Spatial analyses for assessing health interventions

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Background

The assessment of public health interventions is often restricted to an analysis of average effects, which vary according to geographic entities and approximate measures of distance.   Traditional methods used for health evaluation do not make it possible to report on the spatial variability of locations and effects of interventions, much less the factors associated with them.

Spatial analysis uses methods and tools that complement the qualitative and quantitative approaches used in public health. It makes it possible to:

- Explain the health phenomena that have been identified through knowledge of the situation in relation to other units;
- Produce spatialised results in the form of spatial statistics and mapping;
- Assess if the effects of interventions are the same throughout an entire region while examining if the potential differentiations are indicative of inequities;
- Explain why the state of health differs from one area to another in a region;
- Evaluate the socio-spatial and temporal dimensions of states of health or other effects expected from health interventions.

With the prospect of universal health care coverage in the LDCs, spatial analysis is thus a means of improving assessment of interventions but also of strengthening action in places where issues of equity are most important.

In the context of Burkina Faso, affected by high mortality and infant and maternal morbidity rates, experiments in exemption from payment have been carried out since 2008. This study provides two examples to illustrate the potential of spatial analysis of these public health interventions within the context of Burkina Faso:

Methods and data

EXEMPLE 1 : Analysis of the selection of the indigent for the exemption from healthcare payments in the region of Ouargaye

❖ Data

Data produced by Global Positioning Systems concerning respondents from the indigent populations. Using smoothing procedures for point data through mobile means: Kernel Density Analysis.

❖ Spatial analyses and statistics used in this example.

- Map algebra to produce summary maps that characterise the differences in spatial distribution of estimated densities of the selection of the indigent by different committees.
- The Gini index calculated for all distribution of distances between the location of the indigent and the nearest CSPS.
- The characterisation of spatial distribution using centrographic tools of analysis. They make it possible to estimate the concentration, dispersion and directional or geographic trend of the distribution of the indigent.
- Thiessen polygons make it possible to assess accessibility to a CSPS by means of the nearest-neighbour law. The smaller the polygons, the nearer the CSPS and the smaller the medical area.

EXEMPLE 2 : Assessing the effects of exemption from payment on seeking health care in the Dori region

❖ Data

- Three household panel type surveys carried out in 2008, 2009 and 2012
- Socio-demographic, health and spatial data on children under five years of age
- Events of recourse to health care, infant morbidity (malaria, diarrhoea, pneumonia and malnutrition) and populations at risk were compiled on the scale of the 102 sectors identified.

❖ Spatial analyses and statistics used in this example

- Hotspot analysis (Getis-Ord Gi* statistic): the analysis identifies the places where high and low values are concentrated (clusters).   A hotspot exists wherever a strong value is surrounded by strong values. The local sum for a household and its neighbours is compared proportionally to the sum of all households. When the local sum is very different from the expected local sum, and that difference is too great to be the result of random chance, a statistically significant Z score results.
- Kernel density estimation: this tool calculates household densities having recourse to a CSPS in the neighbourhood of each household.
- Map Algebra: producing a summary map that characterises the density of recourse over the period.

LDC: Less Developed Country
CVS: Comité villageois de sélection (Village Selection Committee)
COGES: Comité de gestion (Management Committee)
CSPS: Centre de Santé et de Promotion Sociale (Centre for Health and Social Promotion)

Results

1. Analysis of the selection of the indigent for exemption from health care payment in the region de Ouargaye in Burkina Faso
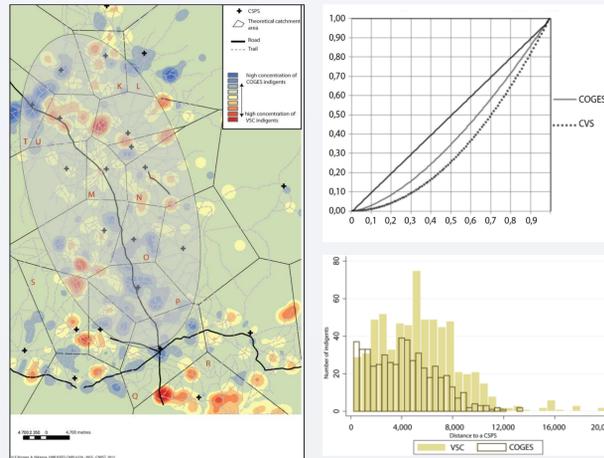

