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Commentary

Perspectives on the new cartography

Introduction

Whether we recognize it as ‘un-cartography’, ‘re-cartography’, ‘cartography 2.0’, “critical cartography”, or whatever we choose to call it, the papers in this collection give a strong and compelling sense of the very exciting changes that are occurring in what has in many ways been a staid set of practices. We might regret the passing of the free gas-station road map of decades ago, the overflowing glove compartment of memorable road trips, and the shoebox of variously outdated, badly folded, and dog-eared giveaways. But these conspicuous changes reflect a number of very profound trends, of which advances in technology may be among the most superficial.

Almost three decades ago I wrote (Goodchild, 1988, page 318) “Digital technology does indeed have the potential to stimulate a revolution in cartography, but the revolution has hardly begun .... The real revolution will be in a redefinition of cartography’s role.” Today geographic information technologies have given us enormous power to acquire, store, analyze, visualize, and share knowledge of the planet’s surface and near-surface. And yet the static, two-dimensional, planimetricly accurate map with its ‘god’s eye’ view remains the celebrated end product of much digital manipulation in geographic information systems (GIS), and the collection of maps remains the metaphor for the organization of information in a geographic database. As with many instances of technological change, the legacy of the past still frames our thinking in the present, just as early automobiles were thought for at least a decade to be little more than ‘horseless carriages’.

In what follows I discuss four ways in which the visualization and sharing of our knowledge about the geographic world are still constrained by the legacy of the past. In the past map-making was expensive, requiring the work of a skilled synthesizer and draftsman, to integrate all of the relevant data and to express it using ink-marks on a flat sheet of paper. But the cost of map-making has gone almost to zero in a few short years, and the expertise of the map-maker is now encapsulated in abundant software and widely available. Moreover, technology has moved far ahead of what is needed to automate the production of maps, opening a vast range of possibilities.

The virtual globe

Globes possess little of the distortions necessary in flattening the Earth so that it can be represented on paper, and techniques for making globes have been known for centuries. Their great disadvantage, of course, is that they are difficult and expensive to reproduce in quantity, and cumbersome to store and to disseminate. In digital form, however, a *virtual* globe can be stored and distributed as easily as a virtual map. It has none of the interruptions of the flattened Earth (see, for example, the problems caused by the interruptions at longitude 180 and at the poles when displaying global interactions in the Hennemann paper in this volume). Al Gore coined the term *Digital Earth* in his 1992 book *Earth in the Balance* (Gore, 1992), and Google’s release of Google Earth in 2005 proved wildly popular.

Why, then, do we still flatten the Earth and still teach the frustrating mathematical complexity of map projections? Why did Google adopt the Web Mercator projection for Google Maps, instead of its own virtual globe? Now that most of the original reasons for projecting have disappeared, perhaps the only remaining justification is that a virtual globe can never show both sides of the Earth at once. But the distortions involved in doing so may well outweigh the benefits.

Citizen engagement

The past decade has witnessed a dramatic change in the relationship between amateurs and experts, especially with respect to map-making and geographic information more broadly. The term 'Web 2.0' was first coined to describe the growing volume of web content generated by citizens, beginning with services such as eBay that allow sellers to post their own announcements, and progressing through blogs, Facebook, and tweets. More directly relevant to cartography is the growth of what can be termed *volunteered geographic information*, a form of crowd-sourcing that has produced spectacularly successful international collaborations, in the form of OpenStreetMap, Ushahidi, and many others. But while OpenStreetMap was originally conceived as a way of avoiding the high costs of government data by using the services of volunteers, the long-term effects of this large-scale citizen engagement in the production of data are likely to be much more profound.

OpenStreetMap is just one of the many demonstrations of what has been termed *neogeography*, a term coined by Turner (2006). Neogeography is seen as a fundamental realignment of the amateur and expert, now that anyone can acquire geographic information and use it to make a map. We are all now familiar with online mapping services that create personalized maps: centered on the user's location, showing the view either from ground level or above, using data such as real-time traffic that is valuable at this moment but so time dependent as to be useless in a few hours, with 3D simulation of buildings and topography, and perhaps showing information customized to the specific needs of the user.

But this personalization or consumerization of mapping is very different from the traditional practices that it augments, and perhaps in the long term replaces. Citizens are not likely to be subject to the rigorous procedures of quality assurance employed by government agencies and mapping companies. They may well disagree as to the name given to a specific feature, and are not likely to refer the dispute to the national toponymic authority (in the US the Board on Geographic Names) and its gazetteer of officially recognized feature names. Vociferous arguments have erupted from time to time within the OpenStreetMap community over the classification of features (Mooney and Corcoran, 2014). Weinberger (2012) has recognized this inability to agree as characteristic of the new electronic media, which are of course inherently capable of sustaining differences rather than needing to suppress them.

This change speaks well to the notion of the map as a social construction, rather than as the objective result of scientific observation. It offers to make mapping a local, community-based, language-specific and culture-specific activity. It stands in sharp contrast to the universal mapping projects of the past, such as the Millionth Map of the World, an international effort of the first half of the 20th century, and the use of the map as a marker of dominion (see, for example, Harley, 2001).

In the past the high costs of mapping have forced the producers of maps to serve as many applications as possible, and to emphasize permanent and semi-permanent features over transitory ones so that the validity of a map continues for as long as possible. But in the world of neogeography the effort of producing a map can be so low that it can serve only a single use, and be valid only for a moment. Land-use maps, soil maps, land-cover maps, and many other forms of cartography that were produced at great expense in the past, and were designed to serve many uses moderately well—and consequently no single use perfectly—are now largely redundant, along with the expertise that was needed to produce them, and then to interpret them to users. For example, a gardener now has many sources of information available at his or her fingertips, all of which are more useful than the coarse-scaled, general-purpose soil map of the past.

