

Geodemographic analysis and visualisation using GIS software

by Jack Hinton

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1. A brief review of the history of cartography

1.1. Origins and prehistoric cartography

The origins of cartography are disputed, as map-like carvings, known as the 'Pavlov Map' have been found that date from 25,000 BC [1][2]. Opinions differ as to whether these carvings may be considered maps as they do not seem to make use of a recognisable scale and the landmarks portrayed are often not readily recognisable [7].

The earliest 'proto-map' that seems to contain accurate depictions of relative distance is astronomical rather than terrestrial and shows the relative locations of The Pleiades [3]. Whilst this may not be used in the same manner as a conventional map would be, it nevertheless displays key skills utilised in the creation of maps. It is worth noting that primordial maps were most often not used for the purpose of wayfinding. One common use was as an aid to storytelling, another was to illustrate personal or social history. Arguably the most important use was to portray the spiritual landscape as perceived at the time. [7]

This draws a parallel with a common use of contemporary GIS software as it is using a 'map' to convey information only tangentially related to geographic/spatial data. It has often been remarked that prehistoric peoples had a great ability to create 'picture-maps' considering the level of technology available to them and that this ability seems to have independently developed in different areas rather than disseminated from a single point of origin. [4][5] From this it may be inferred that the creation of maps is a common step in cultural development.

1.2. Ancient cartography

As society has developed, so has cartography. [6] To illustrate this, there is evidence that precisely scaled maps were made in ancient Babylon in order to facilitate town planning [7] and that maps bearing geological and geographical features were used by the ancient Egyptians to aid them in quarrying the stone required for their devotional structures [8]. It would seem that maps were at this time largely used to provide information about the area they portrayed rather than as narrative aids [9] and thus that the knowledge they conveyed was largely of practical use. This contrasts with contemporary geographic information systems, where maps are used to show both socio-economic trends and geographical data.

1.3. Medieval cartography

During the medieval period, most maps were created for a specific purpose. It was unusual for a map to have multiple functions [9]. The most common categories of map found dating from this time are the world map, the portolan chart, and the regional or local map. A portolan chart is a detailed and spatially accurate map of a coastline and was used by a helmsman or navigator in order to allow them to avoid cliffs, reefs, sandbars and other hazards. Regional or local maps were used to allow navigation using easily identifiable landmarks and were often inaccurate with regards to distance. World maps were used to define the charted landmasses, to speculate on areas unexplored and to educate on religious and social matters [10].

These map types can be compared to projections used today, as they all portray similar data but differently displayed in order to emphasise desired aspects.

1.4. Renaissance cartography

During the Renaissance, independent efforts were taken by scholars such as Christopher Saxton [11], Bernard Wapowski [12], Nicolaus Cusanus [13] and Lázár Deák (Lazarus) [14] to compile the portolan charts and regional maps of the medieval period into spatially accurate and recognisable representations of the portrayed areas. Maps made in this period were greatly influenced by the desire for geographical accuracy rather than local information. To this end, maps detailing the fields of morality, literature and the thematic maps of previous ages, which are analogous to modern GIS aided maps, were considered unfashionable and thus were not often created [15].

1.5. Modern and contemporary cartography

The exact size, position and description of the major land masses are now publicly available. World maps are now precise and accurate, and are increasingly unlike their antecedents. Regional maps are also widely available and are often drawn using the same system of longitude and latitude that is used in world maps. Thus, modern day cartography is now primarily concerned with the combination of maps, whether global or regional, with data in order to create themed maps [16]. Examples of this may be seen in the maps of Europe created for the First World War [17] and in themed maps made using contemporary GIS technology. [18]

2. Use of data visualisation and thematic mapping in software

2.1. Case study

The case study used in this assignment is an analysis of the possible causes in the recent drop of immunisation rates in Swansea, Wales. The resources used in this analysis include those provided by the UK Data Service and the NHS Wales data service.

The primary statistic used to track the uptake of immunisation within Swansea was the percentage of 2-3 year olds in 2011 who were given their first MMR booster immunisations. This statistic was chosen as it ensures that all subjects within this category have had their first MMR immunisation and it eliminates the likelihood that the decision not to vaccinate was that of the subject rather than their guardian, thus concentrating the agency of decision.

