CO-187

THEMATIC MAPPING OF HEALTH

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Thematic mapping with GIS in social/community medicine research has quite a history in Sweden. Due to exceptional circumstances researches in Sweden, along with scientists in the other Nordic countries, are able to perform studies on individual level of life style and environment and its impact on general health.

This paper gives a short introduction to the research field in Sweden focusing on the use of GIS and thematic mapping. It enlightens issues such as statistical awareness, thematic mapping, methodological problem and personal integrity.

Census mapping in Sweden has emerged with the use several official/national registers available as data sources for researchers and governmental bodies on different levels. This has more and less been the case since Professor Torsten Hägerstrand's days in the early sixties. Although quality of data and methods of analysis has increase immense. Major contributors are, as in those days, Statistics Sweden and National Land Survey. Population data are combined with cadastral data giving individuals spatial references. In the case of studying social/community medicine these basic data are combined with primary health care data using the Swedish personal code number.

Nordic countries have a strong tradition in keeping individual notations on health and death causes. In the 18th century the clergy of the church performed this task and today it is the business of the statistical organization in Sweden. Research in social/community medicine is of great importance for National Health administration because it has dimensional effect on the future care taking, an issue of importance for all nations in an ageing Europe.

This paper will focus on two trends within social/community medicine observed in Sweden. On one hand studies made on environmental impact, such emissions (by traffic or industry), on a population of people. Examples of this kind of studies come from Southern of Sweden where the County Council has a co-operation with the University of Lund. Impacts that can be regulated by political decisions or planning strategies. The other type of research concerns the impacts of social economic factors, life stile patterns, and so forth, things that can be changed by reorientation and will of individuals. As an example of this kind of studies the paper refers to studies looking into correlation made between poor health in deprived areas and the supply of health promoting resources.

Research in social/community medicine with a geographical/cartographical approach is of great importance for national health administration because it has dimensional effects on future provision of care. This has been the case in Sweden ever since scientists have been able to use registers with individual-level medical data.

The study of poor health and its underlying causes promotes a societal engineering that gives us new environments in which we can live, work and preserve our health. Clinical studies that produce knowledge and practices that are easy to apply and further develop are critical for future health care administration.

This paper gives a short overview of thematic mapping (each of the examples includes a cartographic presentation) within the disciplines of social/community medicine in Sweden. The discipline of social medicine seeks to understand how social and economic conditions impact on health, disease and the practice of medicine. Community medicine or family medicine (as some prefer to call it) is a medical specialty devoted to health care. It is a type of primary care that provides continuing, comprehensive health care for the individual and the family. It is based on knowledge of the patient in the context of the family and the community, emphasizing disease prevention, health promotion and intervention.

This paper also introduces the science of epidemiology, the study of patterns of diseases in a physiological and /or environmental (social, natural, built) context. Data handled by epidemiologists are either prevalence- or incidence-based registrations stored in databases. Prevalence is a measure of the proportion of a population that has a certain disease at a certain time. Incidence concerns the rate at which people are affected by a disease. It can be the proportion of a population that during a specific time is affected by a disease; it can also be the number of new cases within a specified time period divided by the size of the population initially at risk. Other popular measures used by epidemiologists are different types of risk and odds ratios. In direct connection with the spatial context are the epidemiologists' studies of and processing of data for cohorts and clusters, as well as multilevel studies and studies that track disease risk factors. The Swedish care situation has been described cartographically in a special part of the Swedish National Atlas.

There are also regularly issued cartographic works such as the Cancer Atlas. My presentation only concerns work done by the research community or governmental bodies (local authority studies and private initiatives have been excluded). It starts with a description of the resources that are available to Swedish researchers. Foremost it concerns different kinds of registers which have a spatial component. The paper closes with a brief discussion of methodological issues regarding data compilation and cartographic visualization within health mapping.

Swedish research groups have access to individual data. Data compilation is possible when a number of different data sources with location-based data are available. In Sweden, most of these location-based data are provided by Statistics Sweden. Census mapping has delivered a lot of thematic mapping and cartographic studies since the development of the cadastral data register in the mid 1970's.

