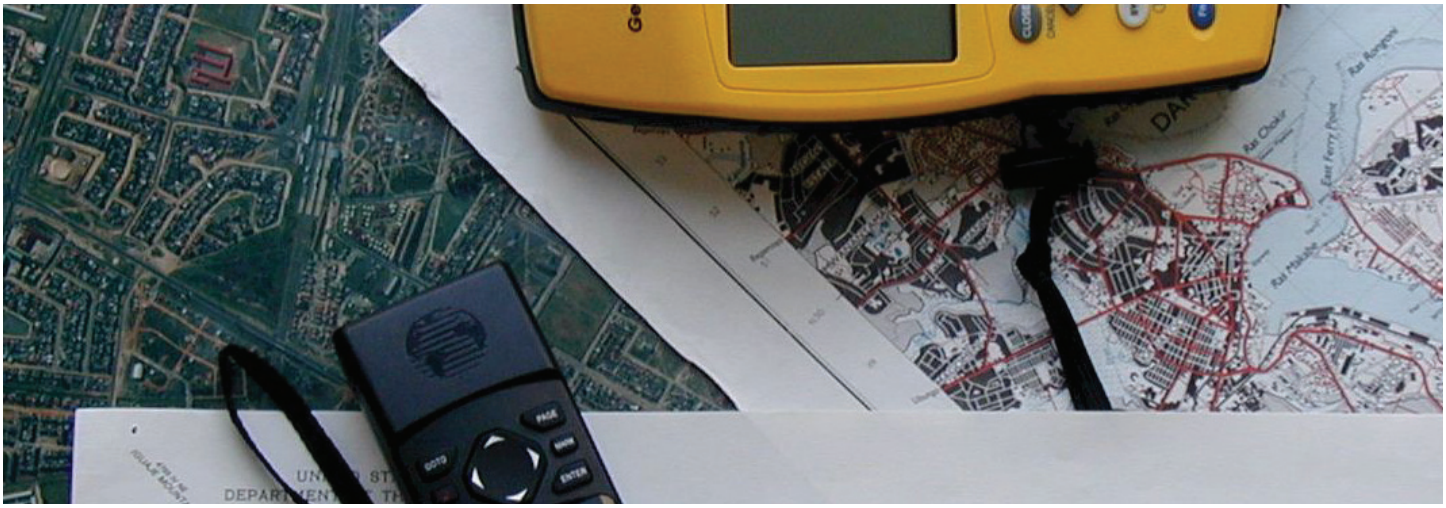
Mapping health service availability in Nicaragua with new techniques



MEASURE Evaluation Fact sheet
KDE: Kernel density estimation

At MEASURE Evaluation, we know that improved analysis and use of data lead to better health program decision making and, ultimately, improved health outcomes. This fact sheet introduces one of the innovative toolsets created for monitoring & evaluating public health interventions.

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Overview: MEASURE Evaluation researchers are using a powerful mapping technique called kernal density estimation to calculate better representations of the spread of people and services across a region or landscape.

Spatial analysts often use tools known as geographic information systems (GIS) to map and analyze entities and events. GIS offer enormous potential for monitoring and evaluation (M&E) efforts. One use is to turn data about the location of health facilities, populations, and other variables into maps that quantitatively estimate the availability of health services in a region.

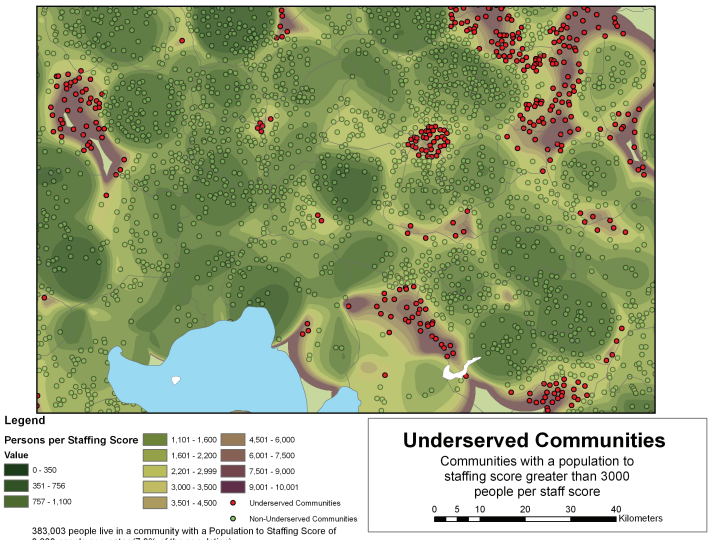
Reaching this potential, however, is a challenging endeavor. The required data can be difficult to obtain. Additionally, finding a technique robust enough to adequately model health systems, yet simple enough to be easily calculated and understood, is a serious technical challenge.

