GIS and Geographic Governance: Reconstructing the Choropleth Map

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Abstract

This paper takes up the challenge of "reconstructing GIS" by examining GIS and governmental rationality. As an aspect of government, mapping is a vital source of geographic knowledge that informs political decision-making. Of particular importance to geographic governance and management are population distributions such as health, wealth, education, density, or criminality. Yet how these distributions have been mapped has shifted and been contested historically. Whereas in the early nineteenth century populations merely filled in pre-existing political areas, by the early twentieth century populations were understood as themselves defining areas and boundaries. Today, GIS has returned to the earlier unproblematic politics of space. I explain these shifts by identifying similar shifts between the choropleth and the dasymetric map. Although commonly used, the choropleth is inadequate and misleading. I discuss the possible reasons for these shifts by re-emphasizing mapping as an aspect of geographic governance.

Keywords: governmentality, GIS, thematic mapping, choropleth, dasymetric

Introduction

In this paper I discuss maps and mapping as ways of politically understanding the distribution of populations across geographic territories. I show first that mapping is a critically important aspect of geographic governance, by which is meant the political decision making, policies, and management of people in place, taken in very general terms. Second, I argue that the particular techniques of mapping both reflect and constitute specific ways of framing and solving problems of governance. That is, maps actively demonstrate current political thinking and at the same time help determine how that thinking will proceed and be carried out. I argue that historically we can trace significant changes in the way that population has been understood. In the early nineteenth century when thematic mapping was invented by political economists, the question of population was one of knowledge about particular places as defined by political boundaries, and the people who occupied those spatial units – from (unproblematic) place to (problematic) people. However, by the early twentieth century, when cartography was formalized as a discipline by cartographers, the emphasis was reversed: now place was to be understood by the density and characteristics of the population that actually constituted it. The hinge that connects these two moments is the famous 1874 *Statistical Atlas* of the first census following the Civil War (Walker 1874, Hannah 2000). The possibility before us now is that we will grasp the dynamic relations between place and people in a more mutual fashion, "reconstructing" GIS in a more politically progressive manner. Maps are stories we tell about ourselves, but they are stories with political payoffs (Crampton 2003a).

In this paper I shall examine the 120 year period from approximately 1820–1940, when the choropleth map underwent a complete reassessment as a way of understanding people and place. Invented in 1826 and at that time incredibly popular, by the time it was named in 1938 it was dismissed as an inadequate technique. Today, the choropleth is again one of our most common mapping techniques, being easy to produce by GIS and digital cartography software. Yet despite its popularity, the choropleth has many limitations for understanding spatial distributions. By contrast, the lesser-known dasymetric map has many advantages and none of the disadvantages of the choropleth, although it is harder to create in GIS. I call for increased usage of the dasymetric map in GIS in the recognition that it will help reconstruct GIS to be both more socially relevant and politically meaningful.

Mapping as Geographic Governance

What does it mean to say that maps and mapping are an aspect of governmental rationality? The concept of governmentality – the governance of oneself and of others – was first formulated in the work of Michel Foucault during the 1970s (Foucault 1978, 1991, 2003). Subsequent studies have applied the concept in a number of domains, including policing (Donzelot 1979), analysis of

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political power (Rose and Miller 1992), and, in geography, as a way of grasping how the census framed spatio-political problems in nineteenth-century America (Hannah 2000).[1]

The attraction of "governmentality" is that it provides extremely fruitful grounds for analyses of societal power relations. First, Foucault's approach was historical, and he was therefore able to emphasize the development over time of political thought and the strategies and technologies of government. Foucault and his colleagues were thus able to trace historical shifts between such different aspects of government as sovereignty, discipline, and government as political economy. Second, it has recognized other forms of government "beyond the state" (Rose and Miller 1992) and at different spatial scales. It is the purpose of this paper to understand GIS in the context of governmental rationality and to suggest grounds for "reconstructing GIS" more politically. Such a reconstruction I take to be the task of a "critical GIS," where the same historical analysis can yield insights into our present rationality and thus provide a launching pad for alternatives.

Governmentality is that rationality (thought, practice, conceptualizations, and discourse) that asks the question, What is government and how is it practised? The "art of government" is the question of who can govern, what is governed, how best to govern, and what governing is (Gordon 1991, 3). It is the *political* question of governing (Foucault discusses this question in his 1976 lectures at the Collège de France; see Foucault 2003). It thus includes efforts to administer hospitals, prisons, schools, businesses, the family, the police, and even the self (the subject of Foucault's second and third books in the *History of Sexuality* series, see Foucault 1985, 1986). In this paper I shall largely examine practices of government more generally. These practices (or what Foucault sometimes calls "technologies of power") are at work in contemporary GIS, most notably in the ways thematic mapping is deployed. It is the contribution of GIS and mapping to political decision making that we can call "geographic governance."

Governmentality first emerged as a specific and autonomous mode of thought in the sixteenth century, when rule was no longer thought of as just part of the "divine order" of the universe that some were ruled and others were rulers. It became an explicit problematic. In fact its most immediate problem was one of *knowledge*: how to know the state and all its interests. In order to govern, certain knowledge must be acquired about how things lie (including their spatial disposition), and of what outcomes had occurred when certain strategies of rule were applied. This knowledge was acquired through polls, observations, surveys, record-keeping, and censuses (the first French and English censuses were in 1801, the USA in 1790 shortly following independence). This "reason of state," as it was called, included knowledge of the strengths and weaknesses of the state, and where it was and was not vulnerable or at risk. It was not just any kind of knowledge that must be ascertained, but a kind of "political arithmetic" about *populations* rather than individuals. To put it schematically, it privileged the counting up of resources through techniques of statistics to reveal regularities, cycles of scarcity, epidemics, rising levels of labour, and wealth that could be quantified (Foucault 1991, 99). It was understood that specific interventions in these regularities could produce predictable effects.

With the advent of governmental rationality in seventeenth- and eighteenth-century Europe, there was an increased shift to administering resources constituted primarily as a population, and to manage those resources for the best possible ends. Residents of a territory were no longer subject to an all-powerful sovereign who could freely expend their lives, either in defence of his own life or for defence of his rule when externally attacked (i.e., through warfare). In the modern state, the concern for life is to administer it through controls and regulations so that resources might be rightly apportioned. Foucault traced two specific aspects of this shift: one centred on the individual through discipline and optimization of capabilities – an *anatomo-politics* – and one centred on the population as a "species body" or a *bio-politics* (Foucault 1978, 139; see also 25–26; 1991, 99–101; Foucault 2003, lecture of 17 March 1976). This shift had occurred by the eighteenth century, a sequence that is reflected in Foucault's own work by a shift from *Discipline and Punish* (Foucault 1977) to governmentality.