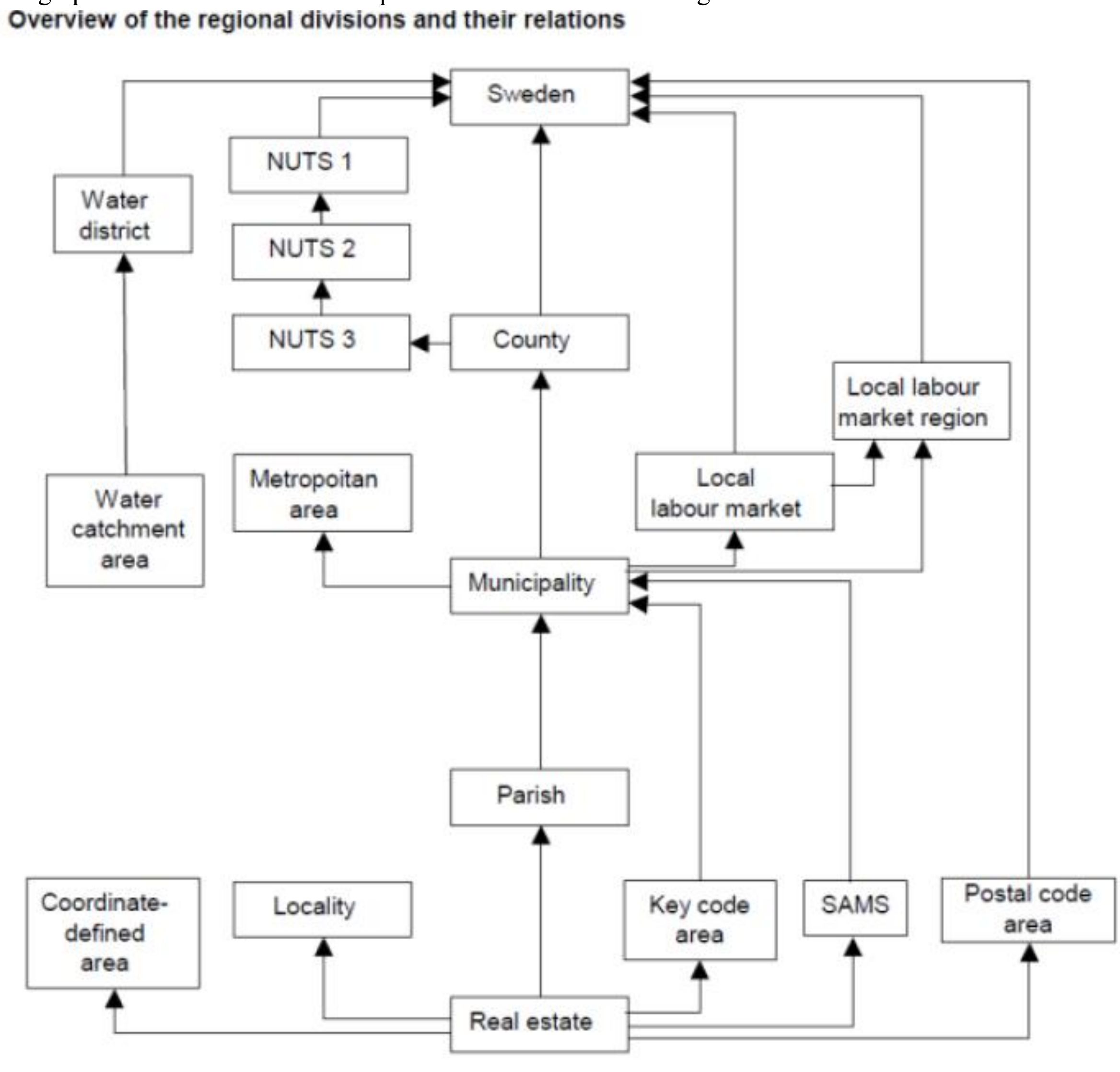


Fig 1. Different statistical levels in Sweden with their different territories, from cadastral units to the national level.

In Sweden, an important asset for geocoding is access to a real estate register with coordinates. Data that can be connected to real estate become geocoded "automatically" (SCB, 2005). This is, for example, the case for populations, since persons are registered by real estate (cadastral) units. Special attention to matters of secrecy and privacy is essential when dealing with regional statistics. The risk for so-called "backwards identification" in tables – and especially in maps – must be considered when handling small groups and where data that define locations can be used to identify individuals or enterprises.

GIS software makes it easy to perform spatial analysis. Thematic mapping is essential in dissemination of the results of such analysis. Maps promote a greater understanding and can even influence the general health among the investigated population.

This section gives examples of the different research groups in Sweden and their achievements within the field of cartography. The most prominent and dominant groups are described. The review concerns academic work and efforts where a cartographic outcome has been presented. It starts with an early study from Uppsala University.

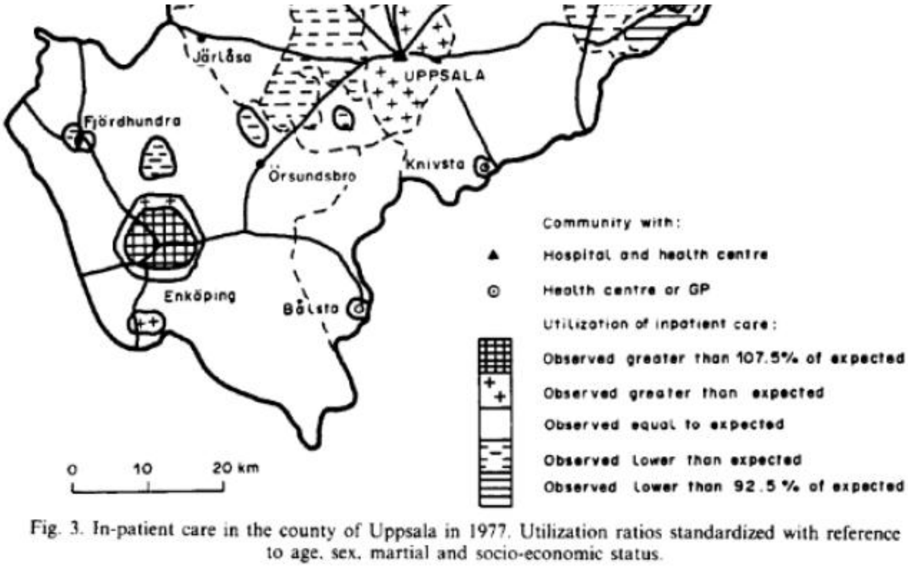


Fig. 2 Early work with computer-assisted cartography (SAS/GRAPH).

The utilization of health services varies greatly by sex, age, marital status and socio-economic status. Cartographic analyses of health services use were carried out in three steps (Haglund, 1989). First, the observed number of individuals within health care was calculated for every reference area. Then, the expected number of individuals with reference to sex, age, marital status and socio-economic status was calculated. Finally, the ratio of the observed and expected number of individuals was calculated. The isarithmic map shows the ratio between the observed and expected numbers of in-patients.

