Using Google Earth as an Innovative Tool for Community Mapping

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SYNOPSIS

Maps are used to track diseases and illustrate the social context of health problems. However, commercial mapping software requires special training. This article illustrates how nonspecialists used Google Earth™, a free program, to create community maps.

The Bronx, New York, is characterized by high levels of obesity and diabetes. Residents and medical students measured the variety and quality of food and exercise sources around a residency training clinic and a student-run free clinic, using Google Earth to create maps with minimal assistance. Locations were identified using street addresses or simply by pointing to them on a map. Maps can be shared via e-mail, viewed online with Google Earth or Google Maps, and the data can be incorporated into other mapping software.

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The use of maps to track disease and characterize neighborhoods has a long tradition in both public health and sociology.[1] The development and availability of geographic information systems (GIS) has greatly expanded the sophistication and analytic power of mapping,[2] and the potential of GIS to be used for public health purposes has been recognized for some time.[3] The process of creating a map can also serve to involve, inform, and educate students and community members.[4] The use of the Internet to make GIS maps publicly available (called public participation GIS, or PPGIS) offers new venues for citizens to participate in community development activities.[5–7] In this article, we look at the use of GIS maps created with Google Earth™ to examine the social determinants of diabetes and obesity in the Bronx, New York.

BACKGROUND

Diabetes and obesity are important problems in the predominantly working-class and immigrant communities served by the Department of Family and Social Medicine at Montefiore Medical Center.[8] Consistent with the principles of social medicine,[9,10] we have adopted an approach incorporating elements of Community Oriented Primary Care (COPC).[11] COPC was originally developed in the 1940s by the Karks in South Africa and was described by them as "a practice of social medicine."[12] COPC begins with a community diagnosis, which is often based on detailed community maps. The community diagnosis informs not only individual clinical practice, but also community-wide efforts to promote health. Such an approach is congruent with the extensive literature examining neighborhoods and their effects on health.[13–16]

Google Earth and Google Earth Plus™[17] mapping software have several advantageous features for such community mapping. Unlike commercial mapping software, they are available either for free (Google Earth) or for a modest price (Google Earth Plus). Map locations can be displayed with varied icons, allowing a visual ranking or classification system. Google Earth allows sites to be identified in a variety of ways: by pointing to a location on a map, by inputting an individual address, or (in the Plus version) by importing addresses from a spreadsheet file or database. People who are not familiar with mapping software can be easily trained to use Google Earth, and the resultant maps can be shared over the Internet.

This article reports on two case studies of the use of Google Earth for community mapping in Bronx neighborhoods. In the first case, medical residents mapped sources of food and exercise around their outpatient clinical site. In the second case, medical students evaluated the availability of nutritious foods in the stores surrounding a student-run free clinic. While we briefly describe our investigations and findings in this article, our primary goal is to demonstrate the capabilities of Google Earth as an inexpensive yet effective mapping technology that allows health professionals (and potentially community members) to better understand their social environment.

CASE 1: MAPPING PLACES TO GET FOOD AND TO EXERCISE

The Montefiore Medical Center Residency Program in Social Medicine is a unique residency program that trains board-eligible clinicians (family physicians, internists, and pediatricians) to work in underserved communities. As part of this training, interns are given a month-long orientation to the Bronx and to social medicine. During this month, we introduce the interns (many of whom are not from New York) to the health problems of the Bronx and their social determinants.[18]

Mapping exercises have been part of the orientation for many years and draw on existing departmental interest and expertise.[19] In 2005 and 2006, we chose to map sources of exercise and food in the neighborhoods around the clinics where we practice. We chose these items to map because of the wide international literature linking the density of fast-food restaurants[20–22] and other neighborhood characteristics[14,23] with low-income neighborhoods and obesity. The mapping exercise was one of several activities designed to help interns understand the social determinants of diabetes and obesity to better inform their clinical practice and develop advocacy activities.

Interns were instructed to survey the 20 city blocks closest to their clinics. This is an area of approximately one square mile. They were to note the names, addresses, and characteristics of places at which food was available for purchase, as well as venues for indoor and outdoor exercise. In 2005, the interns collected the addresses for the map and one of the authors (JF) used Map Info™[24] to make the actual map. In 2006, with guidance from JF, the interns were able to construct their own maps.

Figure 1 was generated using Google Earth. At the center of this map is the Montefiore Comprehensive Health Care Center (a federally funded community health center) run by Montefiore Medical Center; on the western border is Yankee Stadium. Icons indicate sources of exercise (11 sites, nearly all playgrounds) and sources of food (113 in total). Different icons

indicate different types of businesses. Small variety stores (n=44, called "bodegas" in our community) and fast-food restaurants (n=32) predominate. Figure 1 superimposes several maps (layers).