In the modern state, "governments perceived that they were not dealing simply with subjects, or even a 'people,' but with a 'population,' with its specific phenomena and its peculiar variables: birth and death rates, life expectancy, fertility, state of health, frequency of illnesses, patterns of diet and habitation" (Foucault 1978, 25). These variables were assessed in terms of what was normal, as ascertained through statistical measures of the population. What was the population's normal birth and death rate? Could these normal rates be disrupted (for example, through epidemics or early marriages)? What were the risks to the population through immigration of foreigners and other races? Were certain parts of the population more at risk than others (for example, were certain areas of the country more at risk because of lower educational attainment or because more foreigners were settling there)?

To be sure, the problem of knowing and counting a population was not unprecedented (recall the Domesday survey of England in 1086). In a 1977 interview Foucault explained that what was different about the modern state was (1) how *generalized* it became, (2) that *new knowledges* (such as demography and medical knowledge) were obtained, and (3) that "*apparatuses of power*" were established for observing and collecting information (Foucault 1980, 226). The mapping of populations can be understood therefore in very general and multi-

dimensional aspects (such as health, wealth, or criminality) that these understandings become formalized in new scientific disciplines (which occurred in cartography in the early twentieth century), and that this knowledge is intimately tied to power and politics.

Since the early nineteenth century, the disciplines of geography and cartography have been essential components of the question of territory, statistics, and populations – of geographic governance. Thus, I suggest that GIS today takes as its main problematic the question of knowledge about resources (people and things), which may be threatened or at risk (a question of security), or in short supply. What is the spatial disposition of these resources? Many GIS projects in local government, for example, are directed to mapping resources such as traffic flows, and that has implications for emergency vehicle routes, traffic-light timing patterns, speed limits, deployment of police, and so on. Federal government wishes to manage its parklands and wildlife areas (the first GIS in the 1960s was a government inventory of Canada to identify land resources and their use). Businesses wish to know where their potential customers are. All have in common the idea that resources need to be managed and risks to depletion of those resources avoided. Governmentality brings to the fore the fact that data collection and analysis are not done in isolation from specific governmental goals and ends as a political question and in a particular way.

In the next two sections I examine in more detail the shifting relations between mapping and governmentality, first in the early nineteenth century and then in the early twentieth.

EARLY THEMATIC MAPPING AS POLITICAL ECONOMY

Although mapping as such has been practised for thousands of years, it was not until thematic maps emerged – and they did so remarkably late – that populations and their distribution could be known. Unlike previous studies of the political in mapping (e.g., Edney 1997), my analysis is not focused on the relations between the state and "topographic" maps. Thematic mapping is a totally "modern" form of mapping and was developed and refined only from the late eighteenth century onwards. By the 1850s most of the types of thematic maps in use today had been invented. The choropleth map, for instance, was first known in 1826 (Robinson 1982). Choropleth maps were an excellent example of how thematic maps "speak to the eyes," as William Playfair wrote in 1802, and thus to contribute to a discourse of resource assessment. Playfair's own groundbreaking work on graphical statistics was itself directed toward political ends. His graphs of the balance of trade, for example, were published to urge the government to reduce its debt obligations to other countries (such as America).

The 1826 choropleth map depicts the ratio of (male) children in school to the population of each department in France. It was used by its author, Baron Charles Dupin, to identify *la France obscure* and *la France éclairée* (unenlightened and enlightened regions of the country). Scarce resources could now be targeted more efficiently (such as the building of more schools). There was tremendous contemporary interest in this map, and it was later credited with increasing the number of schools in France. It was much copied, and almost identical maps on a range of subjects (crime, education in the Low Countries, etc.) soon appeared. Yet it is significant that Dupin was not a cartographer; he had no interest in the map as a map (or the fact that he had invented such an important map type); rather, he was passionately concerned with "political economy" or the politics of production, distribution, and consumption of resources. Baron Charles Dupin exercised this interest as a member of the Académie des Sciences, being elected to the Chamber of Deputies in 1828 and a senator in 1853 (Robinson 1982; Konvitz 1987). Dupin made a direct linkage between the health of the nation and the education of the population: what is good for the nation is good for the population (Figure 1).

Other examples abound. In the United Kingdom, Henry Mayhew produced a remarkable series of choropleth maps by the 1860s (Mayhew 1861/1967). Mayhew's maps show each English county shaded according to whether its value is above or below the national average. Mayhew's fascination with the population is shown in his choice of map topics: the density of the population, the "intensity of ignorance" (illiteracy), and the rates of criminality, especially to do with factors that might affect fertility (rapes, early marriages, concealment of births, bigamy, etc.). Thematic or statistic maps did not arise in isolation from governmental ends, therefore, nor were they "tools" of the government; rather, they were part of a rationality of calculability of populations.

This rationality was late in starting in America in terms of statistical mapping, but it was finally spurred into action by the Civil War. The first census following the war took place in 1870, when there was an overwhelming need to reassess the stock of the country.

There was, then, a delay between the innovation of statistical maps in the early nineteenth century and the explicit conceptualizations of the science of mapping in the early twentieth century. Hannah's insightful analysis (Hannah 2000) of the 1870 census (Walker 1874) can therefore be seen as a study of the middle passage between the initial invention of thematic maps and the later "reinvention" of thematic mapping. Hannah's groundbreaking work is central to this argument. However, Hannah virtually ignores Walker's atlas itself as a project of knowledge formation.

