GIS skills and expertise in identifying, acquiring, and managing demographic, environmental, and health data. Golden and Chai-Onn provided an overview of the recently released National Priorities List (NPL) Superfund Footprint Mapper, a tool that will guide and translate research through visualization. The Superfund Footprint Mapper is an interactive online mapping tool designed to help researchers, practitioners, regulators, and the general public better understand the general characteristics of vulnerable populations, the built natural features, and sources of exposures near Superfund sites. This tool allows quick visualizations, easy access to data on NPL sites, multiple hazardous exposures, and vulnerable populations. The mapper is built on the Esri Web Application Development Framework, which integrates data layers in an ArcGIS map document. The ArcGIS online topographic base map is also pulled into the application as a service, but Google Earth could have served as the base map as well. The Agency for Toxic Substances and Disease Registry has plotted 1,500 of the 1,716 NPL sites to create polygon shapefiles. The team used that data to create one- and four-mile buffers around the NPL points in the Mapper. In addition to that data layer, they also pulled in 30 socioeconomic variables for populations in the affected areas, data on public and private schools and colleges, data from the U.S. Environmental Protection Agency, and U.S. Census demographic data. They demonstrated the Mapper and showed that it can incorporate new data layers, such as photos, videos, etc. They closed by asking for feedback about the Mapper, especially what would be useful to Superfund research projects.

During the question and answer session, participants focused on the following themes.

For van Geen:
Village Health Worker training in Bangladesh. van Geen noted a country-wide well testing was carried out from 2000-2005 by hundreds of NGO workers with a higher education level. He said that the Superfund project instead uses ten village-health workers in their current survey. People who live in the villages and know they have untested wells are the ones who perhaps should be trained instead of outsiders.

Reproducibility of well testing. According to van Geen, the concentration of wells generally doesn't change over time. There are spatial considerations of variability but not usually temporal ones. However, some wells are more vulnerable to gradual contamination over time than others, depending on the geological setting. Factors that can change As concentration include groundwater flow patterns changing, irrigation pumping being carried out on a large level, or mechanical failure, which is fairly rare.

Current well drilling practices incorporating findings about well depth and As concentration. van Geen indicated that people in the project village have started drilling deeper wells once they realize a low-As aquifer is within reach. Unfortunately, a project involving the country's main mobile phone provider to make local "safe depths" available to 40,000 villages was blocked by the government.

Data entry of As concentrations into Google Earth. van Geen said that there are two supervisors who have college degrees. Each oversees 10 health workers. Once a week, the supervisors connect the GPS devices to their laptops and upload the data to Excel and then to Google Earth Pro. The supervisors have been trained to create the maps that were shown in this presentation.

For Chillrud:
Socioeconomic factors for looking at health disparities. Chillrud explained that they did correct for a large number of variables, including SES. The paper for the allergy study just came out – Cornell et al.
http://www.ncbi.nlm.nih.gov/pubmed/22377682

Separate the role of allergens and allergen sensitization in analysis. Chillrud noted that his colleague, Matt Perzanowski, measured IGE in the serum. If IGE was above a certain threshold level, they were considered to be sensitized to the allergens and were divided into one sub group, and if their IGE was below a threshold, then they were considered to be non-atopic. There was a clear different response to this marker of inflammation.

Metal concentration variability between personal and external measures. Chillrud indicated that three metals were related to the subway path of exposure – iron, manganese, and chromium – and this clearly indicated a source of steel dust from the wheels getting abraded and releasing dust in the air. Some of the students only rode the subway for short periods of time (15 minutes). There were a number of other metals related to the subway – related to brake linings, rat poison, etc. – but none were as high as the metals in the steel wheels and rails.

Personal mapping of movements. Chillrud said the project from the 1990s didn't map the student movement. However, the more recent work, which there wasn't time to discuss today, uses realtime data from a GPS data logger that costs about $100/unit and showed examples from three subjects – one is a young child who lives in the Bronx and goes to school far away. His parent drives him and smokes in the car, and there is a high PM2.5 reading during that commute due to the confined space.

For Golden and Chai-Onn:
NPL Superfund Footprint Mapper data sources for population characteristics. Golden indicated that to estimate populations and their characteristics within the site buffers, the team used US Census Grids population data (raster), a dataset created by the Socioeconomic Data and Application Center (SEDAC) hosted by CIESIN at The Earth Institute at Columbia University. Additional population and demographic data are from the Department of Health and Human Services Community Health Status Indicators Project, the Department of Education, and other US Census sources. All data are publically available. The NPL SF Footprint Mapper Metadata Guide provides a description of the data variables, year published, geographical unit, scale-dependency, and direct links to the data sources.

Availability of grid population data. According to Golden, all of the data used in the SF Footprint Mapper is available to the public from the sources used. The Center for International Earth Science Information Network (CIESIN) is a center within the Earth Institute at Columbia University (CU). CIESIN works at the intersection of the social, natural, and information sciences, and specializes in online data and information management, spatial data integration and training, and interdisciplinary research related to human interactions in the environment. The data generated by CIESIN and the Socioeconomic Data and Application Center which it hosts are all made freely available and accessible to the public. For access to these and other integrated population and environmental data, users are encouraged to visit both the CIESIN and SEDAC websites: ciesin.columbia.edu and **sedac**.ciesin.columbia.edu.

Primary user for the tool. Golden said that the team hopes a wide range of academic researchers, government regulators, and community stakeholders will use the Mapper to visualize critical data about the area and inhabitants near Superfund sites and to better assess the vulnerability of affected populations for a variety of applications. What makes the NPL Superfund Footprint Mapper different from other environmental mapping services is that it focuses specifically on NPL Superfund sites and provides key demographic information on communities living within 1 and 4 miles of their actual "footprints," depicted by polygon data. Although some EPA partners have created other relevant Mappers, the few that include Superfund sites portray them only as points, not polygons. Showing the location and extent of the sites is an important aspect of the SRP mapper. The one- and four-mile boundaries from the actual border of the site (rather than from a single designated point within the site) provide a better visualization of potentially exposed populations, critical infrastructure, and other potential hazards in proximity of the site. This tool could be useful to EPA community involvement teams or remediation teams and could be useful for assessments of Superfund sites. The CU SRP Research Translation Core hopes that the 18 universities involved with the Superfund Research Program can also

use the Mapper for their own research at Superfund sites, and that the data layers they collect could then be integrated into the Mapper. Golden concludes, “Mapping applications can greatly benefit the assessment and remediation of Superfund sites. I’m hoping that in the near future, NIEHS will host a mapping and data workshop for all agencies working on Superfund issues so that we can coordinate our efforts and make the most of geospatial technology.”

Mapping data with different geographic resolutions. Since health data are mostly available at the zip code and census tract data, adding these layers to these data with data available on different geographic resolutions could introduce uncertainties. However, Golden’s team says that the process of gridding the variable reduces this problem as the data are put into a common resolution. The team cautions that there is a modifiable areal unit problem in that the data might look quite different at the zip code level than at the tract level even when it has been gridded. This is something that is difficult to address and can only be characterized by examining a variable at multiple aggregation levels. They conclude that at the end of the day one would still be choosing the aggregation that seems to make the most sense, so there is some subjectivity to choosing the "right" scale.

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