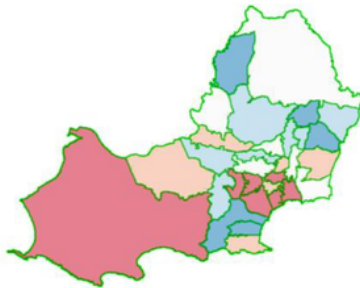


Fig. 1 - Areas of highest and lowest average vaccination uptake in Swansea, where red shows lowest uptake (82.2-92.7%) and blue is highest uptake (98.3-100%)

The data analysed in reference to this statistic were numerous, including average income per annum, Townsend index of area, average education level, average working hours, average availability of personal transport vehicle, area Multiple Deprivation Index, general health statistics and hospital admissions due to alcohol-related ailments.

2.1.1. Townsend index

The Townsend index is a metric created by Peter Townsend in order to accurately portray poverty within an area. It does this using four statistics: unemployment, non-car ownership, non-home ownership, and household overcrowding. [19]

It was initially assumed that there would be a loose correlation between area Townsend index and vaccination uptake, but upon examination no correlation was observed.

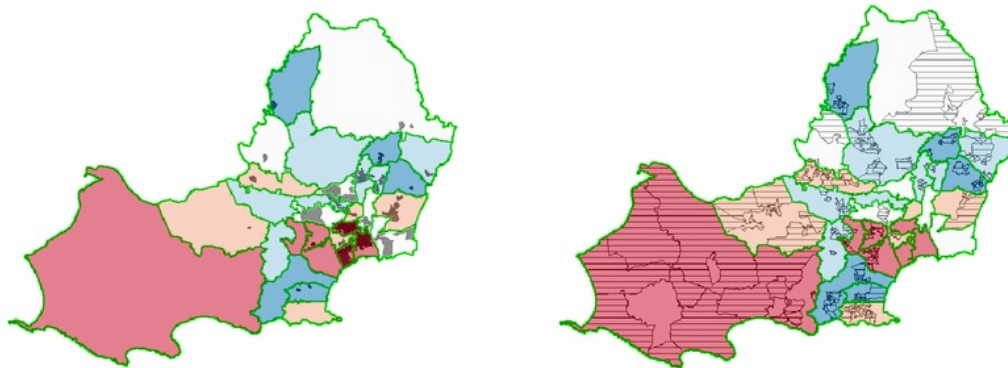


Fig.2 - Comparison of Townsend index and its effects upon vaccination uptake. Areas with a high Townsend index are shown as darker areas (left) and low index are shown as striped (right).

2.1.2. Multiple Deprivation Index

Area Multiple Deprivation Index was then analysed, in order to clarify previous results. Similar conclusions were drawn, based upon the fact that areas with both the highest and lowest deprivation index contain both high and low uptake averages.

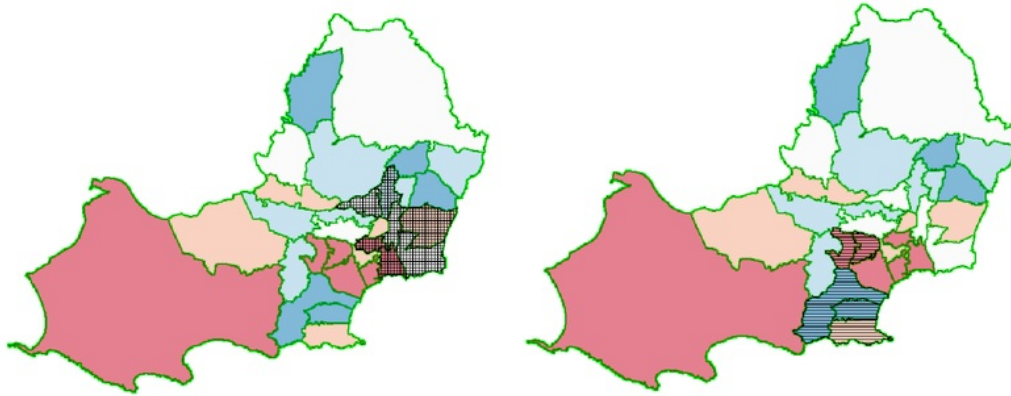


Fig.3 - Areas with a high multiple deprivation index are shown as hatched on the left, and those with a low multiple deprivation index are shown as striped on the right.

In further exploration of these findings the component statistics that make up the multiple deprivation index were then analysed, namely: income, employment, health, education, access to services, community safety, physical environment deprivation and housing quality. Of these, three correlations were observed. Firstly, there is a loose positive correlation between areas with least physical environment deprivation and greater vaccination uptake, as the two lowest quintiles contain only areas of moderate to good uptake.

