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GIS as a tool for rural policy students

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Abstract:

GIS is taught to most surveying and property management students as a tool for managing mapped information and property databases. Sophisticated spatial analytical techniques are not usually addressed as it is thought that these are too complex for non-GIS specialists to learn within a limited timescale, and probably not relevant to their core subject areas in any case. This paper would challenge these assumptions, from the premise that many of these students, when in practice, will be working with spatial policy decisions, either as policy makers themselves or as professionals responding to policy implications and implementation.

Working from this reality of the spatial nature of much policy decision making and the problems of implementation which have to be faced, I would argue that an understanding of the fundamental problems of the “mapping” the real world are core problems of policy studies. GIS is the fundamental tool now available to address these problems and so must be included within policy studies to the same extent as statistical and legal practices.

Key words: rural policy, spatial data, decision making, demographics

1 Introduction: teaching GIS in Policy Studies

Teaching GIS at graduate level has generally followed two routes; either GIS taught as a specific subject to GIS students, who then look for jobs in the GIS industries; or GIS regarded as one tool amongst many which are useful in all professions and occupations which have a need for spatial information or analysis. The author has worked in the latter route for over 10 years, incorporating GIS education and training into the syllabus of land and property surveying courses (Swindell 1998, 2000). For the most part, this has been focussed on general use of digital mapping systems to aid management decision making. Great use is made of overlay techniques to delineate areas of deprivation, flood risk, environmental degradation, rising or falling property values and so on. In the last two years he has been asked to give a number of presentations to students from both surveying and non-surveying courses on the use of GIS in rural policy studies. Building the learning resources for these students has emphasised that this is a technology and approach to data modelling which has enormous potential in this area, but is largely unknown or misunderstood. Students tend to think just in terms of digital forms of traditional mapping and give little thought to the use of dynamic data modelling to explore scenarios or test the reliability of published or surveyed data. The potential for the use of GIS as an aid to policy implementation and retrospective appraisal is largely unknown. This is surprising because of the enormous influence of spatial distribution, regional segmentation and demographic variability on policy. This is the case for all forms of policy, but this paper will concentrate on rural policy as the author's main area of interest.

2 What is policy?

Policy can be thought of as a set of defined rules by which public resources are distributed, collected or otherwise managed. More formal definitions have been made, often getting bloated by semantic detail, but Sanford (1985) makes a simple statement:

...we can provisionally define a policy as a set of decisions which are oriented towards a long-term purpose or to a particular problem. Such decisions by governments are often embodied in legislation and usually apply to a country as a whole rather than to one part of it." Sanford also makes the point that policies generally aim at long term outcomes and management, which may be implemented through a range of short to medium term plans and projects.

Policy generally has a strong political dimension and will vary widely between countries due to the individuality of governments and the different philosophies of development they espouse and promote. Thus policies for population control, for example, may differ greatly between countries with different religious or political systems. Very strong controls are exercised by countries such as China, whereas countries with strong Roman Catholic or Islamic religious establishments will oppose many forms of population control which are taken for granted elsewhere (Potter et al 2004). There are clearly no globally acceptable policy rules and international diplomacy functions largely to help manage these differences as far as possible.

2.1 Spatial dimensions of rural policy making

Regardless of political system, all countries have ranges of policies; national, urban, social, rural or whatever, which they attempt to impose to some degree on their citizens. Almost all aspects of policy have a spatial component and this is especially true of rural policy. Location and place invariably matter. Countryside Stewardship Schemes (DEFRA, 2001) only apply in the countryside (where is it?). Urban regeneration policies only apply in urban areas (where do they start and finish?) (Campari 1996). Even plans to manage and control the growing of genetically modified (GM) crops have a fundamental spatial basis. Crops must be planted a specified distance from non-GM crops, and farmers can request the establishment of GM-free zones under new policy guidelines (DEFRA 2006a) Policies are either developed using information from specific locations, which can be seen from the vocabulary used to describe them, e.g. concentrations of target ethnic populations, defined regions of investment need, areas at-risk of flooding; or they are applied to specified locations (regional policies, contaminated areas policies, managing pockets of high unemployment, up-land protection policies, deprived area policies, etc.). All of these highlighted words speak of place, and often very hard to define or locate places.