For instance, in the preface and introduction to the 1874 atlas, Walker recounts how Congress was invited to fund it:

> ... the importance of graphically illustrating ... the ninth census of the United States, by a series of maps exhibiting to the

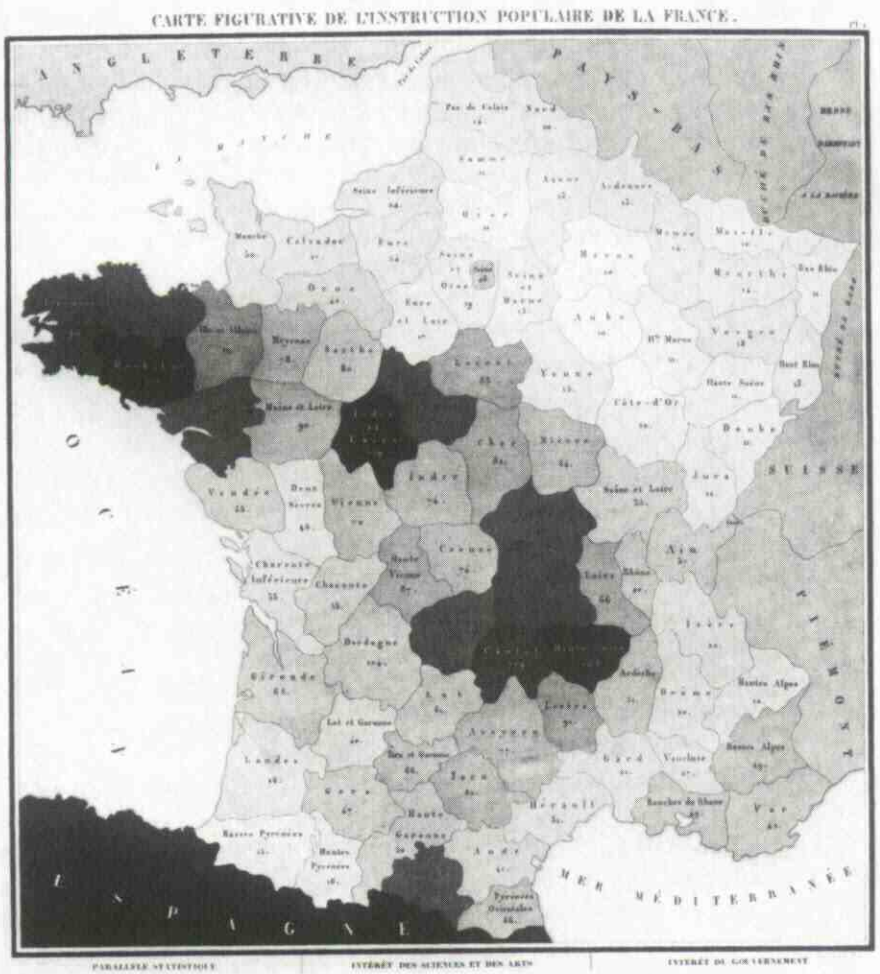

*Figure 1. The first choropleth map, by Charles Dupin in 1826, shows educational attainment by department. (*Source*: Robinson 1982. Used by permission of the Bibliothèque Nationale de France.)*

eye the varying intensity of settlement over the area of the country, the distribution among several States and sections of foreign population, and of the principal elements thereof ... the prevalence of particular forms of disease, and other facts of material and social importance which have been obtained through said census. (Walker 1874, 1)

In 1872, when Daniel C. Gilman had presented the second of two annual addresses to the American Geographical Society, he was able to show seven manuscript maps that demonstrated the nascent plans for the atlas (Gilman 1873). Gilman, who was then leaving his professorship of physical and political geography at Yale to head up the University of California, was one of the first American professors to hold a position explicitly in geography, and went on to become the first president of Johns Hopkins. He was also a close personal friend of Walker (Hannah 2000). The maps presented at that January 1872 meeting illustrated the density of the black population in several southern states, the percentages of foreign-born, and the relation between the two. The maps appear to be by county and state, and are probably choropleth in nature. But for his last map, Gilman asks us to pay particular attention to it,

first, because it is a map of the whole country; and second, because it is prepared with special study and care. It is intended to show us in what parts of every State the German element is most abundant, and then by making a deduction for this preponderance in certain regions, to show what is the average distribution in the remainder of the state. (Gilman 1873, 142)

In other words, Gilman is here describing one of the very first statistical dasymetric maps that were such an innovation with the Walker atlas (see Figure 2).

Walker was not the first to use dasymetric maps – this honour goes to the political economist George Scrope in 1833, according to McCleary (1969, 45; see also Andrews 1966). However, it is not clear to what extent Scrope's map is truly dasymetric; it might be fairer to say that it has undoubted dasymetric elements. Walker's innovation, in my view, is that he systematically and deliberately used dasymetric mapping with the knowledge that it improved upon the choropleth for the mapping of populations.[2] A dasymetric map does not find a number to represent a (previously defined) enumeration unit or area, as does the choropleth. Rather, its aim is to determine the area, the one that is occupied by a certain population of interest. In addition, it should be used where the data occur with sharp escarpments between classes that can still be zonal in nature (Robinson 1960). These data are appropriate for neither the isarythmic map (continuous surface) nor the choropleth (discrete or stepped surface based on political units). In this case Walker and Gilman are concerned with people of German origin, *below* the level of the state, that is to say by imputing their distribution in more detail. As he explains, "See in New Jersey the marked ascendancy of this element [Germans] in Hoboken and Jersey City, and their vicinity, while in the State, as a whole, the German element by no means preponderates" (Gilman 1873, 142).

Because the Walker atlas is the first statistical atlas of the census in America, it brings together developments in several areas that were necessary for the dasymetric map to flourish. First, there was a desire and need for the nascent modern state to know about itself and its constitution through the prosecution of national censuses.

Figure 2. Density of the "constitutional population" in Walker's 1874 atlas. (Source: *Plate 19, Walker 1874*)

