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NeoGeography and the nature of geographic expertise

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NeoGeography has been defined as a blurring of the distinctions between producer, communicator and consumer of geographic information. The relationship between professional and amateur varies across disciplines. The subject matter of geography is familiar to everyone, and the acquisition and compilation of geographic data have become vastly easier as technology has advanced. The authority of traditional mapping agencies can be attributed to their specifications, production mechanisms and programs for quality control. Very different mechanisms work to ensure the quality of data volunteered by amateurs. Academic geographers are concerned with the extraction of knowledge from geographic data using a combination of analytic tools and accumulated theory. The definition of NeoGeography implies a misunderstanding of this role of the professional, but English lacks a basis for a better term.

Keywords: mapping; crowdsourcing; NeoGeography; spatial data infrastructure

1. Introduction

Wikipedia (www.wikipedia.org) defines NeoGeography as 'the usage of geographical techniques and tools...for personal and community activities...by a non-expert group....' This is rather different from the definition proposed by Rana and Joliveau (in press), who argue that the transition from traditional geography to NeoGeography is characterised by a blurring of the traditional roles of subject, producer, communicator and consumer of geographic information: 'In other words, the old geography involves a prescribed role/interaction between the four main components, namely the audience, the information, the presenter and the subject, which are common to most standard practises of learning. In NeoGeography, there are, however, no such boundaries on roles, ownership and interactions of these four components.' In this article I first explore this second definition, and what it implies about the various kinds of expertise employed in the enterprise of creating geographic information. I then distinguish between these kinds of expertise and those employed by academic geographers in the creation of geographic knowledge and understanding. I end with comments about the limitations of the English language, and the need for academic geographers to explain better what it is they do with their familiar subject matter.

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Central to the argument is the question of what exactly Rana and Joliveau meant by 'the old geography'. The phrase 'standard practises of learning' suggests that the context is academic, and thus that NeoGeography is being contrasted with academic geography. But 'the old geography' might refer to the traditional systems of geographic information production, and thus to the authoritative mapping agencies; and it might also be read as equating with map-making or surveying, and thus to the traditional roles of cartographer and surveyor. I explore all of these possibilities in detail in this article.

The separation between scientist and layperson, between expert and novice, is driven in many disciplines by the complexity of subject matter, by terminology that may be essential to precise communication within the discipline, but inaccessible to the outsider, by the high cost of entry into the observational process and the difficulties of empirical measurement, and by the complexity and abstraction of the discipline's main concepts. All of these contribute to making many sciences impenetrable to the average citizen. While the Ivory Tower is often characterised in this way, academics sometimes go to great lengths to make their science accessible, and scientists such as Carl Sagan or Stephen Jay Gould have made a fine art of communicating difficult concepts to the general public. Nevertheless there is no doubt that concepts such as string theory or spatial statistics will always remain largely incomprehensible outside their respective rarified communities. No one would suggest that a *neophysics* might emerge that blurred the boundaries around high-energy physics; or that brain surgery might be invaded by a generation of untrained *neoneurosurgeons*. The complex equipment necessary to engage in observation in many disciplines – electron microscopes, Earth-observing satellites, high-performance computers – creates a barrier to amateur engagement, as does the lengthy process of apprenticeship through advanced degrees that many disciplines require.

Then why NeoGeography? I argue in this article that proximity to and familiarity with the subject matter of any science is a major factor in its public image and in the attitudes that form around it. In short, everyone feels himself or herself to be an expert in geography because geography is experienced by everyone. The same kind of criticism is often levelled at the social sciences generally, on the grounds that all of us experience and deal with human nature. Moreover recent developments, such as GPS, the Web, and open-source GIS, have reduced the cost of entry into map-making and geographic information collection almost to zero. In the next three sections I explore the various kinds of expertise needed to collect and assemble geographic information, and show that in most cases that expertise is now available in some form to everyone. Section 5 explores the broader concept of citizen science, a term used to describe the engagement of citizens in the process of collecting scientific data generally. Section 6 then characterises the enterprise of academic geography, and the various forms of expertise possessed by its practitioners. The article concludes with general comments about the awareness of those forms of expertise among the general public, about how the term geography is overloaded, and about the need for an engagement between NeoGeography and academic geography. Throughout, the terms *academic geographer* and *academic geography* are used to refer to professional geographers and their work. The final section includes a discussion of possible relationships between the 'old geography' of Rana and Joliveau and academic geography.