2.2 Geographic problems of policy

Even without the use of GIS, policies have always involved sophisticated and complex handling of spatial analysis. How is the boundary of a "region" of high unemployment defined? How can data collected from census enumeration area returns be used to develop policy for administrative areas which do not correspond to those census area boundaries? (Martin 2001) These perennial policy problems are classic examples of the *ecological fallacy* ("inappropriate inference from aggregate data about the characteristics of individuals" Longley et al. 2005:147) and the *modifiable areal unit* (MAU) problem ("Chance or design might ... create apparent spatial distributions which are unrepresentative of the scale and configuration on real-world geographical phenomena" Longley et al 2005:148) The MAU is a particular policy problem and recurs continuously during policy development. How can demographic statistics collected from census wards be used to develop health care policies administered through local health authorities which are not congruent with those census wards? As the ecological fallacy emphasizes, policies are developed from the aggregate needs of large groups but are applied ultimately to individuals who may actually have quite different, possibly opposing needs. GIS will not solve these problems, but it does make it easier to study and address them through its abilities to handle the analysis of large datasets at high speed and generate humanly readable visual outputs (maps) from that work. (Longley et al 2005). But maps have their own inherent problems, which are graphical reflections of the ecological fallacy and MAU problem. They are simplified, generalised models of a hugely complex reality.

2.3 Cartographic problems of policy

The problems of policy design and implementation also include some of the classic problems of cartographic design. Defining a region of high unemployment is difficult enough, but before that can be done the very definition of what is “high” must be addressed. Is it a chosen rate above the national average? Or is it a chosen fixed percentage, say 10% or 15% of the adult population? The region encompassing an average unemployment of 10% is likely to be very different from that encompassing an average of 15% . There are no simple answers to where the break points in any scale should occur and there is often a suspicion that breaks are chosen on a very pragmatic basis, either to hide problems or make them solvable. (Monmonier 1991)

A simple example of the problems of break points in rural policy can be illustrated by the definition of “upland regions”. Upland areas are deemed, in the UK, to have particular problems because the height of the land can lead to ecological, topographic and meteorological conditions which make many modern farming systems inefficient and traditional systems uneconomic. Policies are therefore developed to support these areas (and therefore the individual farmers within these areas) to try to maintain the economic and landscape qualities of the areas. But how do you define upland? Using a biological definition (Tayside Biodiversity, 2005) upland lies “...above the upper edge of enclosed agricultural land, usually around 300 - 400 metres”. If upland policies are applied to areas above 300 meters, the supported areas will be quite different from those if the break was set at 400m (figure i and ii)

Choosing the higher break point will eliminate all upland areas from at least two political constituencies and so lose policy support for farmers in those constituencies (figure ii). This will certainly concern the political representatives of these farmers, who may lobby for changes of definitions. Politicians from the geographically higher constituencies may wish to argue for the higher break point so that resources will be more concentrated in their own areas. Whatever decision is taken will find supporters and opponents, there is never a correct answer.

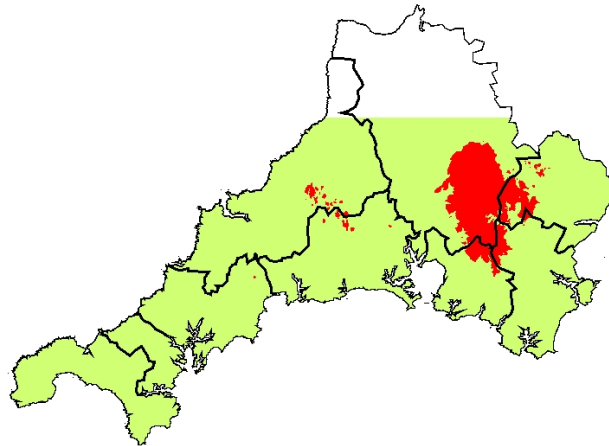


Figure i SW Peninsula of England, showing areas over 300m and political constituencies.

