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Health, poverty, and place in Accra, Ghana: mapping neighborhoods

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The overall objective of our research project is to understand the spatial inequality in health in Accra, the capital city of Ghana. We also utilize GIS technology to measure the association of adverse health and mortality outcomes with neighborhood ecology. We approached this in variety of ways, including multivariate analysis of imagery classification and census data. A key element in the research has been to obtain in-person interviews from 3200 female respondents in the city, and then relate health data obtained from the women to the ecology of the neighborhoods in which they live. Detailed maps are a requirement for these field-based activities. However, commercially available street maps of Accra tend to be highly generalized and not very useful for the kind of health and social science research being undertaken by this project. The purpose of this paper is to describe street maps that were created for the project's office in downtown Accra and used to locate households of respondents. They incorporate satellite imagery with other geographic layers to provide the most important visual interpretation of the linkage between imagery and neighborhoods. Ultimately, through a detailed analysis of spatial disparities in health in Accra, Ghana, we aim to provide a model for the interpretation of urban health inequalities in cities of urbanizing and often poor countries.

Keywords: neighborhood; health; poverty

1. Introduction

It is obviously impossible to undertake spatial analysis without maps, yet when our research began in Accra, Ghana, we discovered that the only available city street maps were highly generalized paper maps showing major roads, some neighborhood delineations and major points of interest, but nothing more. They are helpful in figuring out the 'lay of the land' but are not useful for finding a specific address. They were created largely for tourists and sold on street corners and hotel lobbies. Such maps were not adequate to our research tasks, the overarching goal of which is to improve our understanding of spatial inequalities in health in Accra, Ghana. The premise of our research is that improvements in urban economic productivity require improvements in the health of the urban population. Our research strategy has been to analyze health at the neighborhood level, relating measures of morbidity and mortality to the environmental risks and overall socioeconomic levels in each neighborhood. The first stage of mapping involved the creation of digital boundary files for enumeration areas (EAs) as defined by Ghana Statistical Service (GSS), thus allowing us to summarize census data for each of the 1731 EAs in the Accra Metropolitan Assembly, which is the core district within the Greater Accra Region of Ghana, and was the study site of our research. We created these maps from not-to-scale paper maps provided to us by GSS and this process is described in other papers (Weeks, Hill, Stow, Getis, and Fugate, 2007; Weeks et al., 2012).

Another key element of our research was to interview women in their homes for two different, but closely related surveys: (1) 3200 women in the second round of the 2008–2009 Women's Health Study of Accra (WHSA-II) and its corollary, the 2009–2010 Time Use and Health Study (TUHS), which intensively followed 800 households interviewed in the WHSA-II; and (2) the 2009–2010 Housing and Welfare Study (HAWS), which replicated interviews conducted in Accra slums in 2003 by the World Health Organization in collaboration with GSS. WHSA-II required locating and re-interviewing the 3200 women who had previously been interviewed

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in 2003 and had agreed to be re-interviewed. However, in the initial interview only names and addresses had been recorded, since no GPS units had been available to the research team at that time. The problem in locating the women more than five years later for the second round of the WHSA was that Accra does not have a systematic set of street names and addresses. Additionally, the HAWS focused on collecting data from low-income neighborhoods of Accra. These parts of the city are characterized by a prevalence of high-density informal housing and lack of infrastructure which add to the challenge of navigating the neighborhoods. Since no detailed street map existed of Accra that could be used for our purposes, our task was to create a street map that would be sufficiently detailed so that interviewers would be able to locate the respondents.

Ultimately, the map we produced was turned into posters that were tacked to the wall of the project office in downtown Accra and from which the local research team was able to derive the locations of the women to be sought out and interviewed. The maps accomplished this goal by combining information from high-resolution satellite imagery with a set of data tiles prepared by the Ghana Office of Lands and Surveys which included comprehensive road networks, hydrographic features, and key points of interest such as schools and churches. This was all incorporated into a database built around the digital boundary file of EAs that we had previously created, as noted above.

On-line versions of the map were also created, including PDF files of each of the tiles that had been created, similar to published tiled maps, and an interactive map was created for the geointerest.frih.org website. In the field, however, the printed poster was the preferable map mode because of the very slow internet download times in Accra.