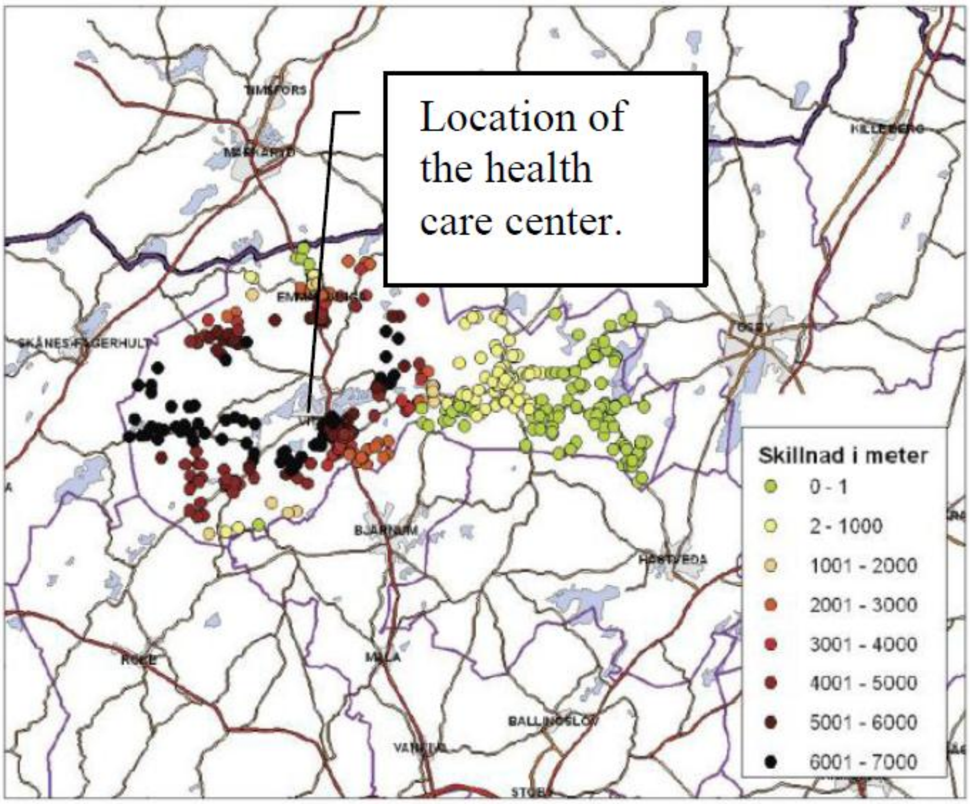


Fig. 3 Dimensional study by the county administration in Skåne – Region Skåne.

An example of a locational analysis illustrating what happens to accessibility of health care services when a health care center is closed or opened at a certain location. Data for the following were used in studies of how people's access to the nearest medical center is affected by the closure are: coordinate set population, roads, and health care center location and catchment area (administrative area).

Distances were measured as the number of meters by road. This method was used when the closure of Vittsjö clinic was discussed by people affected by the closure and politicians responsible for it. The results of the analysis presented in the map (left) show differences in access, in terms of distance, when the health care center in Vittsjö closed. The effect was much larger for people living close to the facility. The further you go from the site the more alternatives you have.