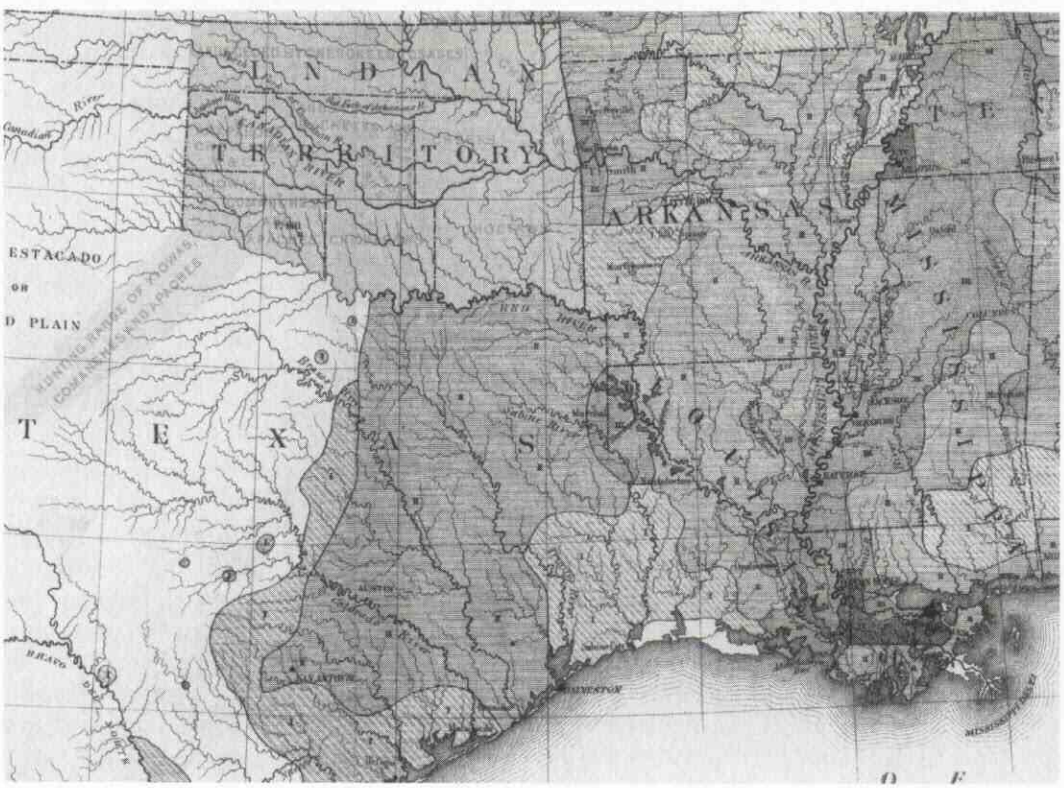

Figure 3. Density of the "constitutional population" in Walker's 1874 atlas (detail). (Source: *Plate 19, Walker 1874*)

This governmental impetus lies behind the creation of the institution of the census (Hannah 2000). Second, the invention of statistics and probability in the first half of the nineteenth century allowed for calculation and measurement. But what was to be measured and calculated? It was, third, the population distributed over the territory.[3] Therefore we have a triad of political cartography: government, statistics, and population, or "biopower" as Foucault has called it (Foucault 1978, Crampton 2003b). The *Atlas* is a hinge that joins the political economists and their choropleth maps with the cartographers of the early twentieth century.

THEMATIC MAPPING AS CARTOGRAPHIC SCIENCE

The initial development of thematic map techniques was achieved by political economists such as Dupin and Mayhew rather than trained cartographers. It was not until about a hundred years later, in the early twentieth century, that statistical maps were theorized and placed within a scientific system of mapping by cartographers. For the cartographers and geographers involved in early twentieth-century cartography – especially Mark Jefferson, Isaiah Bowman, and J. K. Wright – the mapping of populations and their attributes such as ethnicity, language, origin, and density was, once again, a critical issue. These scholars saw the problem in the same light as their nineteenth-century political economic precursors – as a statistical one of population management. By the early 1930s, for example, J. K. Wright was so taken up with the issue of "the cartographic presentation of statistical data and the devising of summary measures of distributions on statistical maps" that it became known to his wife and children simply as "The Problem" (Bowden 1970, 398).

A rash of publications in the early 1900s illustrates this concern with populations, most notably by Mark Jefferson (1863–1949) a cartographer and geographer at Eastern Michigan University (Martin 1968). Jefferson's population work benefited from his innovative cartographic skill and experience (he was the Americans' chief cartographer at the Paris Peace Conference in 1919 where he produced over 500 maps), to give him a sense of where people lived and why. In 1908 Jefferson was able to present the first world population map to the Association of American Geographers, and throughout the rest of his life he grappled with the way in which populations reflect geographic conditions, a study that he termed an "anthropography."[4] In order to know the meaning of a population distribution Jefferson eschewed the deductive method of taking something already given and drawing conclusions. As a student of W.M. Davis, who promoted the inductive approach, Jefferson created maps that reflect his concern to build up a picture of population from the evidence of the thing itself: a grouping of people with certain characteristics. Foremost among these was population density, which should be measured and represented as a continuous surface, not made discrete within pre-existing (and irrelevant or

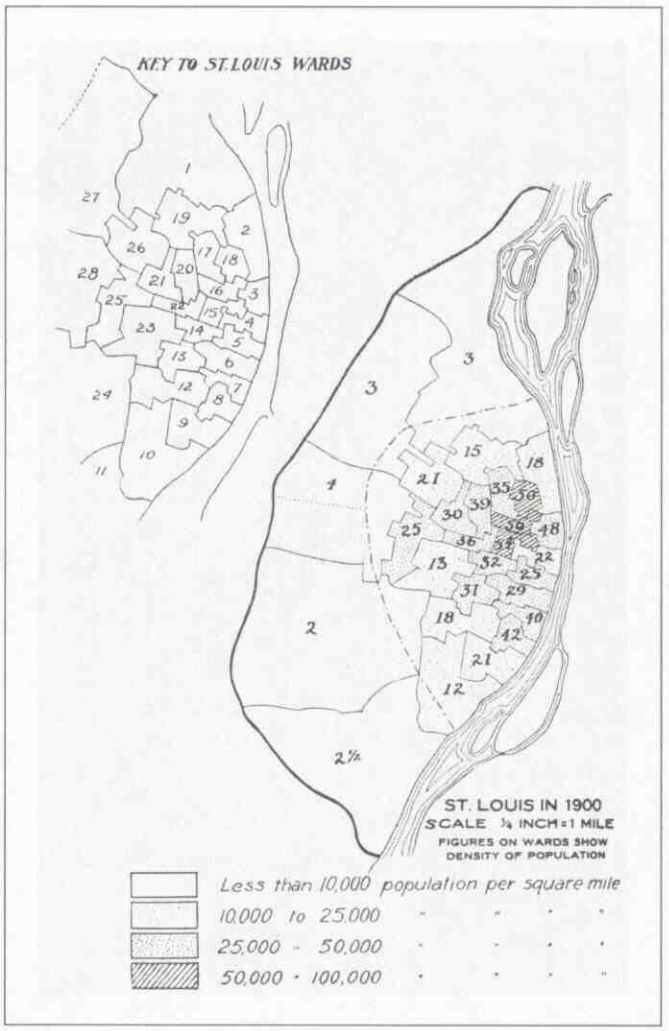

Figure 4. Jefferson's "anthropographic" city, St Louis. The dot-dash line marks the limits of the true anthropographic city based on imputed population densities. The outer suburban wards, although politically part of the city, are therefore excluded. (Source: *Jefferson 1909*)

mismatching) political borders such as city limits. The anthropographic city was not one that would be found on the map; on the contrary, it would be constituted as an object of knowledge in the process of mapping (see Figure 4).