Accra, the capital of Ghana, is a city of about 2 million people, which has mushroomed in size since the country gained independence. It long ago outgrew its colonial infrastructure and there are large areas of the city that are highly dense and passable only by foot or bike. Since a major focus of the overall research was to evaluate the ability to identify areas of high health risk based on the classification of satellite imagery, the imagery was a natural starting point for the making of the map. We utilized Digital Globe QuickBird (Digital Globe, Longmont, Colorado, USA) multispectral image data with 2.4 meter spatial resolution acquired on 12 April 2002.

2. Methods

To best depict the city, it was decided to drape vector data purchased from the Ghana Office of Lands and Surveys over the high-resolution aerial imagery. We purchased 270 tiles of detailed digital survey data, including hydrography, hypsometry, points of interest, road networks, and annotation labels. Each of the tiles and subclasses was provided as an Arc Interchange file (.e00). To display these data in ArcGIS, we converted the .e00 files to individual coverages by feature type. With 270 tiles and five or more feature types per tile, we used a batch convertor to create over 1350 coverage files.

Next, each of the coverage files was converted into a shapefile so that it could be merged, projected, and shifted to account for datum changes since the data were produced. The data provider informed us that the vector data were created using a Transverse Mercator projection with the Accra Geographic Coordinate System datum and 'War Office' spheroid. Ultimately, the accuracy of our data could be described as varied, but reliable. While the location of our points of interest and labels were highly accurate (verified using Google Maps and GPS data), the road polylines were often distorted and offset. Cleaning up these lines was unnecessary, however, since the imagery clearly displayed street boundaries. The labels for roads were of far greater importance.

Since all the labels were annotations from the converted .e00 to coverage files, we determined the best way to map these labels was to convert the annotation centroids to points and then join associated labels to points. This was a challenge since many annotations were often split into separate words. For example, a three-word street name might have three separate points assigned to it and offset on either the same or different lines. Labels were manually adjusted and aligned with Adobe Illustrator (AI; Adobe, San Jose, California, USA) software during the later production process. In the GIS, we used the feature ID (FID) to join the table of labels to each point centroid. Also provided in the annotation tables was a useful attribute called 'ANGLE' which allowed us to automatically set the angle at which to display the street labels in ArcGIS. The resulting angled labels matched perfectly with the angle of each road centerline.

In addition to the aforementioned dataset, our field team in Accra collected extensive GPS point data for most health clinics, hospitals, and facilities in the Accra metro area. These GPS readings were assigned a WGS84 datum and projected with the same projection as the other vector features. In total, almost 2500 health-related locations along with sites of worship, roads, and water features were compiled. Many of these points of interest were found to delineate neighborhoods quite well and often served as helpful landmarks during the interviews. Given the vast amount of features, we utilized 'definition queries' and other selection tools in ArcGIS to filter out duplicate and superfluous labels.

Initially, we produced a map book to aid our fieldwork efforts. This involved creating individual $8\frac{1}{2}$ by 11 inch maps that could show detail at a scale of 1:5250 and were bound together in a spiral book. To accomplish this, we subdivided the entire Accra metro area with a grid and created a key to label each of the cells. A great deal of production effort was required, including the cleaning up of vector-line work and fitting labels in tight spots. The older format .e00 files provided by the Ghana Land and Surveys Office and resulting coverages were quite raw and required extensive formatting. It was also necessary to design clear symbols for the EA boundaries and icons for the different points of interest. We developed unique icons for the various structures of faith such as churches and mosques. Images representing these and other institutions were customized in AI.

All production was completed in AI after exporting the raster (imagery) and vector (line, point, and polygon features) separately from ArcGIS. A high-resolution color-Tagged Image File Format (TIFF) of the imagery using Lempel–Ziv–Welch (LZW) lossless data compression was exported to maximize quality of the maps. Point, line, and polygon features were then exported as AI vector, overlaid on the raster image, and cleaned up where necessary. The final individual maps were saved as high-resolution PDFs (about 110 total at 5–10 Mb each) so that team members in Accra and the US did not require expensive software to view and print them.

