

The Effects of GIS and Digital Mapping on Cartographic Vocabulary

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Abstract: The language of cartography is in constant flux as new technology, new techniques, and new subject matter enters into the discipline. Some terms are new; other terms have developed to replace old ones; and still others have shifted meaning. A selection of map-related terms exemplify these changes. Questions arise as to whether vocabulary is becoming better through thoughtful revision or is being muddied by careless usage, what effects the variety of terms has on the understanding of mapping in today's world, and how vocabulary aids or confounds the dissemination of map information. A website with definitions and longer discussion of terms is one step that could help both in standardizing usage and paving the way for improved vocabulary.

Introduction

The language of cartography is in constant flux as new technology, new techniques, and new subject matter enters into the discipline. The very introduction of the term "geographic information systems" (GIS) muddied the water somewhat in that the subject matter of that sub-discipline overlapped considerably with cartography. Fortunately, most of us pay less attention to trying to define the dividing line between them than to making progress in the whole matter of geographic information, which virtually everyone would agree is the important subject matter and which no one discipline or sub-discipline "owns". Nevertheless, the burgeoning of geographic information systems and the relative separation of GIS and cartography over a number of years has led to some interesting developments in map-related vocabulary.

Digital mapping also enters in. Although the boundaries between digital mapping, GIS, and cartography are extremely fuzzy at this stage in history, there was a period of time when technology separated cartographers into camps of sorts--manual and digital. "Digital mapping" would have included producing a thematic map of a single variable or producing base maps to combine with manually-produced overlays, whereas "GIS" conjured up notions of overlay and finding areas with certain combinations of variable values. Those who developed digital mapping programs were not necessarily trained cartographers, and their use of terms did not necessarily follow "mainstream cartography" exemplified by such texts as *Elements of Cartography* (Robinson et al.) and *Cartographic Design and Production* (Keates 1988) any more than did the terminology of people who identified themselves with GIS.

Despite the convergence of cartography and GIS and digital mapping, map-related vocabulary reflects the past separation. Some vocabulary in use today is new and refers to phenomena or ideas that simply were not a part of cartography in earlier decades. Other terms have changed meaning. Still others are synonyms for words that have long been in the vocabulary. In this paper, I will look at a selection of instances, or "cases", of term usage. I

will then comment on the implications of the general phenomenon represented by the terms discussed and pose the question of what if anything should be done.

Before considering any of these cases, it is important to say that they have not been chosen to denigrate any persons or organizations being referenced. We are all guilty of misusing language and any misuse implied in this study is seen by the author as an indication of the stretching that people and organizations must do to make progress in the rapidly-changing fields associated with the collection, processing, and display of geographic information. Furthermore, changes in terminology are neither all good nor all bad. The motivation behind this study is the question of whether we might benefit by studies of vocabulary and exchange of information about term usage. Such an endeavor will likely find us adopting new terms and discarding old just as often as we insist upon retaining and "properly using" traditional terms.

Case 1. New terms and retronyms

The term *digital mapping* was truly a new term that simply was not in the cartographic vocabulary before the advent of computers. Nor was the term *geographical information systems*. Computer technology in general brought a host of terms into cartography that are not specifically cartographic as well: mouse, monitor, CRT, CPU, diskette, and many others. New terms are expected when new inventions occur.

Interestingly enough, we now have new or modified terms for things or procedures that existed before but did not have to be distinguished from what did not at the time exist. *Manual cartography* was an unnecessary term when all cartography was done manually. It was only with the development of digital, or computer, cartography that the term manual cartography came into existence.

Such a term has been labeled a *retronym*. A retronym is "a modification of a referent originally used alone, to distinguish it from a later contrastive development" (Quinion, 2001). Retronyms undoubtedly existed long before computers and GIS; *quill pen*, for example, would have been a retronym from an earlier era (Quinion, 2001).

Case 2. Is it choropleth, extent, conformant, hatch, patch, or blot?