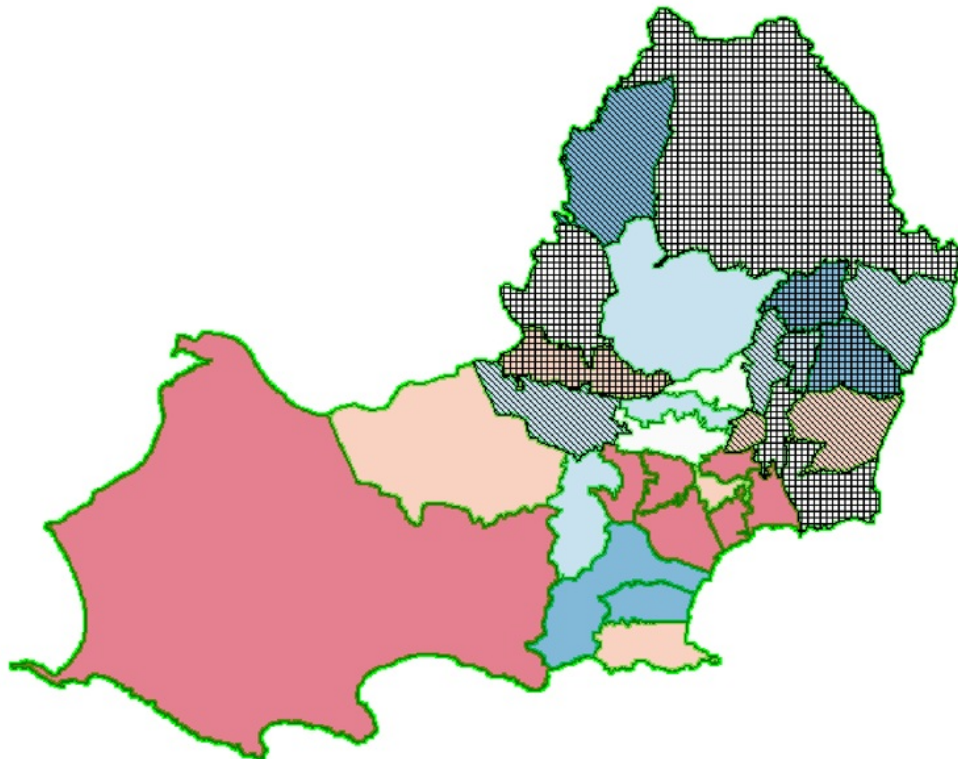


Fig.4 - Aggregate of the two lowest quintiles for physical area deprivation, displayed as checks and stripes respectively.

This may not be considered a strong correlation however, as the upper three quintiles each contain equal numbers of high and low-risk areas.

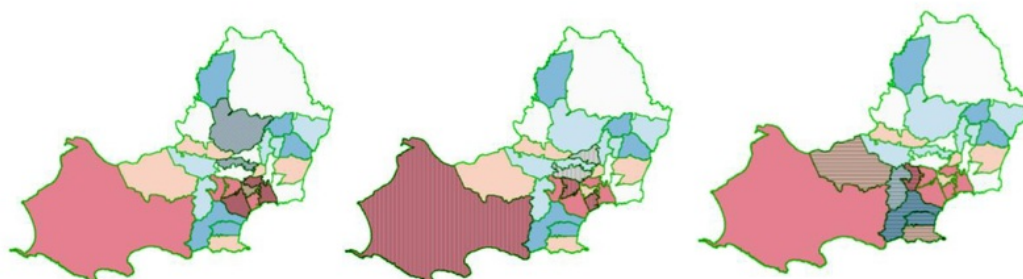


Fig.5 - Three higher quintiles of area physical deprivation, shown from left to right. It is important to note that the total area shown in the central image would initially seem to indicate strong correlation, but this larger area is sparsely populated and so should not be weighted much higher than the others shown.

Secondly, there is a weak negative correlation between the area average level of education and the average vaccination uptake.

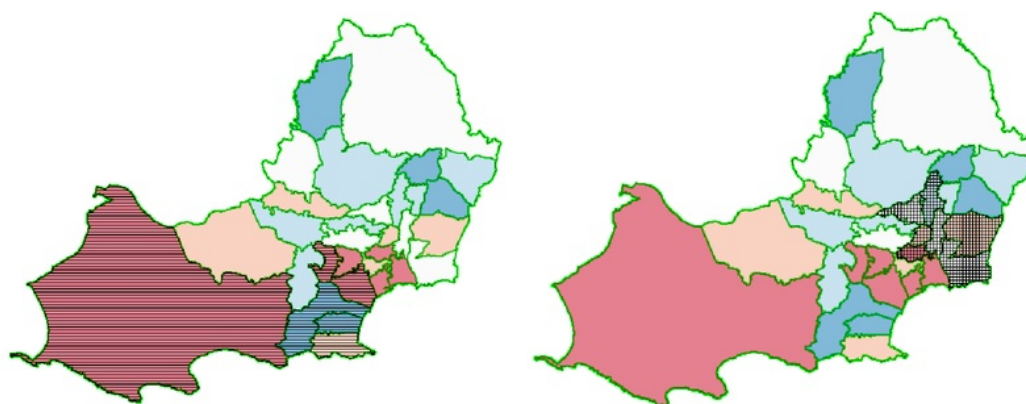


Fig.4 - Areas with a high level of education are shown as stripes on the left, and those with a low stated level of education are shown as hatched on the right.