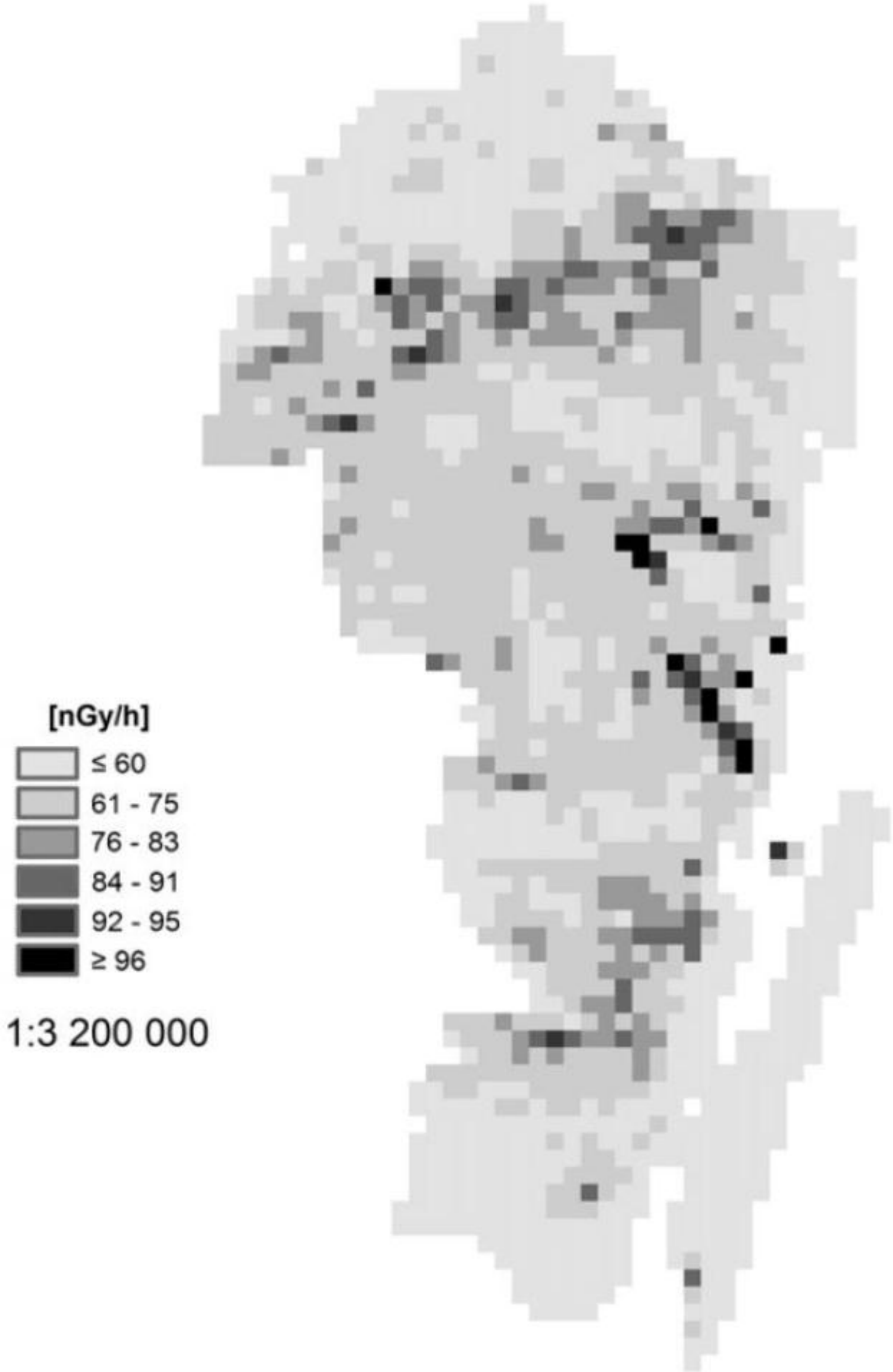


Fig. 4 Identification of populations living in areas of high background radon. University Hospital in Linköping.

Population coverage was intersected by maps of radon delivered by the Swedish Geological Survey Office. Then, the population was divided into those living in high- , normal- and low- risk areas (background radiation). The results could be linked to different health records stored in databases and registers. It's a fairly simple method for performing epidemiological and health system research. This study (Kohli et al., 2000) showed, for instance, that there is evidence that children born in and continuing to live in areas classified as high and normal risk for background radiation from radon have a higher incidence of acute lymphatic leukemia.

In view of the increased incidence of acute lymphatic leukemia in so called "normal-risk" areas, there is a need to reassess the classification of risk from background radon and enforcement of radon-safe building standards.

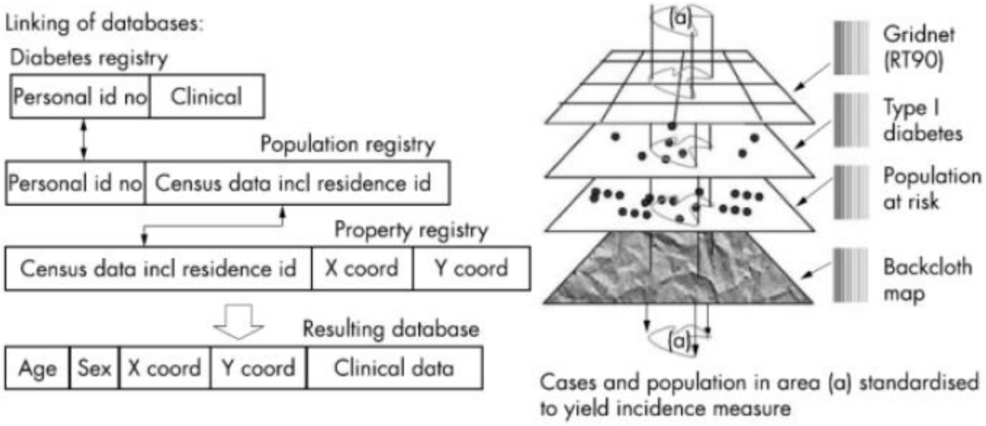


Fig. 5 Distribution of type 1 diabetes in South-East Sweden.

Geographical mapping of type 1 diabetes in South-East Sweden at Linköping University Hospital (Samuelsson & Löfman, 2004) showed that the incidence rate behaved differently when presented at different regional levels. Tests were made at parish, municipality and county level to determine whether the incidence rate had a spatial dependency. Different methods were used and cluster analysis and even kriging were considered. The result showed a weak spatial dependency for incidence data.