The spiral-bound set of maps was somewhat awkward to use for finding directions over long stretches of the city. Thus, the Accra field office expressed interest in a more complete visualization of the Accra maps. It was decided that a large wall poster combining all the individual maps would be quite useful to assist efforts at the field station in Accra (see Figure 1). Access to internet in the field office in Accra was restricted by slow download speeds (up to 2 Mb/s) but most of all by the high downloading costs (6US$ per 100 Mb). Faced with having to pay for internet by the byte we decided to print the maps in the Geography Department at SDSU, and splice them together into six long, narrow strips that could be rolled up as long posters for transportation and then be pieced together in Accra by one of the project team members who traveled from San Diego to Ghana. In addition to mobility constraints, we were limited by our plotter's maximum width of approximately 35 inches. Each map strip ran north to south at a length between 60 and 85 inches, and was 22 inches wide. When pieced together, the six maps depicted the entire extent of our study site. After a few test prints, we changed the digital document's color mode to Red–Green–Blue (RGB) since the plotter printer was connected to an Apple computer with RGB defaults. The poster was delivered to our Accra field office in September 2009 along with a CD containing all the digital files. These products served as a valuable aid for the WHSA-II and HAWS interview efforts.

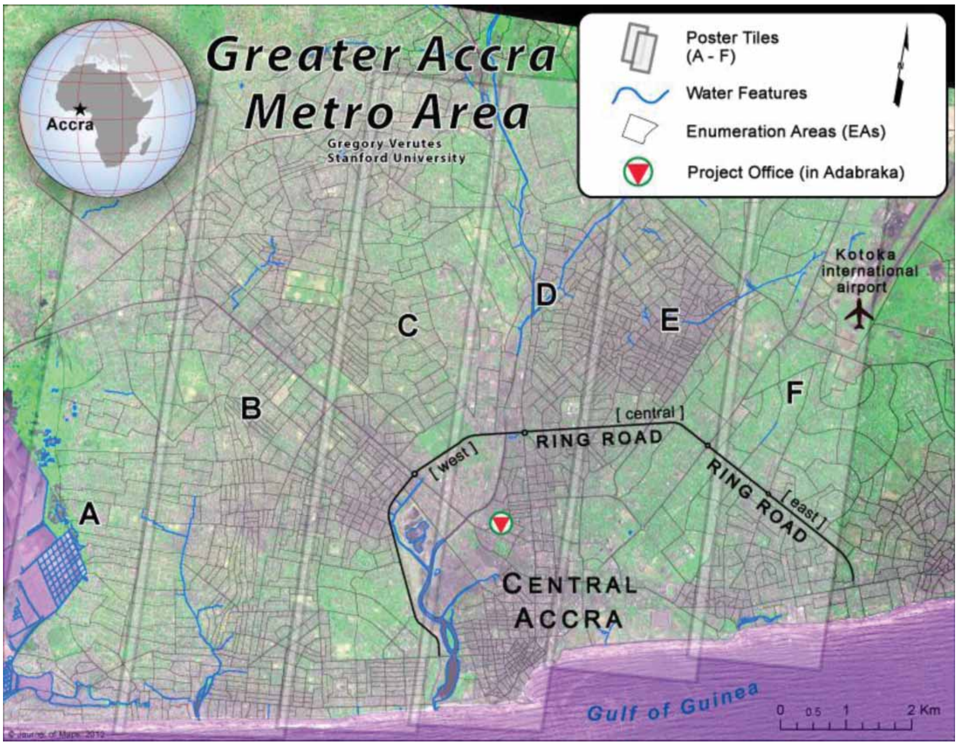

Figure 1. Overview map of Accra, Ghana. This shows the six-color poster tiles that were shipped to and later assembled in the Accra field office.

Table 1. 2000 census population characteristics.

% population	Adabraka	Sodom & Gomorah
Not born in Accra	36	75
Born in the northern region	2	38
Never attended school	24	59
Informal employment	41	51

Table 2. 2000 census housing characteristics.

% houses with access to:	Adabraka	Sodom & Gomorah
Public toilet	36	69
Wooden walls	28	85
Cement walls	59	8
Electricity	87	71
Water piped outside	54	87

Table 3. WHSA-II and HAWS health data.

