Global health and cartography: French and Brazilian perspectives

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Abstract. Most research on health issues, particularly on environmental health, have been using geographical tools and methods, especially GIS (Geographic Information Systems) that can stock, analyze and visualize spatially related data. As it is based on locating available data such as health indexes (morbidity and mortality indexes), risk factors (environmental exposition), socio-demographic data it is able to better access population environmental quality. But major methodological challenges in environmental health remains, in Brazil as well as in France concerning this cartographical approach. This has led to an exchange programme between the universities of São Paulo and Lyon, aiming to discuss cartographic methods used in health geography in both countries.

The common use of various databases formed with different logics implies working with different spatial units thought in different time scales. Choosing the right aggregation of data and the better spatial and time scale to treat health issues can be difficult. On the other hand, using cartography and GIS implies crossing different information, to analyze their interaction and to help indicate spatial patterns, but new representation methods are necessary to guarantee that information is precisely located. The use of dasymetric representations has been a means to enhance local comprehension of life conditions as well as creating new perspectives to calculate favorable human development index such as urban densities and other structures favoring healthy behavior. Especially in peri-urban areas, where most maps are deficient, an effort to better represent sensible data still needs to be done. As a means to measure the impact spatial planning has in city health, describing and analyzing the urban characteristics that impoverishes population health, with a particular attention to social-spatial inequalities, are major issues for both countries.

Keywords: health cartography, time and spatial scale analysis, dasymetric mapping

1. Introduction

Most research on health issues, particularly on environmental health, have been using geographical tools and methods, especially GIS (Geographic Information Systems) that can stock, analyze and visualize spatially related data. As it is based on locating available data such as health indexes (morbidity and mortality indexes), risk factors (environmental exposition), socio-demographic data it is able to better access population environmental quality. In this text we will concentrate on discussing how to present some of the data available insisting on how to locate data and the effects it will have on the analysis derived thereupon.

Health cartography has seen various developments these last years, with some authors developing dynamic visualization approaches to look for correlation between the available data (Stampach, Kubicek and Geryk 2010 Robinson Roth and MacEachren 2011), while others will tend to create guidelines so that adequate methods are used to dispose of public data (GeoSWG 2012, Min. Saude Brasil 2006).

Believing that major methodological challenges remain to treat health indexes, a common effort between researches in Brazil as well as in France has been the means of discussing possible cartographical approaches. This work portraits some of the ideas coming from an exchange programme between the universities of São Paulo and Lyon, aiming to discuss cartographic methods used in health geography in both countries, especially in what it concerns urban areas. Even if the cities described are far from being subject to the same dynamics¹, some basic issues such as scale units can be confronted while looking at two cases of urban sprawl.

¹ No to mention the sheer difference in size – The municipality of São Paulo alone covers 1500 km² while the Lyon has a surface of approximately 50km². That is why in this programme we compare the newly formed "Lyon Metropole", a political administrative unit formed in January 2015 by 59 neighbouring communes close to Lyon, for a total 540km², which is still a third of the global area of the municipality of São Paulo. Nevertheless we aim to cover a diversity of urban areas, the same distinction between central areas and periurban centers is found in both spatial samples.

2. Heath data – looking for the best spatial unit

2.1. Census data and sociodemographic analysis

Almost all researches in the field of health geography start taking into account the mostly free data coming from demographic censuses². Even if data collected this way can differ a lot from country to country as well in the sampling methods as in the time scope it defines, they mostly define a basic spatio-temporal scale. In France, for example, continuous demographic data arrive every year from surveys conducted in part of the country since 2004 in a census cycle covering 5 years (2004-2008, 2009-2013, 2014-2018). In Brazil, demographic censuses are conducted every 10 years, the whole country being subject to the same survey at the same time. While Brazilian data have been available since 2000 in a very detailed manner by the federal institution responsible for its completion (IBGE), France has started later to create free access to the new flow of demographic data available (Thery & Waniez, 2000).

In health geography, the choice of the scale of analysis is a fundamental issue. This choice depends on the study objectives and the data availability. Regarding this point, the need to mobilize the finest possible scales to prevent the loss of information, often faces statistical constraints. This obviously raises questions about the relevance of geographical scales used in health studies. In fact, it seems that no scale is relevant in the absolute, it depends on the issue being studied. If it addresses health needs, analytical scales can be different depending on the type of planned supply (local for Community Care, regionally for more specialized care). If interested in the issues of population health status and health risks, social risks should be analyzed at the level of territories of life and environmental risks concern living quarters. In health studies, potential scales of analysis are numerous. This is clear in France where one can observe a variety of study scales, from national to local level. Among them, those that are most used are those of the region, the department, the township, the catchment area (smaller territory where residents have access to the most current equipment and services - INSEE), the health area, Commune and Iris.