The traditional term "choropleth" refers to a map on which a tone, color, or pattern covers each enumeration unit to represent that unit's value. The value represented is usually a ratio (e.g., percentage of population under 18 years of age), and the definition is sometimes restricted to that type of data. Certainly, however, people have represented counts (e.g., number of persons under 18 years of age) as well. Proponents of the rule that it should be used only for ratio data argue that since size of unit usually varies, the count is influenced by size and that influence is detrimental to map meaning. Those who regard either ratios or counts to be acceptable argue that ratios can be just as confusing. If, for example, one shows crime per capita in urban areas, the lack of population in inner cities distorts the data even more egregiously than showing counts of crimes (Rooney, et al., 1982, p. 113).

That controversy may appear to be irrelevant to the actual usage of the term, but note that there is a connection in word form between choropleth and isopleth, the latter referring to a

map with lines of equal value (an isoline map) on which the values are derived using areas around a point rather than by measuring at the point itself (in which case the map would be isometric rather than isopleth). An isoline map of population density is an isopleth map (values must be measured over areas), whereas a map of elevation is isometric (elevation can be measured at points). It does matter with isopleth maps that the data be in ratio form. The logic of the mapping method (that value at a point belongs to an area around the point) simply falls apart if data are not ratio in form unless all the areas are the same size, in which case the "count" is a density value anyway. But with choropleth maps, the areas are normally shown explicitly. Hence, the values can belong to defined units whether those values are ratio or not.

Choropleth maps in any event are composed of units that are more or less arbitrary relative to the distribution. Any intelligent user of a choropleth map knows that a value of 600 persons per square mile does not suddenly change to 700 if that is the value for the neighboring unit. There are some values that truly do change at boundaries, however, such as tax rates. If person A lives within unit X, person A pays the rate for unit X. If person B lives in unit Y, then even if person B is a next-door neighbor of person A, he or she pays the rate for unit B. The term for such a map (one representing something that is truly tied to the units) was *areal extent map*, a term that is seldom if ever used any more.

One of the most interesting critiques of the term choropleth (and concomitantly areal extent) came from Howard Fisher, creator of the early mapping program *SYMAP*, at the time computer mapping was in its infancy. Fisher's problem with the conventional terminology was that the definition of such terms depended upon what was represented rather than on the form of the map, the latter being central to the way in which one would program the computer. It did not matter in the construction of the program, or at least in the instructions for output, whether the user was mapping ratios, counts, or tax rates--the end product would still have tints, colors, or patterns over enumeration units. Fisher's term for such a map was *conformant*. He stated that conformant maps have "tones of variable darkness spread over the base area of each location to conform with its shape (hence the term *conformant*)" (Fisher, 1982, p. 70). Perhaps unfortunately, the term was not broadly accepted and is seldom if ever used, even now that computer programs are widely employed and the same graphic choices are made regardless of which variation on this general type of map is being produced.

But choropleth is not necessarily the term used either. In Golden Software's MapViewer <www.goldensoftware.com> the term is *hatch*, which suggests that it was coined in the age of manually-produced maps when sticky-backed film with line patterns was cut to fill the enumeration units, or perhaps even further back in history when lines were actually drawn in ink to form the pattern fill. Surely it is a questionable term to be using now that every mapmaker's access to monitors, laser printers, and other output devices has made the use of hatch patterns obsolete.

The term that statistician John Tukey applied was *patch map*. His scorn for choropleth maps is clear, calling them: "...the sort of maps...that I would gladly revile with the name *patch map*" (Tukey, 1979, p. 792). He stated clearly that a tax map was appropriately mapped in this manner but a map of an average characteristic was a "lie, lie, lie."

The popular writer on graphic methods, Edward Tufte, calls these sorts of maps *blot maps*: "Conventional blot maps (choropleth maps, in the jargon) paint over areas formed by *given* geographic or political boundaries" (Tufte, 1990, p. 40-41). He goes on to express the

problems with such a method compared to using small-area grids for statistical mapping, which he finds to be a very acceptable way to map.

Consider for a moment the Tukey, Tufte, and Fisher terms. Patch and blot maps are pejorative. Blot is not particularly descriptive either; it could as well apply to maps showing, say, city areas on a state-wide map. Conformant, on the other hand, is simply descriptive of how the symbols relate to the enumeration units. The term choropleth, of course, is an age-old term and could be argued to be perfectly fine if broadened to include all that is signified by the term conformant (and most people use the term in this way today). But it is hard to argue for a word that is not very descriptive and is not anchored in form in the manner of the term conformant.

