

Calculating Accessibility Ratios in Nicaragua Using Kernel Density Estimation

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In 2001 a health facility census was conducted in Nicaragua. As part of the effort, GPS receivers were used to collect the latitude and longitude of every health facility in the country. When the census was completed and the facilities were subsequently mapped, several different spatial analysis approaches were used to assess the relationship between population and facility locations. Buffer maps were created in a Geographic Information System, however they provided a very rudimentary measure of the relationship between the population and the facilities. Normal population to facility ratios were calculated, however they were constrained by artificial administrative boundaries. Kernel Density Estimation (KDE) is a technique that spreads the influence of a phenomenon across a landscape and is a way to model a facility's possible service area, as well as the dispersion of people. The authors present this method as a better way to produce population to service ratios. This approach is an alternative way to the more traditional method of calculating accessibility ratios using aggregate numbers for a geographic area and offers an improvement by allowing for calculation of ratios at a sub-administrative unit level.

This paper describes the process of calculating population to facility ratios and population to staff ratios for Nicaragua. The facility locations were collected during the 2001 national health facility census using global positioning system receivers; also staffing levels for physicians, nurses and ancillary nurses were collected during the survey administered at the time of the census. Community locations were provided by the Nicaraguan census bureau (INEC) and are linked to population estimates for the year 2000. Within a geographic information system (GIS) KDE techniques were used to calculate population density using 2000 population estimates, as well as the calculation of facility density. Additionally, staffing levels were added to the mix, the number of full and part-time physicians, nurses and ancillary nurses for each facility was also used to determine staffing density. All three density surfaces were calculated at the national level.

Once the density surfaces were calculated, simple map algebra processes were used within the GIS to divide the population density by the facility and staffing density to produce population to facility ratios and population to staffing ratios. Basic GIS techniques can then be used to determine areas of underservice. These areas can then be combined with demographic data to determine the characteristics of underserved areas.

The paper concludes by presenting the strength and weaknesses of KDE as a measure of accessibility.