- The selection of indigent populations appears to be spatially more diversified in the south. There was no particular selection in these areas (no area where a committee selected more than in another); all types of selection were carried out here, by both the VSCs and the COGESs. The differences in colour express the comparison of densities between the VSC and COGES indigent. Where the densities are bluer, the number of indigent persons selected by COGESs is higher than the number selected by VSCs. The colour red indicates the reverse, with the number of COGES indigent selected being lower.
- The ellipse characterises the general distribution of the indigent. The two greatest concentrations are in the northwest and the southeast. This orientation, together with the elongated form, seems to correspond to the main road network. This confirms that the combination of accessibility to the road network and proximity to a CSPS was a major determinant in the selection of the indigent for all of the communities but applied more systematically for the COGESs.
- The small size of the polygons suggests a geographic coverage of CSPSs driven by a concern for efficacy. However, moving southward, the polygons grow larger. The distances to be covered are therefore greater for inhabitants in the southern regions and for those in the east and west margins when the CSPS is off-centre.
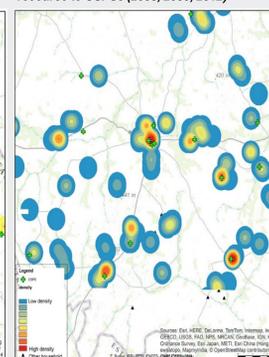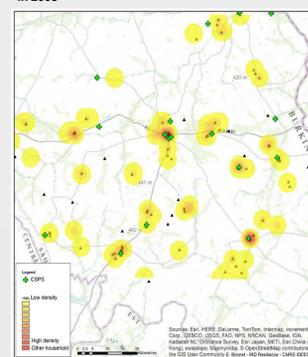
The summary map confirmed the efforts undertaken by Burkina Faso in recent decades to overcome the geographical barrier of access to services.

2. The effects of free services on recourse to health care in Dori Region
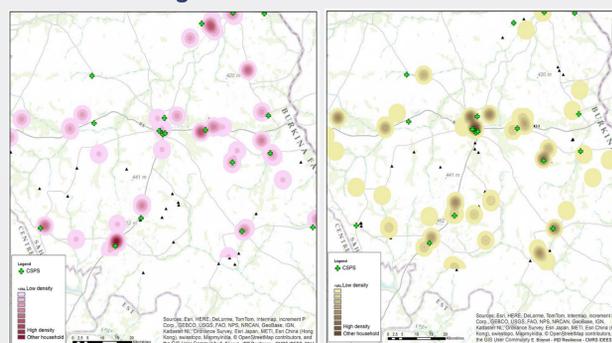
1. Density of households having recourse to CSPSs in 2008

2. Cumulative densities of households having recourse to CSPSs (2008, 2009, 2012)

3. Density of households having recourse to CSPSs in 2012

4. Cumulative densities of households having recourse to CSPSs (2008, 2009, 2012)

This summary map illustrates the household catchment areas for CSPSs.
Maps 1, 2 and 3 represent the density of households having recourse to a CSPS. The absence of colour signifies that the households living in these regions do not have recourse to a CSPS. The blue colours signify that there is recourse but of low density, i.e. not present during the entirety of the study period. The green, yellow and red colours represent the places where cumulative recourse is the greatest.

- Recourse to health care has spatial, temporal, and spatiotemporal heterogeneity
- Spatial clusters were detected in seven census tracts for recourse to health care
- Recourse intensifies in urban areas and villages with a CSPS
- Following intervention, recourse to health care is more widespread throughout the region
- Intervention reduces geographic inequalities of access to health care

- Analysing the coverage per year using the average distance of households from a CSPS, it can be seen that this distance increases and thus the catchment area stretches throughout the region.

Mean distance to CSPS
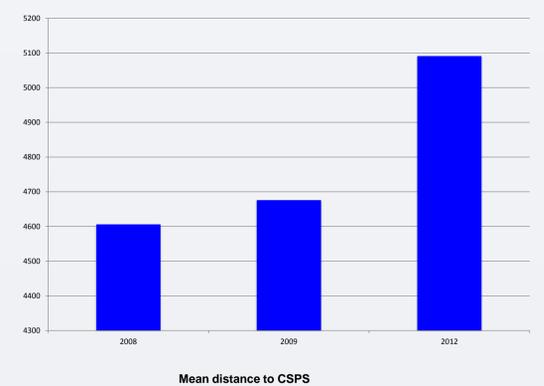
Conclusions

- If spatial analyses are commonly used to illustrate spatial patterns of diseases, they are also useful in the analysis of health care interventions. Mapping, spatial statistics or indeed identification of clusters complete medical knowledge and provide new evidence.
- The proposed method appears to be innovative and useful for evaluating the distribution of benefits of health interventions for populations.
- The findings resulting from these examples contribute to a better estimation of the needs of vulnerable populations and to identifying the most exposed places in order to improve the health of these populations.

References

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