This map highlights our understanding of the social determinants of diabetes and obesity. Clearly, there is a paucity of exercise opportunities within our community. By contrast, food—particularly fast food—is readily available. The proliferation of restaurants and small stores as sources of nutrition is also a health concern and suggests a venue for intervention in improving food quality.

CASE 2: MAPPING THE VARIETY AND QUALITY OF FOOD AVAILABLE IN LOCAL STORES

The Einstein Community Health Outreach (ECHO) Free Clinic has been run by Albert Einstein College of Medicine students since 1999. It operates most Saturdays from the Walton Clinic in the Morris Heights neighborhood of the Bronx. Third- and fourth-year medical students, supervised by volunteer attending physicians, provide primary medical care to uninsured adult patients. Facilities and equipment are supported through grants organized by the Institute of Urban and

Figure 1. Sources of food and exercise around the Montefiore Comprehensive Health Care Center

Legend:
Cross = Comprehensive Health Care Center
Tree = exercise site (n=11)
Dark fork and knife = fast-food outlet (n=32)
Light fork and knife = restaurant (n=16)
Light square/dark center = bodega, or small variety store (n=44)

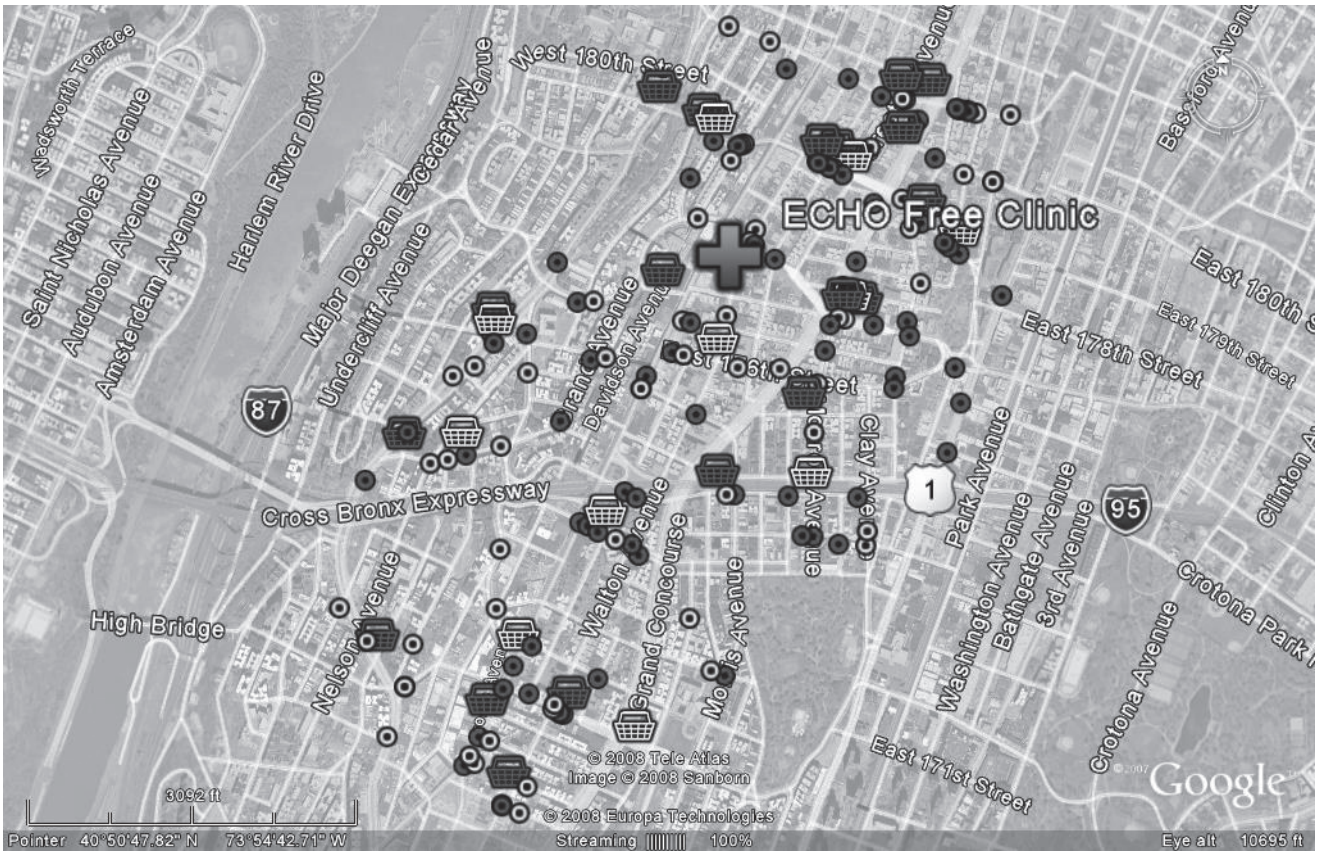
NOTE: Not all icons are visible due to overlapping. Grocery stores are not shown. A color version of this figure is available at http://www.publichealthreports.org.