Incidentally, the help menu in the ESRI's ArcView 3.1 <www.esri.com> has no reference to any of these terms despite the ease with which one can produce this type of map. One selects *graduated color* as the *legend type* to produce such a map.

At the risk of muddying the waters further, consider a dot map of population by county in the state of Michigan. Is it really a dot map or an unclassed choropleth (conformant/hatch/patch/blot) map with a random pattern of dots? In usage, it is probably the latter. In construction, the only difference is the nature of the symbol that fills the enumeration areas. The legend is most likely a dot and the value that each dot represents, but the map itself is actually unclassed choropleth, or unclassed "conformant."

Case 3. The unprojected map and other projections

One of the most curious terms that has appeared in mapping terminology is the *unprojected map*. The plotting of coordinates such that x is a linear function of longitude and y is the same linear function of latitude is such a simple-to-program representation of the earth, and such a simple projection, that it is referred to as unprojected by users of ESRI's software; more precisely, the user gets such a result when *none* is specified for the map projection. It is interesting to contemplate how one would define *map projection* in such a way that it would exclude this form of representation, but nevertheless one hears and sees the term *unprojected* regularly.

That modern usage includes such a non-sensical term is perhaps in part a reflection of how arcane traditional map projection labeling has been. The straight-jacket of projections with specific names is a prime motivation behind Laskowski's work, which is paving the way to a continuum of projections better suited to the wide variety and large numbers of maps that are made today (Laskowski 1997). Labels such as "Goode's homolosine" and "Robinson's" are not likely to disappear soon, but if we stretch the Robinson in the east-west direction to fit a space, we no longer truly have a Robinson projection. The prospect of more flexible map projections and ways of indicating how we have represented the earth without using specific names is a welcome one and it will revise our use of projection vocabulary.

Projection naming problems are well represented in the ESRI products again, in which there are at least three ways to specify projection to produce what is called (see Robinson et al., 1995, p. 84) a "plane chart"; one can ask for "none", "Plate Carree", or "geographic" to get such a representation. Snyder and Voxland (1989) list the projection as Plate Carree with other names "Simple Cylindrical" and "Equidistant Cylindrical (specific form)", whereas

Robinson et al. also mention "equirectangular." The projection terminology problem, in others words, did not originate with the development of geographical information systems. It has simply taken on new dimensions of confusion.

Case 4. Visualization: Mind or Matter

The term visualization was once a good general English term that referred to conjuring up a picture in one's mind. Few cartographers have escaped the new usage of the term, which refers to visual representations, on the computer screen or on paper but usually the former, that show things not visible in the ordinary environment and that are generally used to discover new knowledge. Maps--physical maps, that is, not just mental maps--are now visualizations.

The usage of the term in cartography has come from the general scientific visualization movement. The new use of the term has taken us so thoroughly by storm that the Cartography Specialty Group of the Association of American Geographers is considering a change of name to Cartography and Visualization Specialty Group. No matter how hard one might argue that cartography is a perfectly good word for anything the group might want to do or represent, there is little doubt that "visualization" provides not just a modern slant but a cadre of interests not conjured up by the term cartography.

The notion of visualization and its connection to the scientific community as a whole has obviously been an inspiration within our field. The ICA Commission on Visualization and Virtual Environments has been one of the most active and productive commissions in the history of the organization. To what extent a twist in meaning of a term can inspire such activity is an interesting question. Certainly it takes more than coinage of a new term; the term has to express something that has already been brewing in the minds of a body of prospective users and thus has to fill the need for a term. Proponents who are opinion makers, or trend setters, is probably required as well. Visualization surely must have had every component needed for succeeding as a redefined word.

Case 5. Layer tinting, shaded relief, and other terms

In this age of increased collection of data, one of the techniques that has developed is LIDAR, Light Detection and Ranging, which allows the recording of data in the Z dimension (elevation and heights of buildings). The company TerraPoint has an website that features a number of interesting examples of renderings from LIDAR information (TerraPoint 2000). They are described as shaded relief, DOQ, data or dimensional renderings, and visualizations, but the images do not "make sense" as representatives of such labels as a cartographer would understand them. "Shaded relief" is what cartographers would call layer tinting (applied, innovatively enough, to oblique views of skyscraper landscapes). "DOQ" is not a digital orthoquad as expected but a realistic color rendering, sometimes of an oblique view. "Data renderings" and "dimensional renderings" are three-dimensional diagrams with some limited use of color. And "visualizations" are what cartographers would call shaded relief.