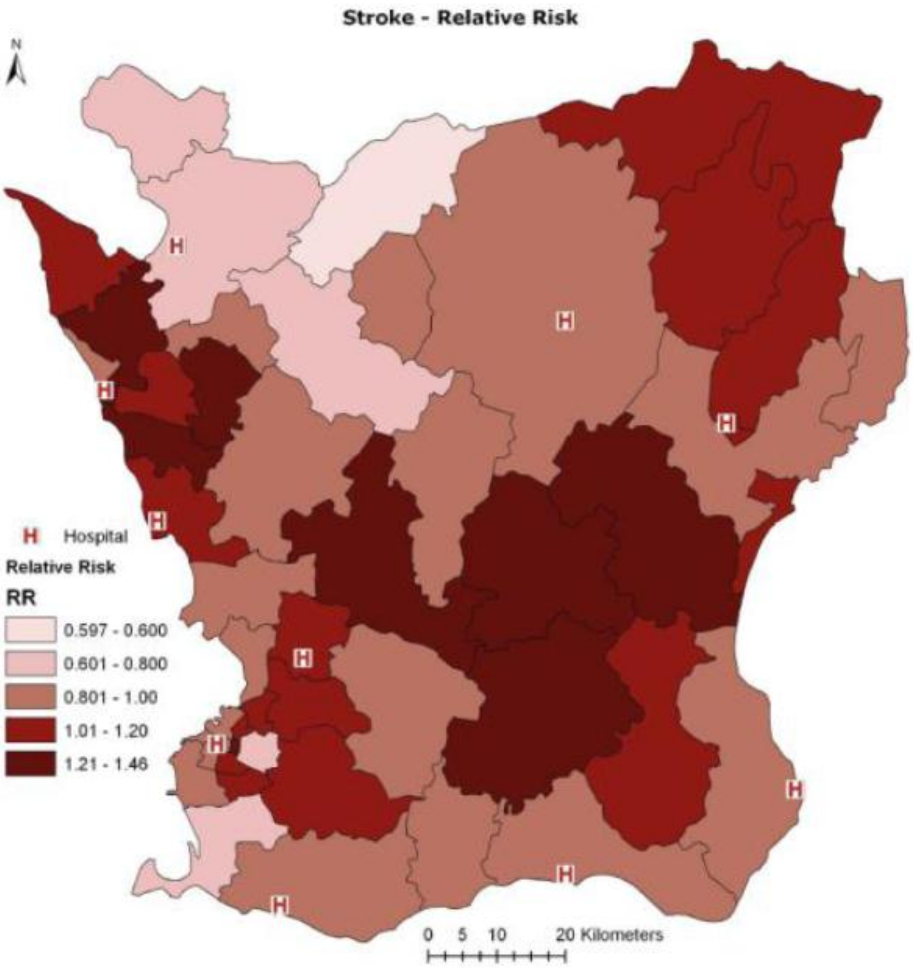
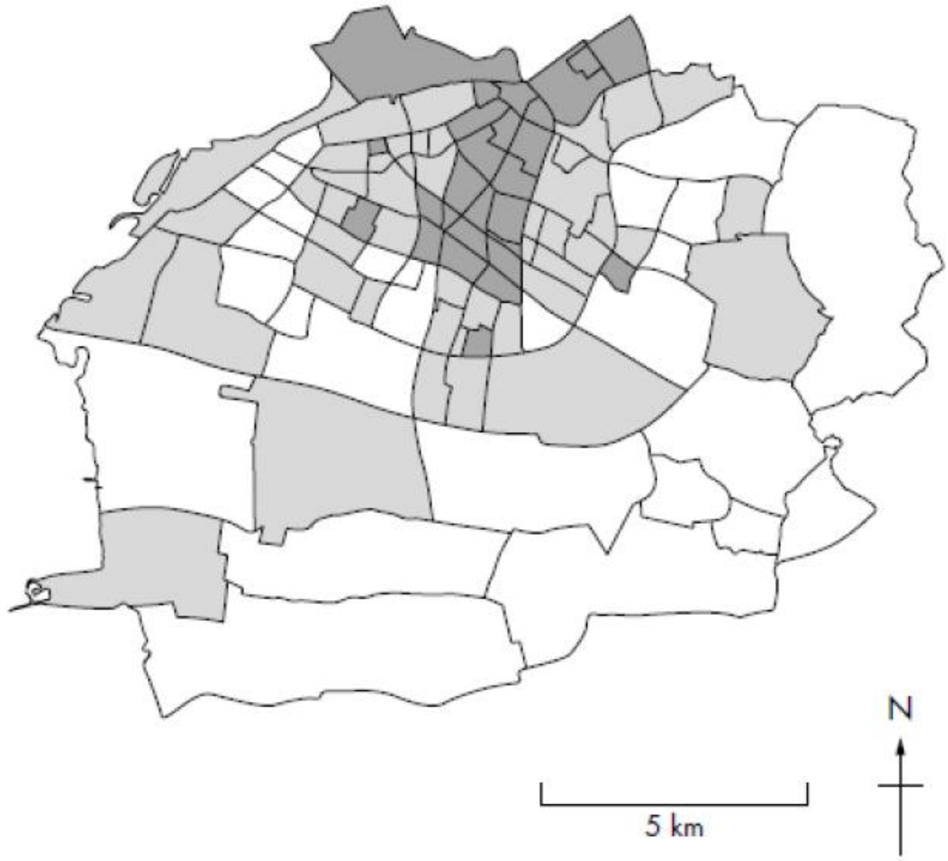


Fig. 6 Long-term exposure to air pollution and hospital admission for ischemic stroke in South Sweden.

This study concerns stroke and the influence of air pollution. The study group comprised 556,912 individuals born between 1923 and 1965 and residing in Skåne in 2002. A further selection was made and 4,904 were found in the Swedish Stroke Register between 2001 and 2005 (Oudin et al., 2009). The pollution map shows a pattern of relatively high levels of pollution in the South-West of Skåne. The map shows the relative risk of ischemic stroke in the investigated area of Southern Sweden. The selected individuals were spatially located. 78% had not changed residential address during the last ten years, so it was assumed that exposure was fairly constant. The results of this study showed no evidence of an association between exposure to air pollution and hospital admission for ischemic stroke.