Family Health, a primary care and research organization. The Saturday clinic sees 20 to 25 patients each session and provided for 814 patient visits in 2006; there have been more than 5,000 visits since its inception in 1999 (unpublished data, ECHO Free Clinic Patient Survey 2005).

Preventive medicine is important to the clinic. In a recent survey, ECHO patients ranked nutrition and exercise as their top priorities for future health education programs. We believed patients would be more likely to eat healthy foods and exercise if they knew where to go. Before clinic organizers could give exercise or food advice, they needed to know what options were realistically available to their patients. This led to the idea of mapping sources of food around the clinics.

In 2006, two of the authors (TL, AL) mapped food stores and restaurants around the clinic. They surveyed an area approximately 10 blocks north, south, east, and west of the ECHO Free Clinic, an area slightly larger than a square mile, within which many of the clinic's patients live. The authors determined the availability of nutritious foods, including the variety of produce offered at all stores and restaurants in the area. They counted produce types by visual inspection or by reviewing a menu. Food stores and restaurants were rated according to a system developed by the authors that used the variety and quality or freshness of produce. The score and address data were tabulated and transferred from a spreadsheet to the Google Earth Plus program, which plotted

Figure 2. Food stores around ECHO Free Clinic, ranked by variety and quality of produce for sale



Legend
Cross = ECHO Free Clinic
Dark circle/black dot = small store with poor produce variety (*n*=81)
Light circle/black dot = small store with some produce variety (*n*=57)
Dark shopping basket = grocery store or supermarket with limited variety (*n*=19)
Light shopping basket = grocery store or supermarket with good variety (*n*=11)

NOTE: Not all icons are visible due to overlapping. A color version of this figure is available at http://www.publichealthreports.org.

ECHO = Einstein Community Health Outreach

geo-coordinates (latitude and longitude coordinates) for the data points.

Figure 2 shows a map of the area around the ECHO Free Clinic; this community is slightly to the north and west of the area described in Case 1. In this map, food stores are characterized by the availability and quality of produce offered and scored accordingly. Scores were determined by a system that awarded points for the variety of different produce types and their quality or freshness. After assigning scores, 168 food stores were separated into four groups and mapped using icons to represent different levels of produce variety and quality: three classes of smaller corner stores and one class of larger, well-stocked supermarkets. The smaller stores were classed as "poor variety" (n=81), "some variety" (n=57), and "good variety" (n=19). Eleven supermarkets offer many healthy options not available in any corner store. Data (not shown) were also collected on produce variety at all restaurants in the study area, as well as locations of parks, playgrounds, community gardens, pharmacies, and social service centers.

Figure 2 illustrates that stores with a good variety of produce are found throughout the study area, although there are a few regions where the distance to such stores is greater than five blocks. From most locations on the map, one walks past one or two lower-rated stores before finding a higher-rated store. Availability of fresh produce is generally quite good for an area with a high percent of low-socioeconomic status residents. Nutritious foods other than produce are also widely available (the presence of whole grains and beans, high fiber/low-sugar breakfast cereals, low-fat dairy, and calcium-fortified orange juice was tracked in each store as well). This area is not a food desert, as has been noted in some low-socioeconomic status areas such as East New York in Brooklyn.[25]

The information from the map about the availability of food and other health resources was collected to better counsel patients about healthy eating options in their neighborhood. We are now evaluating the most effective way to incorporate these maps into ongoing patient education efforts at the clinic.

DISCUSSION

These two cases illustrate the use of Google Earth and Google Earth Plus for community mapping and for teaching both medical residents and medical students about the social context for the health problems they see in their clinics. Whereas previously maps were created in our department by staff with special expertise, Google Earth allowed students and interns to create their own maps. Not only did this simplify the mapping process, but it also actively engaged our learners in the process of map construction. Our experience suggests ways in which this technique might be further extended, as well as some of its limitations.