		Self-reported health (%)					
	Average age	Excellent	Very good	Good	Fair	Poor	Vigorous activity not limited
Adabraka	36	4	78	8	8	2	85
Sodom & Gomorah	26	22	38	39	1	0	95

3. Discussion and conclusions

The project's field office was located in Adabraka, a neighborhood located about 2 km north-west of downtown Accra. The major tasks of the office included implementation of sampling frameworks and testing questionnaires, hiring, training, and managing local personnel responsible for collecting, coding, and cleaning survey data. Accra's neighborhoods were mapped in detail in order to help the field office's personnel with the task of collecting survey data.

Accra's rapid growth has led to unplanned densification and sprawl, a process that is continuously adding to the complexity of the city's structure and making it increasingly difficult for people to find their way around parts of the city with which they are not familiar. The neighborhood map became an important tool for interviewers in the field, providing references to identifiable landmarks such as schools, churches, and pharmacies that provided orientation and allowed the location of sampled dwellings. The combination of high-resolution true color imagery and detailed vector data provided an accurate depiction of the physical context for each of the surveyed EAs. The poster version of Accra's neighborhoods map was placed on the wall of the Accra office where interviewers identified neighborhoods and routes to follow before heading out into the field.

The data collected through the surveys in Accra were aggregated for analysis at the neighborhood level. The analysis of population, housing, and health characteristics at the spatial scale of the neighborhood provide a detailed picture of the diversity of the urban context within Accra. An example of this diversity can be seen through the comparison of 'Adabraka' and 'Sodom and Gomorah', two neighborhoods that are less than 1 km apart but exhibit very different characteristics. In 2000, Adabraka had a population of 4441 over an area of 1.6 square kilometers, whereas Sodom and Gomorah had almost 11,000 people over an area of half a square kilometer. In fact Sodom and Gomorah is one of the biggest slums of Accra with one of the highest densities in the city. The neighborhood grew up around an area originally known as the 'Yam Market' and populated mostly by migrants from northern Ghana (Table 1). The Yam Market area is an important hub for poor rural migrants who use this neighborhood as their point of arrival into the city and where informal employment around the market becomes a source of income.

Compared to Sodom and Gomorah, Adabraka is a more established neighborhood with higher levels of education (Table 1) but also with much more access to infrastructure. While most dwellings in the Yam Market area can be considered shacks made of wood, in Adabraka most of the housing is built of cement (Table 2). Nonetheless, relative to the rest of Greater Accra, Adabraka is still considered to be a low-income neighborhood with more than half of the housing not having access to piped water within the house (Table 2).

The data collected in the WHSA-II and HAWS surveys (with data combined from both surveys) show that there are subtle differences in women's perceptions of health between neighborhoods (Table 3). Women in Sodom and Gomorah are younger than those in Adabraka, which likely explains their overall higher levels of self-reported health.

Software

All the spatial data conversion, analysis, and stylizing for this project was done using ArcGIS 9.3. This includes the conversion of the purchased Arc interchange tiles (.e00) to coverage and then eventually ESRI shapefile. GPS points for health facilities were collected using a Garman eTrex HC Series GPS device and then plotted in ArcMap with a WGS84 datum and projected into UTM 30N. In order to establish a common referencing system, a coordinate system transformation from Accra Datum ('War Office' spheroid) to WGS84 was applied to all the vector tiles layers. The QuickBird image data were pan-sharpened from 2.4 to 0.6 m resolution using ITT's ENVI software. All production on the maps was accomplished using Adobe Illustrator and Photoshop. The vector and raster layers were exported separately from ArcGIS and then combined in Illustrator to produce the final PDFs. The interactive map (Verutes, 2009) was created using Adobe Flash and Action Script 2.0 and is viewable using most standard web browsers with the Shockwave plug-in installed.

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References

Weeks, J.R., Getis, A., Stow, D., Hill, A.G., Rain, D., Engstrom, R., . . ., Coulter, L. (2012). Connecting the dots between health, poverty and place in Accra, Ghana. *Annals of the Association of American Geographers*, Retrieved August 23, 2012, from http://www.tandfonline.com/loi/raag20.

Weeks, J.R., Hill, A.G., Stow, D., Getis, A., & Fugate, D. (2007). Can you spot a neighborhood from the air? Defining neighborhood structure in Accra, Ghana. *GeoJournal*, *69,* 9–22.

Verutes, G. (2009, February). Interactive map of Accra, Ghana, Retrieved June 6, 2009, from http://www.geointerest.frih.org/accra.swf.