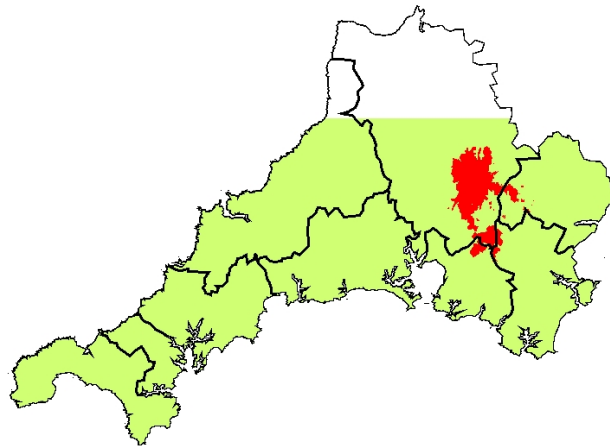


Figure ii SW Peninsula of England showing areas over 400m and political constituencies

The upland definition problem does not just end there, as Tayside Biodiversity (2005) go on to say “...but descending to near sea level in north-western Scotland”. Does it descend to near sea level in South West England? Difficult decisions must be made to ensure policy implementation is possible, but the results can be very arbitrary and will undoubtedly be seen as unfair by those individuals adversely affected. The problem of definition is recognised, but without any attempt at solution, by central government “Although there is no statutory definition for the 'Uplands', areas above the upper limits of enclosed farmland containing dry and wet dwarf shrub heath species and rough grassland are referred to as such.” (DEFRA 2006b)

These classical cartographic problems are also exacerbated by the MAU problem mentioned earlier. It may be possible to define a region with a particular problem such as high unemployment quite clearly and accurately. Surveys and census can define location of unemployed people and the concentrations of the unemployed can then be mapped out with some confidence. (GIS density mapping tools can do this very effectively, as the author demonstrated in mapping the densities of medieval Scandinavian settlements in the UK) (Culpepper 2005:7) However, that mapped region is very unlikely to match administrative units, which are most commonly used as a basis for policy implementation (figure iii).

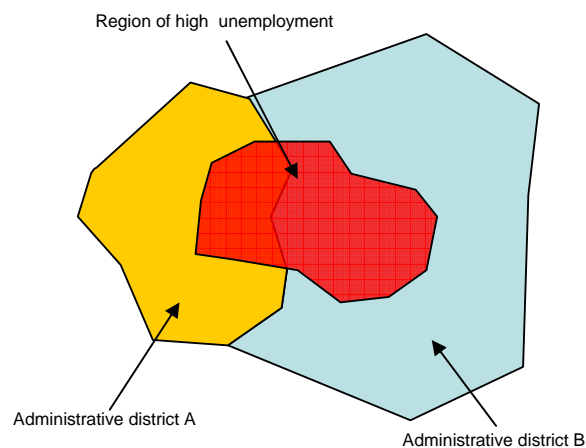


Figure iii A region of high unemployment may span over several political districts. The average unemployment in each district may be below the threshold defining “high” unemployment. Policies are likely to be applied at district level, so no special measures for tackling unemployment will be put into place in this circumstance

This problem of the modifiable areal unit can become so complex that many areas of national policy making may be completely incompatible. Raper et al in 1992 identified 23 different classes of areal units used in the UK ranging from “countries” (there are either four or six in the UK, depending on how you classify the Isle of Man and the Channel Islands) to census wards (10,044 census wards in 1981; 175,000 census “output areas” in 2001) (ONS 2006a). Few of these units coincide or nest with others, leading to near meaningless confusion.

3 Modifiable areal unit problem in policy making

The difficulties raised by the MAU have been mentioned repeatedly and all parties working with policy, either as citizens or governors, are well aware of the problems, even if they do not use the explicit terminology. The very pejorative term of “gerrymandering” arises from a politician trying to define the shape an electoral ward that would inevitably result in his party’s electoral victory. In more recent times, the boundary of “Northern Ireland” was defined to ensure that it contained a majority of Protestants within it and so in any plebiscite would choose to stay in the union with Great Britain. The areal units were clearly being defined to ensure a predetermined political outcome.

Despite this poor record, there is a desire to improve the fit of political areal units so that there is some confidence in the congruence of the distribution of actual problems and the policy implementation intended to alleviate them. The problems arise from the multiplicity of areal units and the indeterminacy of their boundaries.