Why the confusion

The question that comes to mind is why there is such confusion in the use of mapping terms in this day and age. One of the possible explanations is that over a number of years people trained in GIS were not nearly so likely to take coursework in cartography as cartographers were to take courses in GIS (Estes ~1997). Conditions are changing and there is far more integration of cartography and GIS at this point in history and likely more cartographic content in GIS programs. Such developments, in turn, should be catalysts for a discussion of terminology.

There are other reasons for the development of the confusion as well. Traditional terms are not necessarily good ones and do not necessarily fit current needs. Many who use different terms are doing their best to coin reasonable and useful terms. Such was certainly the case with the term conformant.

We are all guilty, too, of sloppiness in writing or speaking, and sometimes that simple explanation accounts for usage that departs from normal. There are probably many examples of misuse of terms, resulting from misunderstanding, that appear in printed material. It is difficult at best to retract the usage.

The whole phenomenon of having to stretch intellectually to embrace and use modern technology in innovative ways means that we are not all going to be trained in consistent ways. Were society to have insisted upon some canon for all people involved in the mapping enterprise over that past few decades, we would have missed a lot of progress.

Perhaps at least as important as any of these points, however, is what is available for newcomers into the mapping-related areas to access cartographic vocabulary. Some cartographic terms appear in geographic dictionaries (e.g., Small and Witherick 1995; Mayhew 1997), but people are relying more and more on the web for information of all sorts, and the discussion of cartographic terms on the web seems to be limited. At least two glossaries of terms readily located (Woolwine Moen Group, no date; Perry-Castañeda Library 1999) are sets of formal definitions from one source: Thompson's *Maps for America* (1988). The AGI GIS dictionary is much broader in scope and it includes references for further reading about each term defined (AGI 1999).

If it matters, where do we go from here

Questions arise as to whether vocabulary is becoming better through thoughtful revision or is being muddied by careless usage, what effects the variety of terms has on the understanding of mapping in today's world, and how vocabulary aids or confounds the dissemination of map information. It is difficult to argue that terminology changes have all been for the better or even that most of them have been. The variety of mapping terms, such as multiple terms for choropleth maps, certainly has not kept the world from making advances in mapping, but it is not easy for today's students to match textbook and software terms. The confusion at the very least makes communication within the geographic information sciences more difficult than it needs to be.

In general, there is little doubt that some level of consistency in the use of mapping terms is necessary for clear communication. We cannot decide individually what we want terms to

mean. On the other hand, there are limits to consistency; terminology should and will continue to evolve.

Because of the dynamic nature of field at this point in history and the converging of various mapping-related disciplines, this would seem to be a good time for discussion of terminology in ways that allow us to find the discussions easily and understand the reasons for the existence of the term. We also need to be able to coin new terms when appropriate, not just when there is no old term but also when an old one is inadequate.

There are many possible ways to approach vocabulary problems, including specialized published dictionaries, encouragement of input into current web dictionaries, and persistent chiding of colleagues to use accepted terminology. There is one step in particular, however, that would appear to be especially useful. It is the development of a cartographic terminology webpage that carries discussion of terms and not simply dictionary-type definitions. An excellent example of such a set of pages in other areas of vocabulary is Quinion 1996. An exposition of several paragraphs about a term or set of synonyms or set of closely related terms would allow understanding of terminology that would aid everyone in deciding whether or not to use a certain term. The origin of definitions is in the literature, but it is impossible for everyone needing to use cartographic words to find them by searching original sources.

Final words

One thing is certain; vocabulary changes are neither all good nor all bad. Insisting upon using old terms that are difficult and obtuse is no better than inventing new terms for lack of knowledge of standard vocabulary. When revised terms are easily-remembered and clearer in meaning, they can contribute positively to the language of maps.

In keeping with the language limitations of the author, only English terms have been examined in this presentation. There are undoubtedly developments in other languages that could benefit the development of mapping terminology in general.

Certainly in the English language, there is need for a webpage that would give ready access to terms and would air terminology sufficiently to lend understanding of the term and to be the catalyst for the development of clearer terminology.

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