Coordinates

In a GIS every feature, whether a point, line, area, or volume, is defined by its geometry, which is normally expressed in some standard coordinate system such as latitude and longitude. To depict the feature on his or her map, the cartographer makes the best possible effort to locate the feature in its correct position using a map projection: that is, a set of equations that convert those standard coordinates to a measured position on the map.

Determining latitude and longitude is a measurement problem, and like all measurements these will contain a degree of uncertainty. Even with the Global Positioning System it is generally impossible to determine the position of any feature to better than about a meter, because of Earth tides, the movement of tectonic plates, and measurement error. A one-meter uncertainty implies that latitude and longitude should never be quoted to more than five decimal places. Moreover many features are themselves vaguely defined; for example, the boundaries shown on a soil map are fictions, since soils do not usually change suddenly. Yet with very few exceptions traditional maps have shown features as if their locations were exactly known, and used pen strokes whose width reflects only the need to be visible. In reality, the contours shown on topographic maps, for example, are almost always more uncertain than their depicted widths would suggest, except at the coarsest mapping scales. Dashed lines are sometimes used to depict ephemeral streams, or disputed international boundaries, but the implied uncertainty is not over the measurement of position, only over whether the feature exists.

Despite much research, it has proven enormously difficult to communicate uncertainty by modifying mapping practices. In part this is because maps have traditionally been presented as error free, and it is difficult to overcome this legacy of the past. In part also it is because computer-produced maps convey a greater sense of accuracy than paper maps. And in part it is because map users typically are not aware of the map's provenance and its implications for uncertainty.

Rarely, however, is the need for planimetric accuracy questioned. Yet humans have been drawing and using sketch maps for guidance for centuries, and distorted maps are used by almost all of the world's major cities to portray their transit routes. The famous Beck map of the London Underground, first drawn in the 1930s and often updated since, abandons planimetric accuracy in the interests of clarity, aligning all routes in one of eight cardinal directions, and spacing stations at approximately equal intervals along lines. Humans, of course, have no means of measuring distance accurately without aids, and have long used a range of heuristics to navigate successfully. For example, while the distance between stations on the London Underground varies between a few hundred meters in the center to several kilometers in the periphery, allowing three minutes per station provides a simple estimate of travel time.

Planimetric accuracy is clearly needed if location is to be used to link information. This is often claimed to be the most valuable function of GIS, yet the impossibility of perfect measurement of position means that links established from geometry can never be certain. Humans, on the other hand, can be much more certain when information about places is linked using place names.

Recently there has been growing interest in a *platial* approach to geographic information. Besides this advantage in information linkage, a platial technology would be much easier to learn, because its approach would closely match that of human discourse and reasoning. It would also more readily accommodate cultural and linguistic diversity, as suggested in the previous section. Finally, it would support the capture, storage, sharing, and synthesis of the vast amount of knowledge about places that is currently locked in human brains.

The interactive map

In Weinberger's (2012) model of the role of media in the traditional practice of science, a process of filtering was necessary to compress a vast amount of observational data and reasoning into published form, either as a journal article or book. While it was incumbent on researchers to report experiments in sufficient detail to permit replication, nevertheless the filtered publication marked the end of the research, and the beginning of a period in which the results were immutable, unless directly challenged by further research. In a similar way the published map brought the process of map-making to a close.

In designing the map, therefore, it was necessary to ensure that the product served as many purposes as possible, and left the user satisfied that the relevant information had been communicated. But this model is now being replaced, by one in which filtering is no longer necessary, and publication no longer brings anything to a halt. Maps can engage the user in various forms of interaction, from panning and zooming to more sophisticated forms of analysis.

Consider, for example, the map commonly provided to the media by weather agencies during the development of a hurricane. Such a map typically shows the track of the hurricane's center to date, and the forecast of its future track as an expanding cone, or perhaps as an ensemble of possible tracks. The average citizen, however, is likely to require something quite different. Rather than forecasts of the future location of the hurricane's center, what is needed is an expectation of damage at a point of interest, such as home or workplace, perhaps in the form of expected maximum wind speed and its duration. It is not possible to deduce this information from the map without the means to model the distribution of wind speed around the hurricane's center. This information is available to the weather agency, but there is no way to include it in the single published synthesis. But an online, interactive map would readily support this particular use case, and others that are readily formulated.

Why, then, is it still considered appropriate to publish the map, knowing that citizens are likely to misinterpret the expanding cone as a prediction of a growing hurricane? How might the papers in this issue be enhanced if many of the included maps could be available interactively on the web? Would an interactive map designed to support one or more anticipated use cases be less likely to encounter the 'eye-candy' epithet?

Conclusion

As I noted at the outset, this is a very exciting time for cartography. New technologies have brought far greater attention to maps than they have enjoyed in the past, and enabled many new kinds of maps. It will be some time before the full impacts of these new technologies are recognized and understood.

That said, however, this overview paper has identified four ways in which thinking about geographic information is changing. The new technologies appear to provide enhanced opportunities for a global perspective that is relatively free of the distortions inherent in map projections, by enabling digital versions of the familiar globe. They are clearly changing the role of geographic information in the everyday life of the citizen, who is now able to function both as a consumer and as a producer of geographic information. This engagement of the citizen is leading in turn to a rebalancing of the relationship between space and place, and between a global, standardized set of mapping practices and a more humanist, community-oriented approach. Finally, the new technologies allow maps to become dynamic and interactive, replacing a one-size-fits-all design with one that accommodates and supports specific well-defined use cases.

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