Jefferson was more interested in the meaning of the place in which people lived, rather than in defining places by political borders. In this sense Jefferson was markedly ahead of his time, in that he understood place as actually experienced space, an understanding that would later be influentially articulated in political geography (e.g., Agnew 2002).[5] We see here, then, the explicit desire to understand place as it was constituted through people and their actual lives, rather than the approach of the nineteenth-century political economists, who wanted to know what kind of people lived in certain (politically predefined) areas.[6]

While the political economists invented and fell in

love with the choropleth map with its clear political borders, Jefferson rarely used it. His contemporaries were similarly wary. Remarkably, both J. K. Wright and Erwin Raisz pointed to severe inadequacies of the choropleth map almost immediately after it was named as such by Wright in 1938. Wright introduced the term in an unassuming staple-bound document devoted, once more, to the problems of mapping population statistics. Wright disparaged areal maps that "distribute the symbolism evenly over the whole area of each unit, as is often done" (1938, 11), that is, choropleth maps. As early as 1930 Wright was pointing out that "the average density of population of any area, particularly of a large area, is at best an abstraction. It seldom bears any relation to the density that prevails over the greater part of the area, for the concentration of population in cities will always raise the average" (Wright 1930, 158). Such maps were mere "cartograms" as opposed to "genuine" maps. For Wright, cartograms show distributions "in a more diagrammatic manner and with less geographical refinement than does a genuine map" (Wright 1938, 2–3). Here Wright echoes the sentiments of Georg Mayr who used the word in 1914 (*Kartogramme*, see McCleary 1969, 64). Again in his introduction to Paullin's classic *Atlas of Historical Geography* (Paullin 1932) Wright had similarly defined a cartogram as "a cartographic outline upon which are drawn statistical symbols that do not conform closely to the actual distribution of the phenomena represented" (Wright in Paullin 1932, xiv).[7] Wright was not opposed to publishing cartograms (e.g., choropleths) if nothing better could be obtained, but they suffered from an insufficiency of data. Although the *Atlas* used about 60 choropleth maps, Wright noted that "had data been available ... the picture would have been more realistic and would have resulted in a series of *genuine* maps" (Wright in Paullin 1932, xiv, emphasis added). Before closing the subject, Wright noted the many areas where more maps and knowledge were needed before giving up: "But it is hardly profitable to add to these examples" (xiv–xv).[8]

The first textbook of modern cartography in English is Erwin Raisz's *General Cartography* (1938). Choropleth maps were mentioned by name in Raisz' textbook (see Raisz 1938, 246, 302) citing Wright, 1938. Raisz echoed Wright's doubts about the choropleth map. He noted that "generally such a map [choropleth] will not give a true picture of distribution, because in most cases it is not at the county or township line where the value changes" (1938, 246). Raisz was here marking the difference between the spatiality of dwelt human life, and the artificiality of its divisions on the map. Where human life is lived continuously, the map (especially the choropleth) chops up and divides. Raisz reserved special criticism for choropleth maps by state because "they give a particularly false picture of distribution" (246). He therefore recommended that choropleth maps be turned into other kinds of statistical representations, such as dot or isopleth maps, as they "give a vivid portrayal of distribution." However, this was equally problematic, because of "the lack of detail in the available statistical data" (246).

These comments by Wright and Raisz here at the outset of thematic mapping's scientific formalization are extremely illuminating. Choropleth mapping, although recognized as a viable technique for representing statistical data, is immediately problematized. This ambiguity is made manifest by a fascinating document from 1944 in which Wright devised a chart or table of thematic symbol types that could be used for an atlas of disease the AGS was considering (it eventually appeared as a series of individual maps in the *Geographical Review* in the 1950s). (See Figure 5.)

Wright's table categorizes space into point, line, or area, and measurement into qualitative or quantitative (Wright 1944), a conception of space that has had an enduring effect on cartography and GIS. Could GIS today do without a conception of space as point, line, area? In the case of quantitative area symbols, Wright proposed that a number of map types were suitable for mapping quantitative areal symbols. Among these types were "chorograms," "chorisograms" (used to map continuous isarythmic surfaces such as hypsometric tinting or shaded isopleth), and the "choropleth." Today, only the choropleth is widely known.[9] But as he had six years earlier, he warned that "choropleths indicating absolute quantities pertaining to those units are misleading ... (e.g., showing total population by counties)" (Wright 1944, 651). Wright's chart was later published in the first and second editions of Robinson's classic textbook *Elements of Cartography* (Robinson 1953, 1960). In the third edition (Robinson and Sale 1969) the chart is separated into symbols for points, lines, and areas, and these charts were frequently reproduced in other textbooks. This genealogy established GIS' conception of space as container comprising points, vectors, and polygons.

In a sense, then, thematic maps were invented twice: once by political economists in the early nineteenth century and again by rational men of science in the early twentieth century. For the European political economists, the map was but a way-station in the process of addressing governmental concerns of territory and its population. Cartography, as a self-conscious discipline with a history, was barely on its legs at this time and would not blossom until decades later (Harley 1987). By the time of the systematizing geographers in the US of the early twentieth century, the problematic of mapping and government had undergone a shift. While population was still the concern, now it was understood as defining place, rather than being defined by it. Space was no longer unproblematic but was in focus as an explicit political question. In order to address this question, it was now possible to speak of map types appropriate to the data, to rank the different types of maps, and to open up the question of the sufficiency of statistical data.