In the above figure (left) the areas with a high level of education include a majority of high-risk zones and contain relatively few low-risk zones. By contrast, the areas with a lower level of education (right) contain a majority of low-risk zones. However, it is worth noting that the two low-risk zones contained within the high-education area are ones within the lowest band of risk.

Finally, there is a moderate positive correlation between a greater area ratio of part-time workers to full-time workers and immunisation uptake.

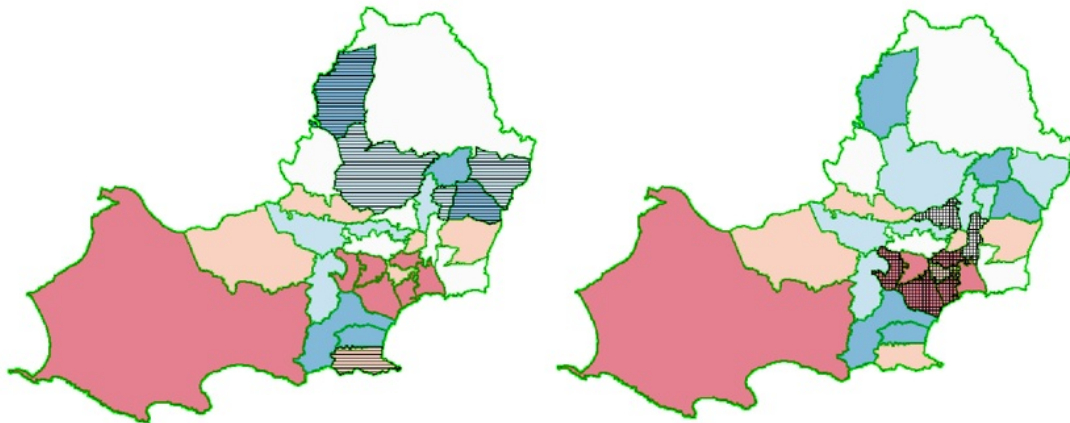


Fig. 5 - Areas with a ratio of between 2.3 and 2.73 part-time workers to every full-time worker are shown as stripes on the left, and areas with a ratio of between 0.93 and 1.9 part-time workers to every full-time worker are shown as hatched on the left.

Of particular note is the second quintile (between 1.9 and 2.06) as it includes the areas previously observed to possess both a high education and a high vaccination uptake.