² In France, census data were sold until a new cycle of "continuous census" was started in 2004. Still some detailed data need a specific authorization and is not available for public download. Brazil has started public assessment to national data in the end of the 1990's, its first public census published alongside with its cartographic basemap was offered as soon as 2000.

Among these scales, we must distinguish the scales of analysis and planning scales. In other words, according to the available data and the constraints of anonymity, health indicators, and associated analyzes are usually mapped across the department, Commune and Iris. Otherwise, actions taken as a result of spatial analysis of these indicators are at the level of health territories. The Law Hospital, Patients, Health and Territories issued on July 21, 2009 provides that each regional health agency (ARS) "defines the relevant health territories for public health, care and equipment of health facilities, decision care and medical and social support as well as access to health care of first resort. Health territories thus constitute the first level of geographical division in which health projects are planned. The current division of the country has 108 health areas (Rhône-Alpes region is organized into 5 health territories). The average population of these health areas is 605 000⁵. Thus, the analysis of health indicators is particularly done taking into account the department, Commune or Iris. These analyzes then allow the development of health projects that will be applied across the health territory.

Still, more than a decade after this first arrival of free data, it is possible to see some of the pitfalls created by using the available data. Normally disposed according administrative units, it has been subject to constant redistribution according to other networks, mostly imposed by health institutions. We can see in France the appearance of "health territories" (*territories de la santé*) used as a means of rearranging the availability of health centers throughout the country in order to unify a rather important amount of local administrative units (more than 36000 communes). In Brazil, the Unified Health Care System (SUS - Sistema Unico de Saude) established the Family Health Program, which defines the territory of operation in order to understand that particular segment of the population, with continuous updating. The spatial unit that is the territorial base of the health system is the catchment area of each basic health unit.

⁵ These health territories have themselves varied scales: three French regions have used the regional level for the definition of their health territories, two regions have chosen to work above the departmental level, 12 regions have defined their health territories in accordance with departmental boundaries, 9 regions have maintained a level inferior to the department.

2.2. Going further than microdata

In the opposite way, trying to look demographic data in detail has lead to try and see further in the microdata available in each country. In France the IRIS network (*Ilots Regroupés pour l'Information Statistique*) divides the more populated communes of the country to reach a homogenous mesh each having originally 2000 inhabitants. Brazil has its 316 574 enumeration areas (EA), both urban and rural, leading to a very detailed network of data. We can then seek to depict urban density to this level and better approach different intra-urban characteristics (Figure 1).

The dasymetric map of São Paulo refines the spatial resolution of EAs by incorporating underlying ancillary data, which include the digital cartographic database of the city blocks, the database of municipal cadastre, Landsat satellite images with a spatial resolution of 30 m and digital aerial orthophotos with mean spatial resolution of 45 cm (Barrozo et al., 2014, more details in Barrozo et al., forthcoming).

As it is normally expected, densities vary from the higher rates in the center of the cities to reach lower levels in the outskirts of the urban areas. Some higher densities can be seen in some of the previous "faubourgs" in Lyon as well as in São Paulo, some of which have been subject to annexation in recent history (Guillotière in Lyon, Santo Amaro in São Paulo). Other areas of interest depict regions where specific housing or planning programmes have led to high densities. In some cases central areas may even seem to have become less dense than other peripheral areas. Thus density can be a way of approaching urban dynamics and specify a certain territorial quality index, if large dense areas are depicted with no free/natural spaces that could enable sport practice, or other leisure amenities.

Still, in dense urban areas one cannot but try to reach for further analysis. Remote sensing dispositives permit us to isolate inside these areas real location of inhabited areas. In France this can be done using an European remote sensing project, CLC - CORINNE LAND COVER, that identifies more than 40 land cover unities related to 5 major themes : artificial , agricultural, natural areas as well as wetlands and water bodies. CLC project, although subject to critics about the themes and scale depicted, has been renewed twice and could be a means of following changes in regular time intervals for many European Countries. Figure 1. Examples of density calculated in Grand Lyon : on the left calculated according to IRIS network, on the right after calculating densities to inhabited areas as revealed in the European project CLC.



Sources : IGN, IRIS 2000 & INSEE, 2011.