3.1 Multiple areal units

As mentioned, Raper et al (1992) identified 23 classes of administrative areal units in the UK, including district health authorities, local education authorities, European Constituencies, Counties, Police areas and even commercial television regions, which are used for the implementation of a number of regional policies. (This is probably because the typical citizens have a better idea of which regional TV broadcast they can receive than of which arbitrarily defined geographical areal unit a politician has chosen to allocate them to.) It should also be noted that there have been so many changes of government, local government reorganisations and endless tinkering with health and education regions and policies that the number of areal unit type is almost certainly now far higher than this 1992 listing.

There have been attempts at bringing some sense to this chaos, most importantly in the preparation for the 2001 national census in England and Wales (Scotland and Northern Ireland have separate censuses, so UK comparisons are surprisingly difficult to establish). Martin (2001) sets out in clear detail how the problems of comparing statistics between decadal censuses, because of differing data classes and in particular, because of differing shaped census enumeration districts, has weakened the reliability of this commendable long term data gathering process. For 2001 an attempt was made to both automate the creation of the fundamental enumeration districts (the physical areas within which census staff collect data) and the output areas, which are yet another new areal unit, which are the areas for which census data is published. (Enumeration district figures are kept private as they are so small that the confidentiality of citizens within them may be jeopardised.) These output areas attempt to combine the enumeration districts, postcode areas (which are widely used for commercial purposes now) and political administrative units. The process is complex but automated within a GIS. The output areas are grown from the fundamental enumeration districts, but based on the postcodes of addresses, so that to a large extent, particularly within urban areas where the bulk of the population resides, the outputs relate to specific postcodes, but not necessarily to defined postcode areas. These new polygons are further refined by clipping them to the borders of administrative units, so that the polygons are constrained both by the postcode boundaries and the administrative boundaries. The resulting polygons are further refined to simplify what may

be overly complex shapes (Martin 2001). It is clumsy but gives useful regions. Where the real test will come will be in 2011 when the next census takes place. The correlation between postcodes, administrative and enumeration areas will all have changed to greater or lesser extents, so the match between sequential output areas may be less than perfect.

3.2 Indeterminate areal units

Defining administrative and census polygons is difficult, but the final boundaries chosen are quite clearly defined, if open to dispute. A further problem of policy *implementation* arises from the usually indeterminate boundaries of areas of need, which policy may set out to address. Regions with particular health problems do not match health administration regions, but are defined by the location of the instances of the problems. A recent, non-human case of this was the foot and mouth disease (FMD) epidemic in the UK in 2001 (Swindell 2001). The occurrence of the disease was published on a county basis, but as these varied hugely in size, it gave a very false impression of the true location of the disease outbreaks. Whilst, for example, the county of Gloucestershire was listed as an infected region, the distribution of the cases within the county was very uneven, with some areas having no presentations of the disease at all (fig. iv).

FMD is very contagious and moves very fast. For this reason policies on the restriction of animal movements had to be implemented as rapidly as possible, but using existing administrative units for this was very ineffective, for the reasons given about the distribution of the disease. The then Ministry of Agriculture Food and Fisheries (MAFF, which was replaced shortly after this epidemic, largely because of its perceived shortcomings in dealing with it effectively) addressed this by defining fairly arbitrary restriction zones, based on a combination of buffer zones around known cases and predicted wind patterns, as it was feared, probably incorrectly, that the disease vectors could be air borne (fig v). The problem with this approach was actually communicating the location of these regions to the farmers and the general public. They do not match any accepted boundaries. They were published on the internet, but in 2001 this did not reach the majority of the public, and in any case, there was nothing on the ground to indicate where the boundaries actually were.

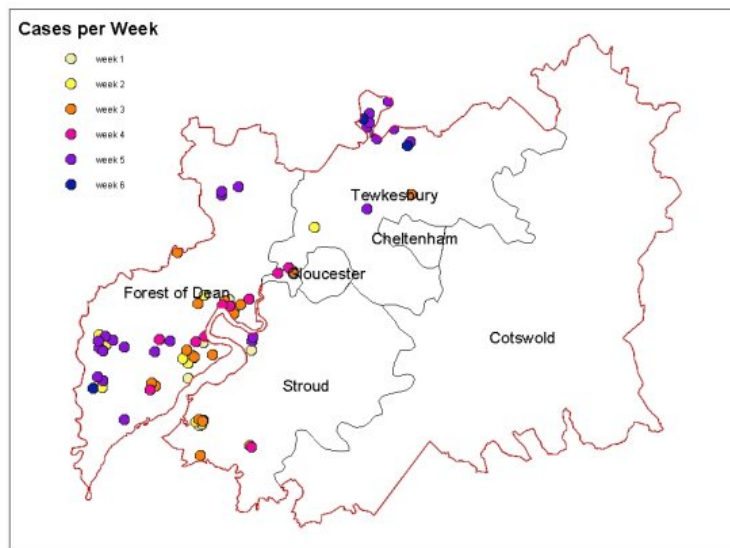


Figure iv Actual location of FMD cases in Gloucestershire, with the local governments districts shown in outline.