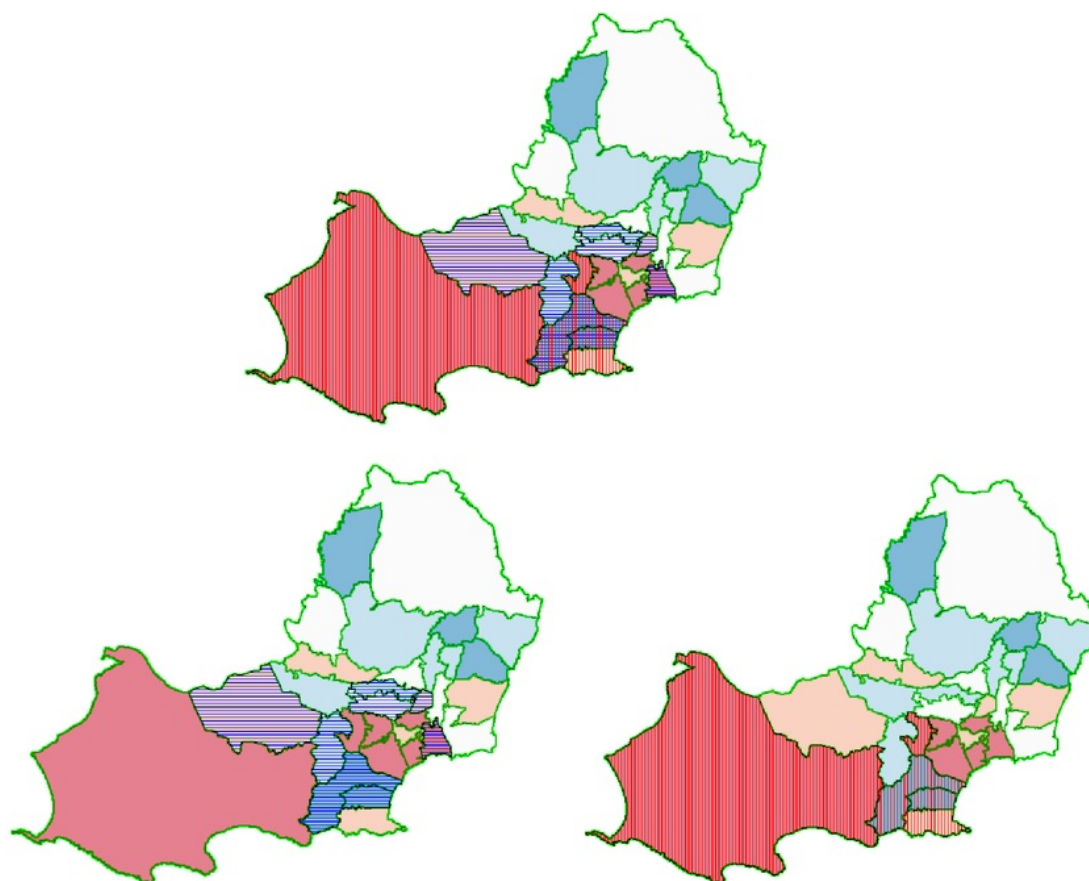


Fig 6 - The second quintile of part-time to full time workers is shown using blue horizontal stripes on the top-left, and the areas of highest education are shown on the top-right. A combination of both is shown below.

It is thus postulated that the greater factor in the variance of vaccination uptake within Swansea is the ratio of full-time to part-time workers, with level of education and physical environment deprivation being less important contributing factors. One possible explanation for this could be that guardians working part-time within a family may find it easier to schedule and attend appointments to vaccinate their wards, whereas guardians working full-time in a family may not be able to.

3. Types of data involved in geo-information systems.

Data types commonly used:

3.1. Geocode

'Geocode' is a term used to describe an item of data that precisely designates a location upon the earth. Examples of geocodes include specific place-names, postcodes, zip codes, Ordnance Survey grid references and latitude/longitude tuples.

3.2. Projection

In cartography, the term 'projection' is commonly used to refer to the mathematical model by which the spherical surface of the earth is rendered onto a two-dimensional plane. Many projection models exist, the use of which is determined by the emphasis desired.

3.3. Statistic

This is used in generating overlays or 'themes' that may display pertinent data on a map. Examples of this can be seen above.

3.4. Rasterised image

A rasterised image is one that is stored as a collection of pixels with attendant colour values. Rasterised images do not require a great amount of processing power to render but sacrifice quality on close inspection as they have a fixed level of definition and any attempt to scale past this will result in 'blocky' edges. Rasterised images are difficult to compress losslessly due to the nature of their encoding.

3.5. Vectorised image

A vectorised image is one that is stored as a combination of shape vectors and colour values. Vectorised images require more processing to render than rasterised images as they are generated from their component parts rather than read from file in a coherent fashion. As vectorised images are stored as relatively-spaced objects, they are well suited to scaling and transformation. Vectorised images may be compressed losslessly due to the interconnected nature of their encoding.

4. Bibliography

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GRADEMARK REPORT

FINAL GRADE

72/100

GENERAL COMMENTS

Instructor

22,27,11,6,6 (72)

1) An excellent introduction with some interesting research that you use well to reflect on the available modern day technology. Your comparison of old and new shows great insight and understanding. The University has a vast collection of Portman/thematic maps at the Lampeter library.

2) With reference to your case study please place a legend with your map displays. Fig 2 provides a great visual but again no map legend so it's difficult to instantly interpret the data. (But if affluence is portrayed in red then there is less of an uptake in these areas).

3/4) You have used your data well and presented some great visuals but again I reiterate without the map legend contained within your report it can become a bit laborious to plough through text before we get to understand opinion on the stats.

In one area there was somewhat confusing because you use the same colour for your MR theme and your Townsend theme? This section was a little unclear.

5) However, you use the case study well and your final conclusion was based on the evidence that you provided in your GIS. You make an interesting point about full and part-time guardians which could promote further investigation. Interestingly, part-time working guardians usually come from more affluent areas.

You do present some discussion on the types of data why not use this in your final conclusion which I feel was a little brief or non-existent. This is a shame because the overall structure and flow of your report was generally excellent.

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