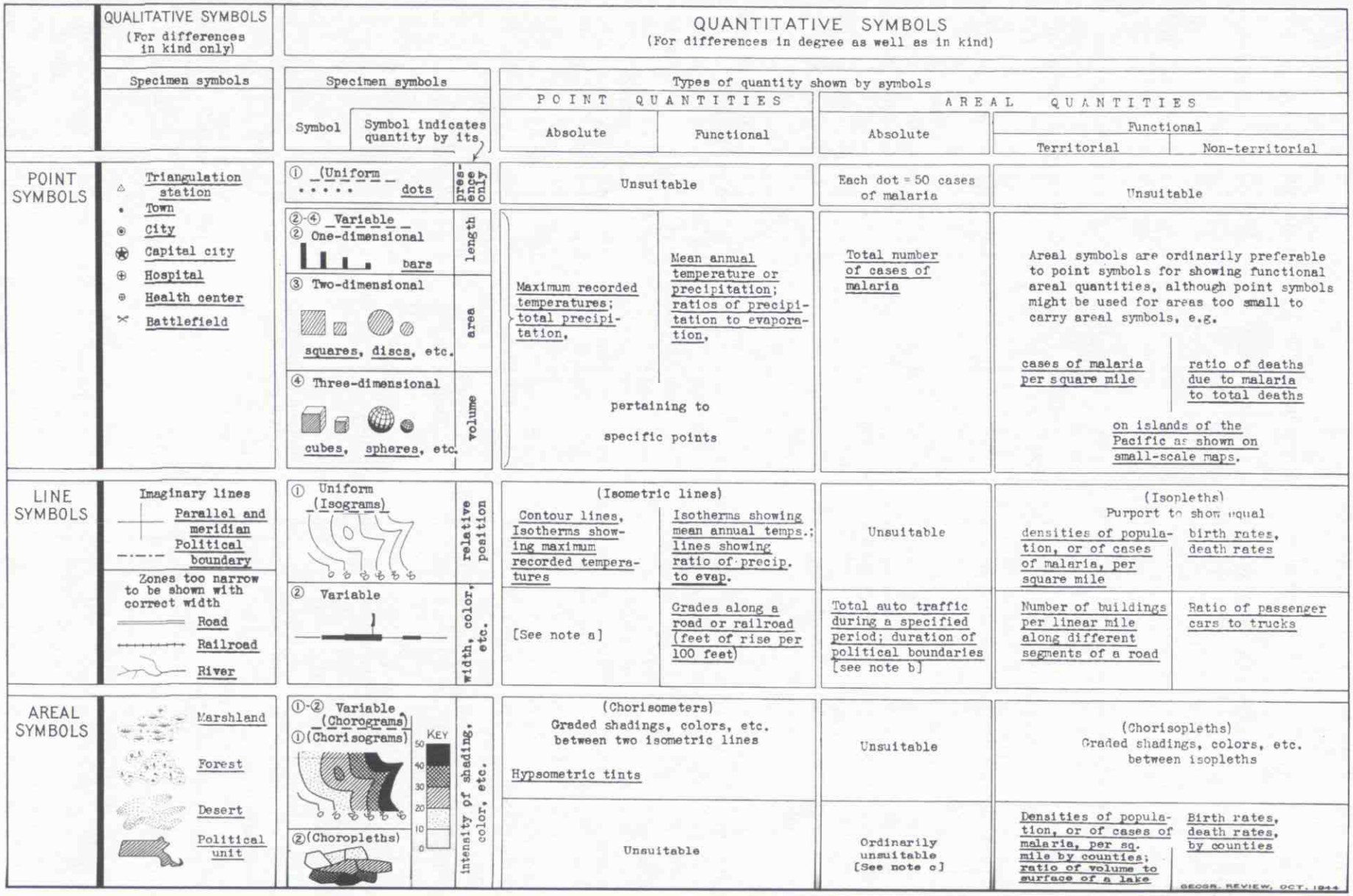

Figure 5. Wright's formalization of cartography as a matrix matching map types to qualitative or quantitative data occurring as points, lines, or areas. (Source: *Wright 1944. Reprinted by permission of the* Geographical Review *and the American Geographical Society.*)

While lack of data did concern the political economists, the discursive formation of scientific mapping initiated by statistical atlases (including Paullin's and Walker's) aimed for a totality of territorial knowledge (limited in practice only by resources). This shift was accompanied by a similar shift in the types of maps used to understand population, from the choropleth to the dasymetric. In the next section I will examine the possibilities of the dasymetric for more fruitfully understanding population distributions.

Alternatives

THE DASYMETRIC MAP

The objections to the choropleth map fall into two classes. First are those of political philosophy. These include the fact that choropleth maps (1) assume an unproblematic politics of space in order to investigate what characteristics its population possesses; (2) that choropleth maps constitute that population in terms of an average in relation to a norm. The second class of objections are geostatistical : (1) the fact that enumeration units may vary widely in their attributes but are shown with a single number in choropleth maps, and (2) that population distributions rarely follow previously defined political boundaries.

As discussed above, the dasymetric map is an alternative to the choropleth that does not possess these disadvantages. If one is trying to grasp the distribution of a population, with its sharp escarpments and attempting to avoid the "cartogram" or choropleth map, then the dasymetric map might be usefully employed. I argue that GIS today are almost completely constituted as resource management, whether it be such typical subjects of GIS enquiry as utilities, pipelines, disaster prevention, law enforcement, conservation, public safety, telecommunications, water/wastewater, or tourism. By exploring alternatives, such as the dasymetric map, we can explore how maps and social life may interact more meaningfully.

Dasymetric mapping has historically been undervalued, however, because of the understanding of populations as summaries or averages of a group of people over a politically defined enumeration unit. By contrast, in order to produce dasymetric maps, the mapper or GIS user has to have specific knowledge of the place in question. Averages and means are not sufficient, and in the dasymetric method, are obstacles to be overcome by the proper elucidation of the conditions at each place. Dasymetric maps are fundamentally different from choropleth maps because the enumeration unit is not defined prior to data collection (as the county or census tract is, for example) but rather by the data themselves. Great attention must be placed on the data and interpretations made by the mapper. Because choropleth map boundaries are constructed as objective objects, or at least pregiven, this has suppressed interest and usage of the dasymetric map – to the detriment of cartography and GIS. This leads Eicher and Brewer to note that "surprisingly little literature exists on dasymetric mapping" (2001, 125).

The differences between choropleth and dasymetric maps can be dramatically illustrated with an example from Holloway, Schumacher, and Redmond (1999), who were unsatisfied with choropleth maps produced from census data. One problem they faced in their work on resource management was getting social data at a scale of sufficient detail. Unfortunately, one of the few demographic variables available at the finest scale, that of the census block, is population. Long-form (sample) data are available only at the block group level, for reasons of confidentiality. A second problem is that, for some parts of countries like the United States, population is concentrated in a few towns and cities. This leaves large areas of land relatively uninhabited (especially in western North America). However, when these areas are mapped using the choropleth technique, the entire census tract is evenly shaded. As Holloway and others point out, "The results often reveal more about the size and shape of the enumeration units than about the people living and working within them" (1999, 285). And a third problem with choropleth maps is that they cut space into discrete units, whereas life is lived continuously (Langford and Unwin 1994).

Using techniques implemented in Arc/Info, Holloway and others apply a series of spatial filters to identify uninhabited areas within each census block group, and apply data about land cover / land use and ownership to further restrict the inhabited areas. In this, they return to the dasymetric techniques invented in the nineteenth century. Their results show that for the choropleth map the predominant class is "less than 100" people per square mile, which occupies nearly 97% of the entire count (Figure 6A, shown in lightest shade). The dasymetric map, however, shows that this class occupies only 7% of the county, and that a new class is needed showing a population density of "none" (Figure 6B, shown in white).