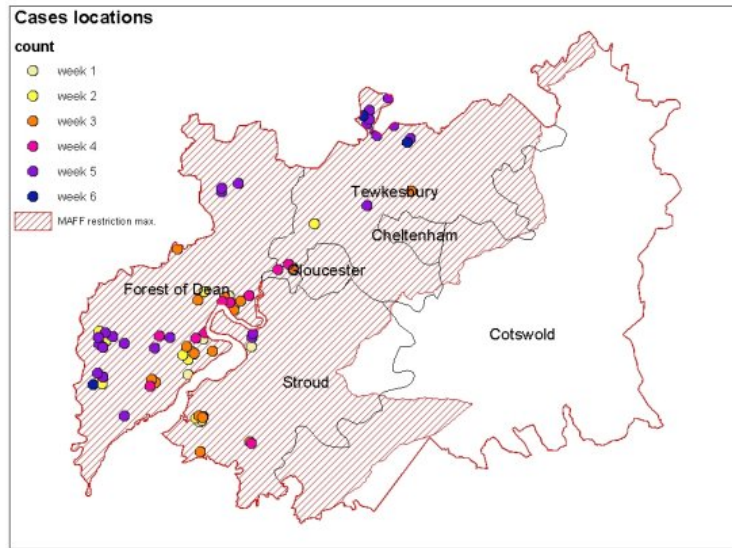


Figure v Restricted areas in Gloucestershire, where no animal movement was permitted

The author published alternative maps to show the infected areas, based on density mapping of individual cases (Swindell 2001). This gave a tighter definition of the infected areas (fig vi) but could still not address the problem of communicating and defining these areas on the ground as rapidly as they needed to be. This last map also shows the problems of working within arbitrarily defined boundaries. The concentration of cases in the north of the county was in fact part of a region of very heavy infection which overlapped into the adjacent counties of Worcestershire and Herefordshire. This is a real example of the problem demonstrated in figure iii, where a major problem is divided over several regions and so is recorded as not so significant in each one.

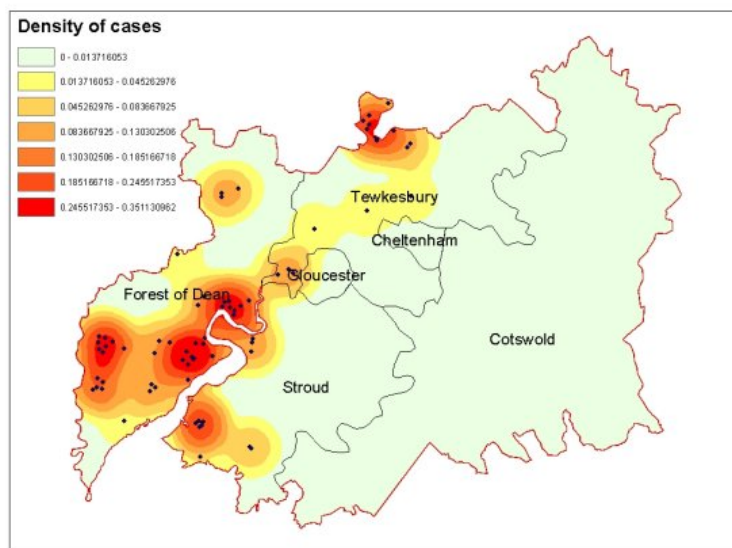


Figure vi Density map, based on actual outbreaks, showing concentration of disease hotspots. (Swindell 2001)