Mental disorders due to psychoactive substance use



Neurotic, stress related and somatoform disorders

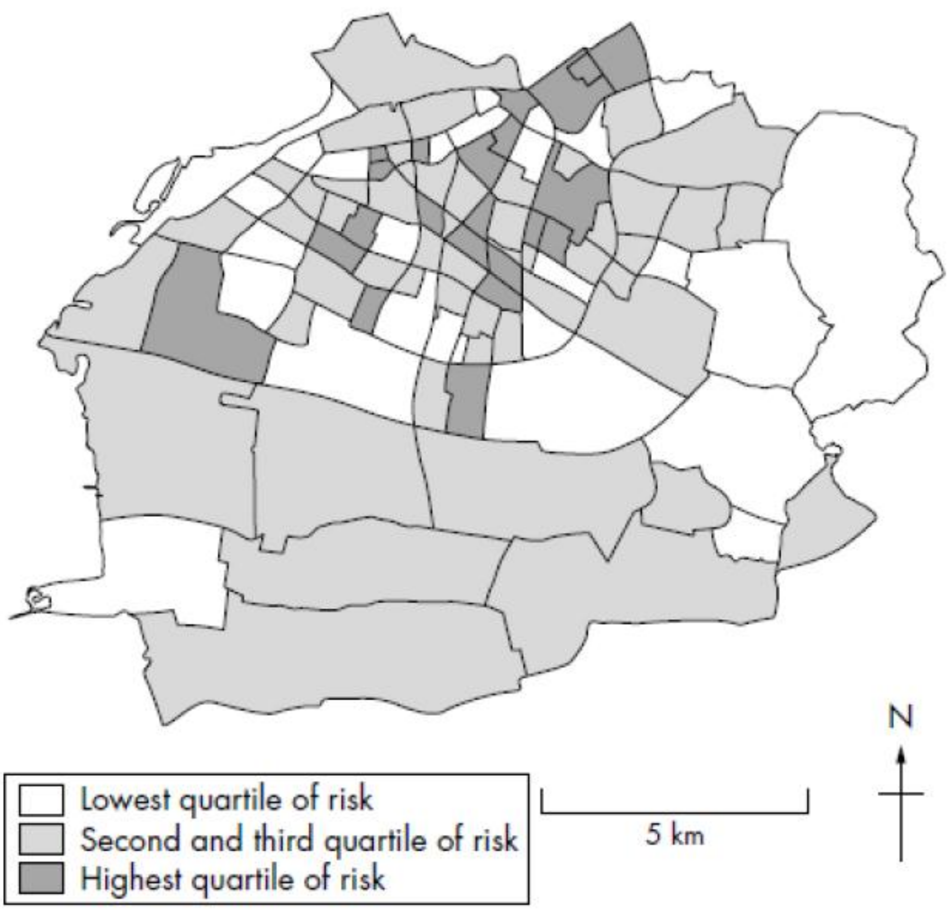


Fig. 7 Neighborhood-level variation in the prevalence of substance use-related and neurotic disorders.

This study shows that different kinds of mental disorder have different spatial patterns. Disorders due to substance use and related to neurotic conditions have similar spatial clustering patterns, with increased prevalence in the northern part of Malmö (Chaix et al., 2006). GIS techniques were used to establishing spatial scale and social context. Spatial scan techniques were then used to find clusters. Finally, geostatistical methods were used. In the study, two dimensions of social context were used: neighborhood deprivation and social disorganization. Individuals with disorders due to psychoactive substance use had greater variation when it came to the influence of neighborhood deprivation than those with neurotic disorders. Looking at variables like crime incidence (social disorganization), there was a higher prevalence when it came to mental disorders due to substance use. The contextual variable income was more strongly associated with neurotic disorders. Independent associations with crime were found only for the group of disorders that varied spatially on the small (cartographic) scale. Associations that operated on a local scale were tied to contextual deprivation and neurotic disorders.

In Sweden, most research groups are working with GIS analysis and thematic mapping within the context of either environmental or epidemiological studies or surveys. Available to them are dynamic tools for visualizing health care information and statistics

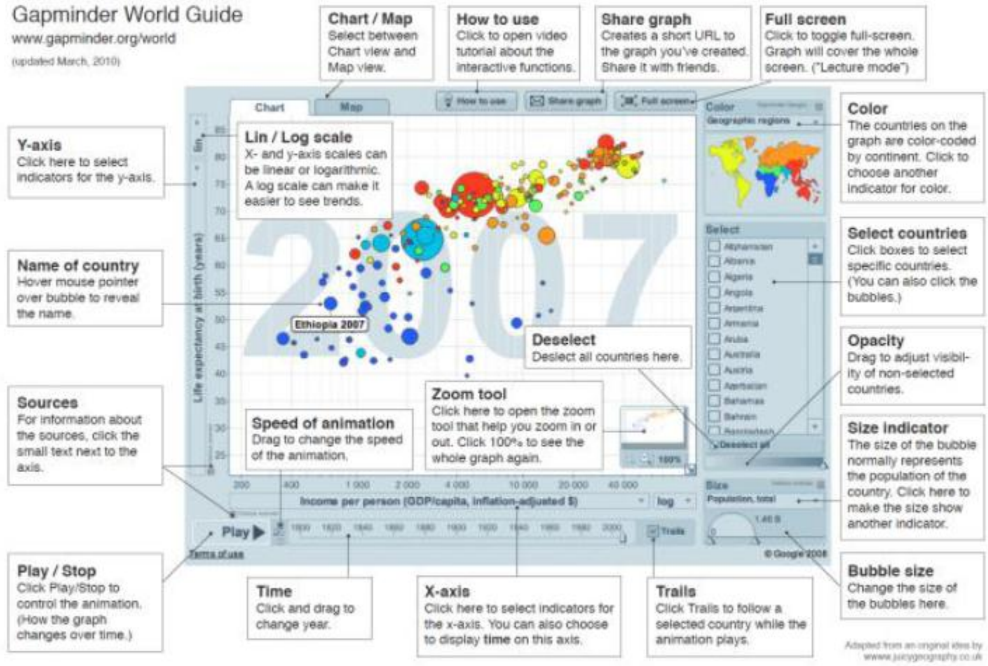


Fig. 8 GapMinder.

The world famous GapMinder Visualizer, with which one can present conditions on time and space scales based on worldwide statistics, has a Swedish counterpart in eXplorer.

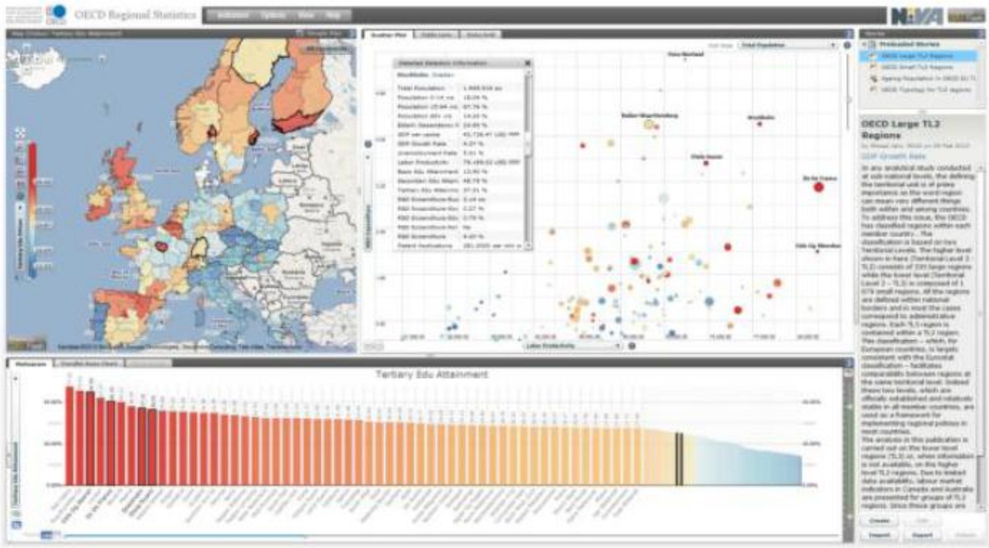


Fig. 9 eXplorer.