Holloway and others demonstrate that dasymetric mapping can be implemented in GIS, although it is not in the least as easy to implement or produce as choropleth maps (see also Eicher and Brewer 2001). They argue that any variable, such as socio-economic data collected by the census, can be mapped using the dasymetric method. Because dasymetric maps are more spatially sensitive to actual population distribution, they suggest that with dasymetric maps "one is better able to ask and answer fundamental questions, such as 'Where is it?' 'Why is it there?' and 'How can we benefit from knowing that it's there?'" (Holloway and others 1999, 290).

As environmental managers these authors are still motivated by the kinds of governmental rationality that we saw emerge with the "double invention" of thematic mapping: the inventorying of at-risk resources (including human subjects), and the political problematic of

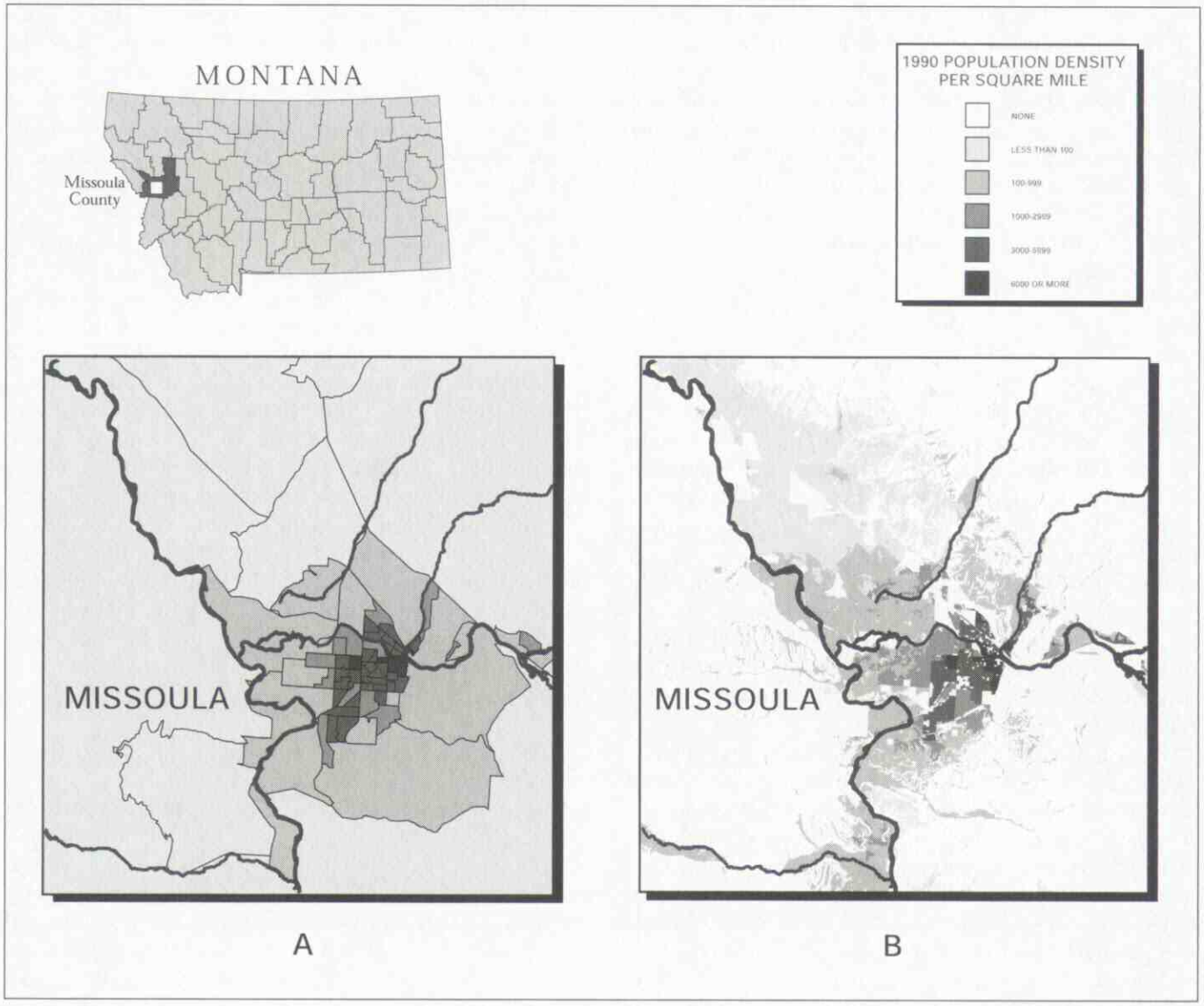

Figure 6. Choropleth and dasymetric maps of population density for Missoula County, Montana. (Source: *Holloway and others 1999. Used with permission of R.L. Redmond.)*

the population. But their deployment of the dasymetric map undercuts the notion of space as extension (*res extensa*) within discrete boundaries and allows us to return to the notion of meaningful spatial zones (Eicher and Brewer 2001).

The dasymetric map is an underused tool in GIS and mapping. Of course, it is only a partial solution. It has a number of its own problems, namely that people are still treated as manageable resources produced through calculation. But it does help us to escape from the spatially bounded conceptions of human life produced by the choropleth map. The choropleth produces a view of human life as crammed into pre-given political units. Since McCleary's classic thesis there has only been a smattering of interest in the dasymetric (several leading cartography textbooks omit it entirely), but it seems likely that there will be more possibilities for producing dasymetric maps with GIS in the near future. It is toward this end of reconstructing GIS more progressively and richly that this essay is directed.

Summary and Conclusion

My goal in this paper has been to outline how GIS is part of governmental rationality. The motivation for this work is twofold. First it is to understand how mapping helps produce political conceptions of human populations. I argued that human distributions across a territory are particularly central to politics, in fact that politics is explicitly concerned with exactly this issue. Politics as such is constituted by the problematic of human dwelling and place. Political economists saw the issue of population as one of management and husbandry of precious resources that might be at risk. The risks included threats to the welfare, health, educational attainment, and regenera-

tive potential (birth/death rates, incidence of early marriage, overpopulation, immigration) of the population. The political economists approached the governance of population by relating the characteristics of the population to norms – characteristics that they would ascertain through the technologies of statistics and probabilities. These statistics would be collected by the newly established procedures of census taking. The population was therefore manageable as a whole, thanks to a shift of focus from the individual to the population. Their question "Is the population healthy?" could now be answered by establishing norms and assessing whether there was significant deviation from these norms in the population in question.