4 GIS in policy studies

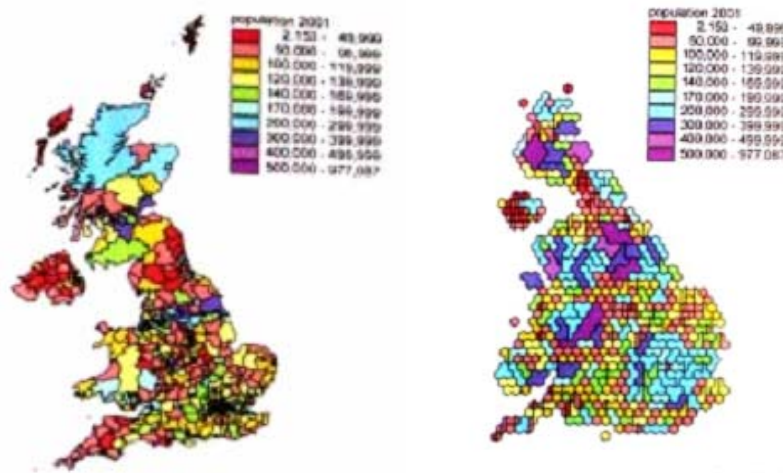
It is clear from the foregoing discussion that studying, defining, creating and implementing policy is fraught with problems. Many of these problems are spatially based. GIS cannot solve them, there is no “solution” to the modifiable areal unit problem. What GIS can do is help with studying these problems and making them apparent. Differing scenarios can be rapidly modelled and the potential outcomes studied. Sensitivity testing of break points in statistics can be mapped. Different policy outcomes can be overlaid and combined by map algebra. GIS tools and algorithms were, for example, extensively used in automating the generation of the census output areas in the most recent England and Wales census of 2001 (Martin, 2001). Policy makers must have at least a grounding in these processes if they are to understand how the areas have been defined.

One feature that becomes apparent when working with policies is that ultimately they apply to or effect people, not geographic regions. It makes little practical difference to the landscape how it is classified. The changes will come about from the changed behaviour of people in those landscapes, which is what policy is aimed at managing. Despite this, much policy is based on geographical regions because it is believed that tailoring policy to individuals is just too big a project to be tackled. There are over 60 million people in the UK with over 600,000 births and 500,000 deaths in England and Wales in 2004 alone (ONS 2006b). However, this may change. These numbers do seem big, but in a computerised world of megabytes, gigabytes and increasingly terabytes, are they really too big to manage? The time may be approaching when policy can really move from a geographical basis to a demographic one.

4.1 Demography, not geography

It is unlikely that policy implementation will ever move far from a geographical basis. It is difficult to explain to people living on one side of a street why they receive differing services from those on the other side, simply because the county line runs down the centre of the street. However, this split *can be* explained and everyone is familiar with the term “We’ve got to draw the line somewhere” (a cartographic term *par excellence*, usually delivered with a shrug of the shoulders, but which has led to millions of untimely deaths in Kashmir, Bosnia, Palestine, Israel.... Examples of the power of maps as determinants of political action) (Wood 1992).

In terms of policy development however, it is increasingly possible that it will be developed on a demographic basis. Several attempts have been made to go beyond the simple cartographic delineation of *geographical* space to people centred *demographic* space. Recent work by Thomas and Dorling (2004) has attempted to redefine the “shape” of the UK in terms of population concentrations. This still retains a link to administrative units, political constituencies in this case, but the units have been expanded and contracted on the basis of the numbers of people in each constituency, rather than the geographical extent. Building a geometry from these distortions is achieved through the use of nesting hexagons. The result (figure vii) is still remarkably recognisable as the UK, but the dominance of the large conurbations (London, Glasgow, Manchester etc.) become clear. This approach, as it develops, may give a better fit between allocation of resources and number of citizens benefiting, but it does raise the spectre of communities in lightly populated areas (the rural countryside) being marginalised even further than they already feel to be the case. It is estimated that 75% of the population of developed countries is in urban areas (Moor 2002). This does give rise to concerns, which are entrenched in the UK, that rural problems can largely be ignored, as they can never comprise a majority of the electorate (Countryside Alliance 2005). The tyranny of the (policy of the) majority, to misquote de Tocqueville (1862), is a real fear in the countryside.



(After Thomas and Dorling 2004)

Figure vii A conventional representation of UK political constituencies (on the left) based on geometrical shape and size, with Thomas and Dorling's representation of the same data mapped on hexagon based units based on the population size within them. This is a mapping of demography rather than geography.