Somewhat more graphical than GapMinder Visualizer's interface, eXplorer's interface rests on cartographical communication. Both applications work with flash animation, are Internet-based, and are able to use external datasets.

Both applications work with choropleth maps as standard representations, although there are possibilities to produce different chart maps. However, the data are always tied to an administrative area. Simultaneous presentation of statistical bars and raw data in table form gives the viewer the opportunity to review the data and to add information to the cartographic presentation.

The health sector in general is very interested in developing maps for use as tools in their scientific work. However, they encounter methodological problems well known to cartographers since the day of the first thematic map. For instance, the National Center for Health Statistics in the US conducted a quality survey with focus groups in order to elaborate recommendations for a new mortality rate atlas (Pickle, 2009).

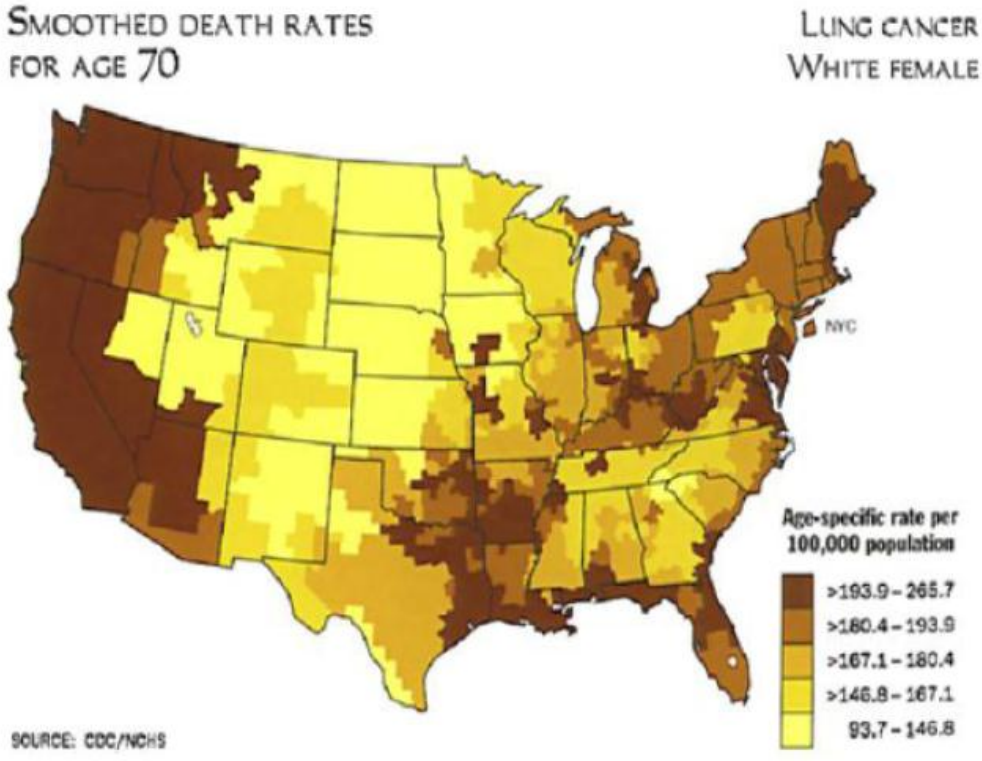


Fig. 10 Smoothed death rates for women aged 70.

Maps of smoothed rates were preferred by focus group participants for judging general patterns, but are not intended to show accurate information for each small area. Smoothing algorithms can be model-based or non-parametric, but in either case the population heterogeneity needs to be taken into account so as not to smooth away reliably estimated hot spots.