Researchers from MEASURE Evaluation recently employed a data analysis technique called kernel density estimation (KDE) to assess the availability of health care throughout Nicaragua. KDE can estimate how the number of health facilities, and the number of health facility staff members in a region compare to the number of people in a given population. These estimates will help researchers better understand health-care accessibility and guide future health-improvement efforts.

How KDE Works: A health facility can be represented as a dot on a map, but representing the geographic range of that facility's influence, or its "service area," is more difficult. Service area depends on facility staff and supply levels, the conditions of nearby roads, and other factors. Likewise, the population of a community is not located on a central point; it spreads unevenly across a region. KDE can accommodate these realities by dispersing populations, health facility influence, or other phe-

nomenon over an area instead of just on a single point.

Maps produced from KDE use facility locations, staffing, capacity, and other attributes, as well as the population distribution of communities being served to assess the availability of health services in a region. Unlike many other data-analysis techniques, KDE is not constrained by administrative boundaries such as city limits or borders between countries or counties when calculating a service area or population-density estimates. Since people are also not always constrained by administrative boundaries when seeking health care, KDE has the potential to more accurately represent health-care seeking behavior. An additional advantage of KDE is that, if the necessary source data such as population or facility locations are available, then most GIS software packages can calculate them easily.



Taking Important Variables into Account: KDE accommodates the role that proximity plays in determining access to health care. For instance, if family A lives 0.5 kilometers from a health facility and family B lives 2.5 kilometers away, family A will likely find it easier to take advantage of that facility's services, even if that facility can serve both families (assuming all other factors remain equal). KDE can accommodate these effects by assigning a greater weight to places near a health facility and a lesser weight to places located farther away. KDE also accounts for other factors, such as facility staffing and capacity, which affect a facility's service area.

On the other hand, a commonly used alternative to KDE, the "Euclidian buffer" technique, simply draws a circle of a specific radius (e.g., five kilometers) around a health facility and places the health facility as the central point in the circle. A community or home within the buffer is considered to have access to the facility, while a community outside is not. While this method is easy to calculate and understand, it does not automatically account for factors such as facility capacity or staffing, or the size of nearby populations. Access is calculated as a binary variable: a community 4.9 kilometers away from a health facility may be calculated as having complete access, while a community 5.1 kilometers away may be calculated as having no access.

Using KDE in Nicaragua: In 2001, the Nicaraguan Ministry of Health (MINSA), with assistance from MEASURE Evaluation, conducted the Nicaraguan Health Facility Survey. Field teams visited each health facility in the country. At each facility, they assessed staffing and service levels, and used a global positioning system (GPS) to capture facilities' exact geographic coordinates. After the facility survey was complete and MEASURE Evaluation began mapping the data, the Nicaraguan Census Bureau provided community locations with population counts from 1995 and population estimates from 2001.

Initially, mapping the facilities was a goal in and of itself, but once the maps had been created, there was interest in cartographically displaying the facilities to look at issues of accessibility, services offered, and staffing, ultimately to understand the relationship between facility locations and population distribution. MEASURE Evaluation researchers performed a series of KDE calculations, resulting in maps showing population per square kilometer, facility locations, and staffing density maps, which the allowed population-to-facility ratio maps as well as population-to-facility-staffing maps.

The sensitivity of KDE analysis uncovered important variations in Nicaragua's health accessibility that Euclidean buffers wouldn't have detected. When looking at population-to-facility maps, there were areas that appeared to be underserved. However, when staffing of the facilities was included in the calculations, the number of underserved areas decreased dramatically. In other words, just looking at the facilities, without considering the staffing or capacity of the facilities, missed an important part of the picture.

The KDE analysis of health systems in Nicaragua provided valuable information about access to health care and the relationship between populations and available health facilities. MEASURE Evaluation's analysis also provided further testing and validation of KDE in the health-care setting.

For more Information

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