The main advantages of Google Earth are its free cost and simplicity. It does not require specific addresses, as locations can be identified by simply picking them off the map. This greatly expands the ability to map locations without addresses (e.g., trails) or informal locations (e.g., street vendors). Icons can be easily changed and new icons imported. Icons of

How to use Google Earth™ for mapping

1. Google Earth can be downloaded for free at: http://earth.google.com/.
2. Locating points of interest (PoIs) on the Google map
   a. Locations to be mapped are called PoIs.
   b. PoIs can be found using a street address via the Fly To tab in the search menu.
   c. Users can navigate to a specific location using navigational controls and then indicate that this is a PoI. This is useful for parks and similar features that may not be associated with street addresses.
   d. GoogleEarth Plus™, which is not available for free, contains a geocoding module. This allows multiple PoIs to be imported using a formatted list data file.
3. Marking and saving PoIs
   a. Placemarks: The Add Placemark function marks a selected location with a symbol that can be edited, saved, and shared.
   b. Use of icons: Icon symbols can be edited (for individual locations or groups of sites) using the Properties function to select symbol from default icon set, or can be created from scratch using an existing image file.
   c. Information about places: Detailed descriptions, photos, hyperlinks, and access to driving directions can be saved with each placemark.
   d. Creation of layers: Multiple PoIs can be saved to a common folder, which can be used as a layer to display or hide groups of PoIs easily.
4. Saving and e-mailing images
   a. Saving: Save (Place or Image) can be used to save a Google Earth placemark file or image of active map.
   b. E-mailing maps: The Email Image function generates an e-mail message containing a photo image of the selected location.
   c. E-mailing files: Email (Placemark or View) generates an e-mail message containing a Google Earth data file representing one placemark or a collection of placemarks that another Google Earth user can use to recreate the generated map.
5. Using places: managing work files
   a. The Places portion of the Google Earth interface uses commands and functions common to PC or Mac platforms to manage mapping files.

differing shapes, sizes, and colors visually display a classification system. Maps and mapping data can be transferred among users via e-mail and transferred between Google Earth and ArcView™ or MapInfo™ (the other major mapping programs available) as well as Google Maps; the technical details of this are beyond the scope of this article. Visualization of actual structures provides more information than traditional maps. Recent developments in online mapping applications (called "map mashups") offered by Google and other companies may also provide further means for creating collaborative public community maps.[26] In the last year, for example, news organizations and individuals have created public Google map mashups that allowed individual reports of violence in Kenya, wildfires in Southern California, and flu incidence in the U.S. to be mapped in real time.[27–30]

LIMITATIONS

There are, however, limitations to the use of this software. Not all areas of the country (or world) may be mapped as easily as New York City, where an address grid is available and integrated into the program. Google Earth's ability to map is limited by the accuracy of the database. Available detail on the map often drops off outside of urban areas, and certain areas of the map may be obscured for security reasons. In these cases, a global positioning system receiver may be used to map geo-coordinates for later uploading into Google Earth Plus. There is also a lack of flexibility in labeling when there are many points, although this may be a problem only in dense urban areas. Maps using a photographic image of the community may not be ideal because of excessive visual detail; it is possible, however, to view the data in a map format.

Some of the limitations of Google Earth, such as the need to input individual data and the inability to create legends, are not present in Google Earth Plus. As of February 2008, a one-year license to use Google Earth Plus cost $20. Google Earth offers many solutions for the purposes of community mapping. While it is useful for the purposes of collaboratively sharing geographically linked data, Google Earth is not GIS software and thus lacks the advanced spatial statistical analysis functions of GIS. This limits its utility as a means for epidemiologic analysis.

In these case studies, we did not attempt to formally confirm the locations mapped. This was due in part to the small number of sites and their easy verification by visual inspection. In larger or more complex maps, and in settings where the map makers are not familiar with the community, verification may be an issue.

CONCLUSION

Maps give visual representation to many of the social determinants of clinical problems in ways that words on a page cannot. They can offer a new perspective on clinical problems, such as the availability and promotion of alcohol and cigarettes, sources of pollution, and distribution of crime. A bank of community maps at the national or international level would serve as both a teaching and planning resource.[31] This would require standardization and better methods for verifying data points. The classifications and quality rating used in these cases would need validation before its use could be generalized to other settings.

Within the COPC model, a community diagnosis leads to a community prescription. This is a process that requires active community involvement. We are currently planning to work with community partners to create additional maps that can serve as planning tools for joint projects between health centers and the communities they serve.[32] We believe that Google Earth will allow us to actively involve local community groups in the evaluation, analysis, and solution of local problems. Health-care facilities and agencies can partner with community advocates to use data visually displayed on maps to positively influence the social determinants of health. This is the essence of good community medicine.

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