The establishment of norms is a significant step. By doing so, we create a division between who is normal and who is abnormal, with a view to treating the abnormal. The work of Foucault has proved particularly germane to the understanding of these norms in the fields of mental health, criminality, and sexuality. He has shown that these norms vary historically, giving us hope and grounds for reconstructing difference and identity in more meaningful and liberating ways.

Second, mapping and GIS have constituted human populations in terms of norms that have shifted historically. Maps have long played a critical role in managing human occupation of territory, but it has been a role that has shifted over time. When thematic mapping was first invented in the early nineteenth century, the choropleth map was the favoured method of representating population distributions. But the choropleth map reinforces the characterization of a population as filling in previously defined political units (states, counties, census tracts, etc.). This unproblematic politics of space had shifted by the early twentieth century into a more nuanced investigation of how populations themselves create a sense of place. For example, how does the frontier (defined as a certain population density) create a national identity through human occupation, of areas that are dwelt in? Commensurate with this shift (marked for the first time by Walker's 1874 *Atlas*) the choropleth was spurned as a valid method of geographic knowledge. In its place the early cartographers such as Wright, Jefferson, and Raisz advocated a form of mapping in which populations defined and created their own areal extent, boundaries, and politics of place; that is, the dasymetric map.

I suggested, third, that today's GIS and digital mapping software has returned the choropleth map to predominance. It is far easier to produce, and more amenable to automation than the dasymetric. But this convenience comes at the price of re-establishing an unproblematic politics of space in GIS. This might be thought of as an objection based on political philosophy. To this we can add a methodological objection that data on choropleth maps are very generalized and may not reflect actual conditions on the ground. On a map of per cent minority by county, for instance, there may be nowhere in the county that actually matches the county rate shown on the map. Technically, this is an example of the ecological inference problem (EIP; see King 1997) in which it is fallacious to infer characteristics of the subgroups from the group as a whole. The EIP can be solved (or at least alleviated), however, if further information can be brought to bear. It is this further information that constitutes the attraction of the dasymetric map. Dasymetric mapping is therefore the cartographic equivalent of the solution to the EIP.

In conclusion, I have shown that both the early nineteenth-century political economists and the early twentieth-century scientific cartographers understood the world as one of populations and territory (space), but whereas the political economists directed themselves to political questions, as it were *from* the map *to* politics (a problematic now almost entirely absent from GISci and cartography), the early cartographic scientists recast thematic mapping into a question of its own nature as a science (and in doing so formed the disciplines of cartography and GISci). This loss of the political problematic is one that GISci desperately needs to recover and that a renewed emphasis on the relationship of mapping to political governance can help recover.

Notes

1. For a range of applied cases, see Burchell and others 1991, Barry and others 1996, Donzelot 1979, Dean 2002.
2. In this, I endorse the views of McCleary (1969, see *inter alia*, 53, 61–71, where he states that dasymetric mapping owes much to the work of the statistician Georg von Mayr after 1870).
3. We might argue that historically, nations were first concerned with mapping their territory (e.g., the great Cassini surveys) and then, when the borders and boundaries were filled in, with the populations that occurred over them. However, this might be too simplistic, and the increasing knowledge of territory and populations occurred hand in hand.
4. Jefferson was influenced here by Ratzel's term *anthropogeography*, which he understood as the interaction between the environment and a people, but he saw it as "vague and fanciful" when it veered too close to determinism. He went on to say, with some irony, "If no other explanation of qualities is available one may always refer to the 'climate'" (Jefferson 1917, 4; see also Martin 1968, 227). In other words, Jefferson was leery of a strong environmental determinism and more interested in the mutually productive relationship between people and place. Ratzel's ideas generated a great deal of dasymetric population work after his book appeared in 1882.
5. Agnew has argued that politics can best be articulated if we grasp its relations to place: where the latter is "lived or experienced space ... it refers to how everyday life is inscribed in space and takes on meaning for specified groups of people and organizations'' (Agnew 2002, 15–16).

6. Jefferson summarized, "The anthropographic ... city [is defined] according to the distribution of people, just as the lines indicating grades of population may be called isanthropic lines and the maps isanthropic maps" (Jefferson 1909, 544).
7. This atlas has long stood as the epitome of historical cartography. Originally conceived by the American historian J. Franklin Jameson in 1903, the *Atlas* was nearly 30 years in the making. Its principal author was C. O. Paullin of the Carnegie Institution, and it was completed with the assistance of the American Geographical Society between 1929 and 1932 under the direction of J.K. Wright. Some 5,600 copies were printed, approximately the same number as the Walker 1874 census atlas (Wright 1965).
8. Although he could not later resist musing over a map of "the density per square mile of flat-footed children under the age of ten" by townships (Wright 1938, 1).
9. The term *isopleth* itself appears to have been coined in 1858 by von Sydow (Robinson 1982). In the 1920s and 1930s there was a flurry of new terms (always the sign of the formalization of new knowledge). Many of these are forgotten today, such as *isontic, chorisometer, chorisopleth,* and *three-dimensional thermoisopleths* (Harold-Smith 1929).

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Résumé : Cet article relève le défi de la « reconstruction du SIG » en se penchant sur le SIG et les décisions du gouvernement. En tant que responsabilité de ce dernier, la cartographie est une source essentielle de connaissances géographiques qui informe le processus décisionnel politique. Les répartitions démographiques relatives à la santé, la richesse, l'éducation, la densité ou la criminalité sont d'une importance capitale pour la gouvernance et l'aménagement géographiques. Et pourtant, la façon dont ces répartitions ont été cartographiées a changé et a été contestée à travers l'histoire. Alors qu'au début du XIX^{e} siècle, les populations remplissaient simplement des zones politiques préexistantes, à l'aube du XX^{e} siècle, elles étaient vues comme définissant elles-mêmes les zones et périmètres. Aujourd'hui, le SIG en est revenu à la politique antérieure incontestée de l'espace. J'explique ces changements en en identifiant d'autres similaires entre la carte choroplèthe et la représentation dasymétrique. Bien qu'elle soit couramment utilisée, la première est insuffisante et trompeuse. Je discute les raisons possibles de ces changements en insistant à nouveau sur la cartographie en tant qu'élément de gouvernance géographique.