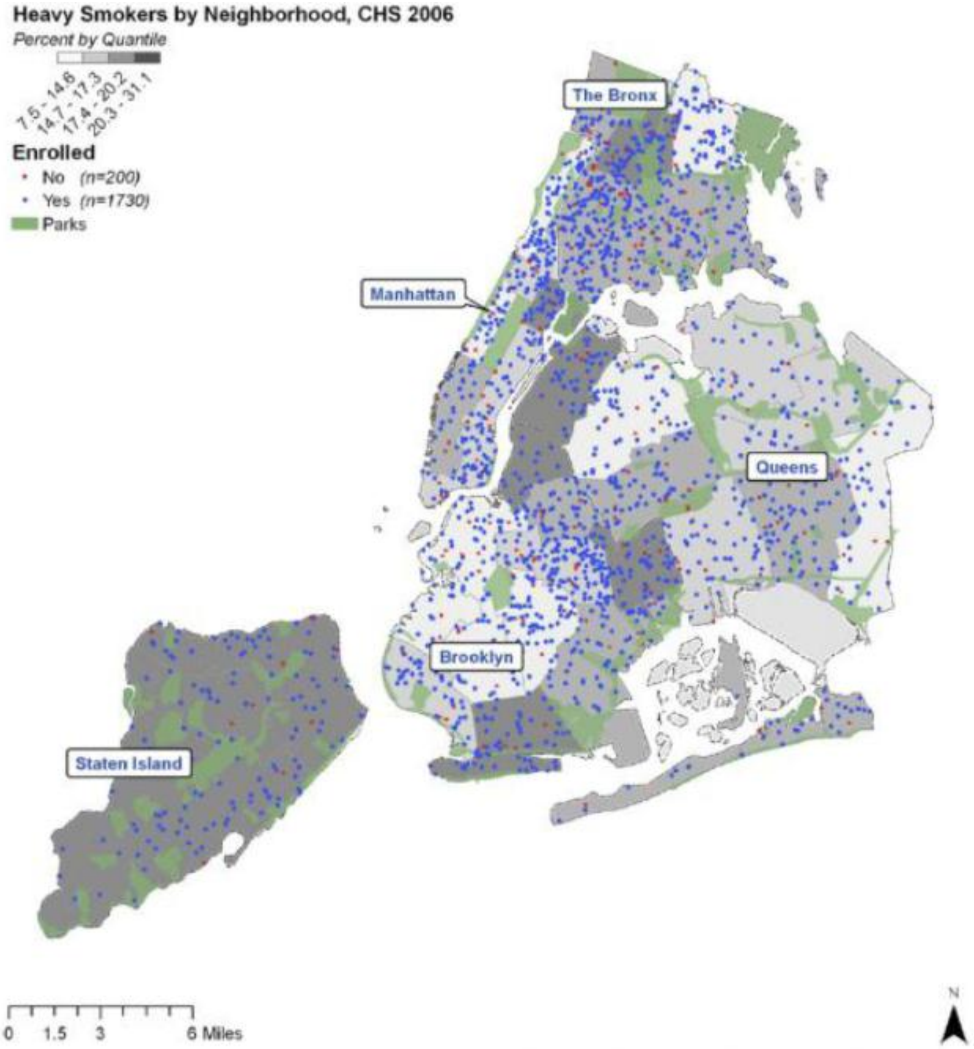


Fig. 11 Maps from a nicotine replacement therapy program.

This map is a daily distribution map illustrating the locations of applicants and enrollees, overlaid against neighborhood smoking prevalence rates. This map demonstrates that certain neighborhoods with high smoking prevalences, such as the South Bronx, (smoking prevalence 19.8%, smoker enrolment 4.2%), had higher enrolment rates than other neighborhoods with high smoking prevalences, such as Coney Island in Southern Brooklyn (smoking prevalence 23.5%, smoker enrolment 1.9%) (Czarnecki et al., 2010).

It is clear when you look upon the field of mapping that medical researchers are looking into spatial techniques to combine with traditional biostatistics. They are also looking for a solution to the methodological problem of how to handle data connected to a point or an area. Much of the foreign literature is concerned with the area issue, in which point-related survey data create integrity problems. A review of this research field confirms that the question is very much alive, and that, as the authors of these studies rightly point out, there is much methodological work yet to be done.

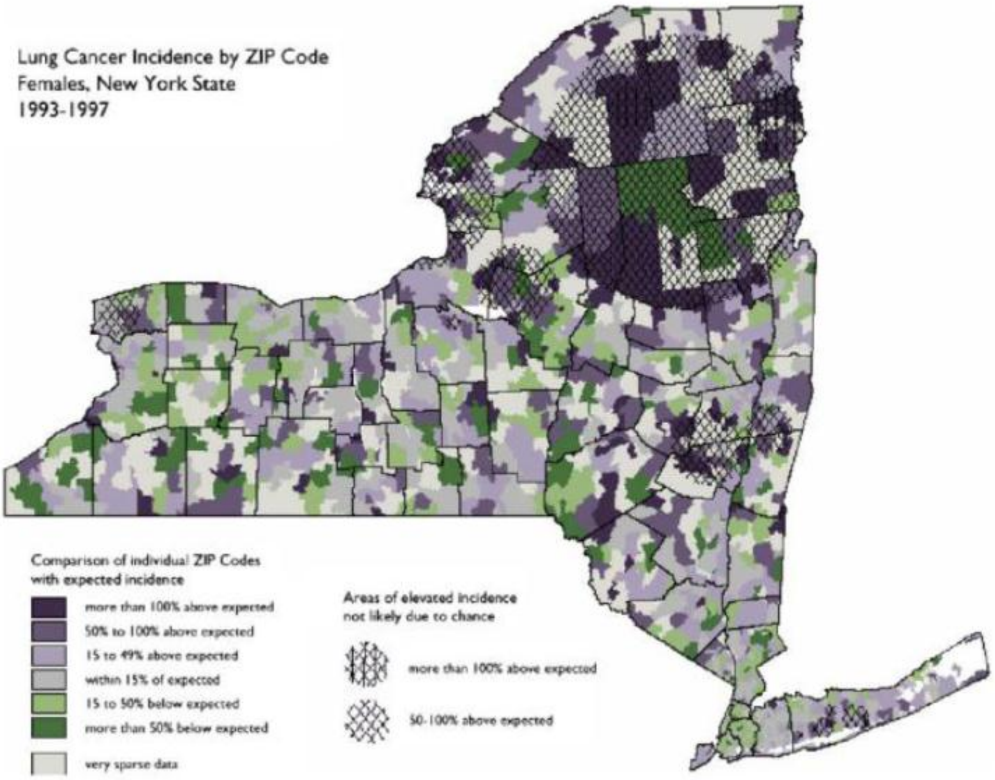


Fig. 12 Lung cancer incidence in New York State. Scan analysis found circular clusters.

Another issue relates to cluster analysis, where "The circular spatial scan statistic tends to detect a larger cluster than the true cluster by absorbing surrounding regions where there is no elevated risk" (Jacquez, 2009). "Returning false positives as part of a cluster appears to be a property of scan-type statistics that employ a likelihood function to average risk across cluster member candidates – it is not limited only to circular spatial scan statistics".

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