Most changes in density values can be seen in a peripheral circle around what is figured as downtown areas, be it in Lyon or in São Paulo. Dasymetric mapping creates more meaningful zones and insists on better depicting housing conditions in peripheral areas, especially where discontinuous urbanization tends to appear alongside with very densely build-up areas. Pockets of dense and mostly low income housing projects often appear farther from existing town centers, subject to deficient transportation possibilities which explain why land tenure values are also lower. It can be revealed in some areas of illegal occupation (*favelas*) in south São Paulo, but also in some regions in the south and eastern part of Lyon Metropole, such as in Jonage or Givors, where moderated-rent houses (HLM) constitute an important part of the whole housing equipment.

3. New units for spatio-temporal analysis

Dasymetric mapping can be a better basis to check other health data available. In France, data describing health care units are easily available whilst surveys on population well being/health state are mostly partial. The BPE⁷ – permanent equipment database proposes every year a relatively exhaustive list of equipment and services existing in French territory. And since 2013 it is possible to precisely locate most health equipment data included to coordinate levels. Confronting these data to dasymetric density calculated early clearly defines over and under-equipped areas (Figure 2).

In São Paulo, Basic Health Units are located according to population density (Figure 3). Their distribution follows the principle of universality, equity, decentralization, advocated in the Unified Health Care System, from a territorial perspective.

^{7 &}lt;u>http://www.insee.fr/fr/methodes/default.asp?page=sources/ope-adm-bpe.htm</u>

The use of these coverage indexes could helps us determine vulnerable population in what respects access to health care. Some medical specialists can be a means of indicating where an effort is needed to comfort population needs and eventually create new care centers⁸.



Source : CLC, 2006 / INSEE, 2013.

Figure 2 *Dasymetric mapping and health accessing Lyon – pediatric location does not always follows density patterns.*

⁸ This is mostly true concerning basic care centers. For other specific care units, such as Cancer treatment unities, where there is a latent effect (sometimes 20 to 30 year long for some cases of cancer), that implies rebuilding the whole length of the exposition periodand can rarely be considered immediately.

As such, medical demography data are quite illustrative of inequalities in access to care by territories. If primary care structures are relatively well distributed throughout the country (although some rural and urban areas suffer from a lack of general practitioners), the strongest inequalities occur in the area of specialized care. It may take with respect to the example of pediatric healthcare provision.

According to the Ministry of Health, in 2008, France had about 7,125 pediatricians. Almost 50% of them work in a hospital (public or private) and 40% work in private sector. The average density of pediatricians (all modes combined exercise) is 61 physicians per 100 000 children under 15 years. The Île-de-France with a density of 90 doctors and PACA with a density of 78 doctors are among the best equipped regions. The regions of Poitou-Charentes, Loire, Champagne-Ardenne and departments overseas were the least well-endowed regions with densities ranging from 40 to 42 doctors.

As for the Liberals pediatricians, data in CaisseNationale d'Assurance Maladie (CNAM) show a strong interdepartmental inequality, which has greatly intensified between 1999 and 2008. The ratio between the maximum and minimum density (excluding Lozère which there is no Liberal pediatrician) is currently 1 to 29, when it was only 1 to 9 in 1999. Besides the already mentioned Lozère, departments that currently have the minimum density (3 per 100 000 children aged 15 or less) are the Haute Loire and Deux Sèvres. The maximum density is observed at Paris (73 per 100,000) and in the Hauts de Seine, the Alpes Maritimes, the Haute Garonne.

Finally, at the territorial level, the concentration of Liberal pediatricians is strong, with 94% of them work in urban centers. Thus, nearly 20% of French live in a medical desert regarding pediatricians. If this lack of pediatricians is evident in some rural areas, it is also observed in some urban areas. This is particularly true in urban neighborhoods that record adverse socio-economic indicators even though the needs are great.



Municipality of São Paulo - Population Density and Basic Health Units

Figure 3 Dasymetric mapping and health access – Basic Health Units in São Paulo and density pattern.

4. Conclusion

The use of dasymetric representations can be a means to enhance local comprehension of life conditions and it could be developed further to more intelligent techniques (Mennis and Hultgren, 2006). It could also create new perspectives to calculate favorable human development index where not only urban densities but also other structures favoring healthy conditions can be assessed. Specially in peri-urban areas, where most maps are deficient, an effort to better represent sensible data still needs to be done.

As a means to measure the impact spatial planning has in city health, describing and analyzing the urban characteristics that impoverish population health, with a particular attention to social-spatial inequalities, are major issues for both countries.

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