5 Conclusions

Policy is difficult. It is difficult to make, to implement, to administer and to appraise. This will never change. A policy benefit to one party will be a deficit to another. Compromise is inevitable, which can only be supported if there is an openness in how policy is developed and implemented, and if policy is flexible enough to address inevitable shortfalls. Most policy makers are familiar with problems of demographics, statistical averaging and sampling. GIS is an extension to this, and a powerful one. It makes the spatial aspects of policy accessible and manageable in a way that has not historically been possible before. It enables policy makers both to study a problem and publicise their intentions and for these reasons alone it is becoming an increasingly important component in the education of future policy makers. They may not yet be familiar with the terminology of GIS, but they have been grappling with the common problems of geography and cartography ever since two tribes first tried to demarcate their own tribal lands. We have not really moved very far beyond that in political terms and probably never will.

6 References

- Campari I. 1996 'Uncertain Boundaries in Urban Space' in *Geographic Objects with Indeterminate Boundaries* Burrough P. and Frank A. (eds) Taylor and Francis 1996 pp 57-69
- Countryside Alliance (2005) *Rural Policy Handbook* Countryside Alliance
- Culpeper J. 2005 *History of English* Routledge
- DEFRA 2001 *The Countryside Stewardship Scheme*
<http://www.defra.gov.uk/erdp/pdfs/cssnews/060CSSIntro.pdf> (Accessed July 2006) Dept. for Environment, Food and Rural Affairs
- DEFRA 2006a *Secretary of State Margaret Beckett's statement on GM policy*
<http://www.defra.gov.uk/corporate/ministers/statements/mb040309.htm> (Accessed July 2006) Dept. for Environment, Food and Rural Affairs

- DEFRA 2006b *Uplands Land classification* <http://www.defra.gov.uk/rural/uplands/land-classification.htm> (Accessed July 2006) Dept. for Environment, Food and Rural Affairs
- Moor J. 2002 'Urbanization' in Falconer A. and Foresman J. (eds) *A System for Survival: GIS and sustainable development* ESRI Press 2002 pp 49-51
- Longley P., Goodchild M., Maguire D. and Rhind D. 2005 *Geographical Information Systems and Science 2nd Ed* Wiley
- Martin D. 2001 *Geography for the 2001 Census in England and Wales* <http://www.statistics.gov.uk/census2001/pdfs/georoadshowpaper.pdf> (accessed July 2006) Office for National Statistics
- Monmonier, M. 1996, *How to Lie with Maps* Chicago University Press
- ONS, 2006a *Output Geography* <http://www.statistics.gov.uk/census2001/op12.asp> (accessed July 2006) Office for National Statistics
- ONS, 2006b *Population* <http://www.statistics.gov.uk/ci/nugget.asp?ID=6> (accessed July 2006) Office for National Statistics
- Potter, R., Binns A., Elliott J. and Smith D. 2004, *Geographies of development 2nd ed* Pearson Education
- Raper, J. Rhind D. and Shepherd J 1992, *Postcodes, the new geography* Longman Scientific and Technical
- Sanford S. 1985 *Better livestock policies for Africa* International Livestock Centre for Africa
- Swindell J. 2001 'Tracking the Course of a Virulently Contagious Disease; the Foot and Mouth Epidemic in the UK', proceedings of *International Conference on Agricultural Science and Technology*, Beijing vol. 6 pp 548-556
- Swindell J. 2000, 'GIS in the field; introducing spatial analysis as a basic skill to agriculture students' proceedings of *EUGISES 2000 Second European GIS Education Seminar*; University of West Hungary, Szekesfehervar, Hungary
- Swindell J. 1998, 'GIS and the Rural Surveying Student: giving specialist skills to the non-specialist', proceedings of *FIG '98, XXI International congress, Commission 2, professional education*. International Federation of Surveyors: Brighton pp 274-286
- Tayside Biodiversity, 2005, http://www.taysidebiodiversity.co.uk/Section2_Upland_U2.htm (access July 2006) Perth and Kinross Council
- Thomas B. and Dorling D. 2004, 'Advances in Human Cartography of the UK' *Cartographic Journal* Maney 41/2
- de Tocqueville A 1862 *Democracy in America* Server and Francis
- Wood, D. 1992, *The Power of Maps* Routledge