Central to the argument is the distinction between data, information and knowledge. The term data is most often associated with observation, while the term information implies that data have been manipulated, filtered, processed and interpreted into a form that addresses some definite use. Knowledge includes the general principles that are abstracted from information: the theories, models and procedures that have been tested and found to work, and are available for application.

2. Spaces of familiarity

Johnston *et al.* (2000) define *activity space* as 'the area within which the majority of an individual's day-to-day activities are carried out.' It defines an area unique to each individual that encompasses home, place of work and local areas used for recreation and other normal activities. It is related to the concept of neighbourhood, though the latter conveys a stronger sense of community affinity and interaction, and may not include place of work. For the purposes of this discussion activity space will be taken as a surrogate for familiarity; that is, I will assume that an individual has some degree of personal knowledge, acquired directly through the senses, about the geography of his or her activity space. That knowledge may be no more than familiarity with the broad topographic structure of the area, and some of its place names, streets and hydrography. On the other hand it may include the comprehensive knowledge that a person acquires after long-term residency in an area.

Of course a variety of specialised activities lead to the spatial extension of this expertise. Travel for business or pleasure, learning through formal and informal means and exposure to the media all serve to extend an individual's area of familiarity over a larger geographic domain than is implied by his or her routine activity space. Moreover, migration adds a temporal element to activity spaces, such that by the end of a lifetime an individual may have acquired some level of familiarity with widely scattered areas of the planet, at various points in time. In the past academic geographers have often prided themselves on the spatial extent of their expertise, have become experts in remote areas of the planet, and have developed courses and texts in regional geography. Much of this has disappeared recently, however, as geographers have argued that possession of geographic facts, and familiarity with exotic parts of the world, is of less importance than understanding of the processes that occur on and near the Earth's surface. This trend mirrors a larger one in which geographic ignorance is a well-documented feature of today's citizenry, despite a steady expansion and enrichment of the educational process; and contrasts sharply with recent increases in international tourism and what one might assume to be their benefit in increasing familiarity with distant places.

From this viewpoint academic geographers might be defined and distinguished by the unusually wide spatial extent of their familiarity and experience. Nevertheless Vermeer pictured his Geographer as confined to an office poring over maps that were likely made by others, and gazing somewhat wistfully into the real world outside his window (for a commentary along these lines see Downs 1997). In Saint-Exupéry's *The Little Prince* the geographer is someone who never travels, relying entirely on the reports of others and struggling with the assessment of their veracity (Saint-Exupéry 2000; see also Cowan 1996).

Geographic familiarity is subject to a form of spatial and temporal interpolation. Suppose, for example, that I visit a location **x** and at time t. My familiarity with that exact point at that exact time will be high; but I will also have acquired a degree of familiarity with nearby points **y** even though I have not precisely visited them; and my familiarity with a location at time t serves to provide a degree of familiarity with that location at other times u. In the spatial case one might expect familiarity to decline systematically with distance $\|\mathbf{y}-\mathbf{x}\|$ from each visited point, characterised by a length parameter λ. For example, λ might be defined as the distance over which familiarity halves, and might be defined at least in part by the limits to sensory perception. In the temporal case one might argue that interpolation is asymmetrical; that by visiting a location at time t one gains a greater sense of familiarity with its future than with its past. For example, having seen the Walt Disney Concert Hall in downtown Los Angeles I might feel more familiar with that area of the city 5 years from now, and less familiar with that area 5 years ago before the building was constructed. Thus decline in familiarity in time might be characterised by a forward parameter τ_f and a backward parameter τ_b, both expressed in temporal measure.

Consider Figure 1 as a map of geographic familiarity. It identifies all of the counties of the coterminous US that I have personally visited in the past 46 years (where *visited* is interpreted to mean entering the county on the ground). In this case there is no temporal decline (τ_f is infinite), and the spatial decline is reflected in the use of the county as the reporting zone, implying that visiting a single point within the county is sufficient to acquire familiarity with its entire area, but that familiarity falls to zero at the county's boundaries. This assumption is clearly more tenable for the smallest counties (the city-counties of Virginia) than for the largest (San Bernardino County in California).

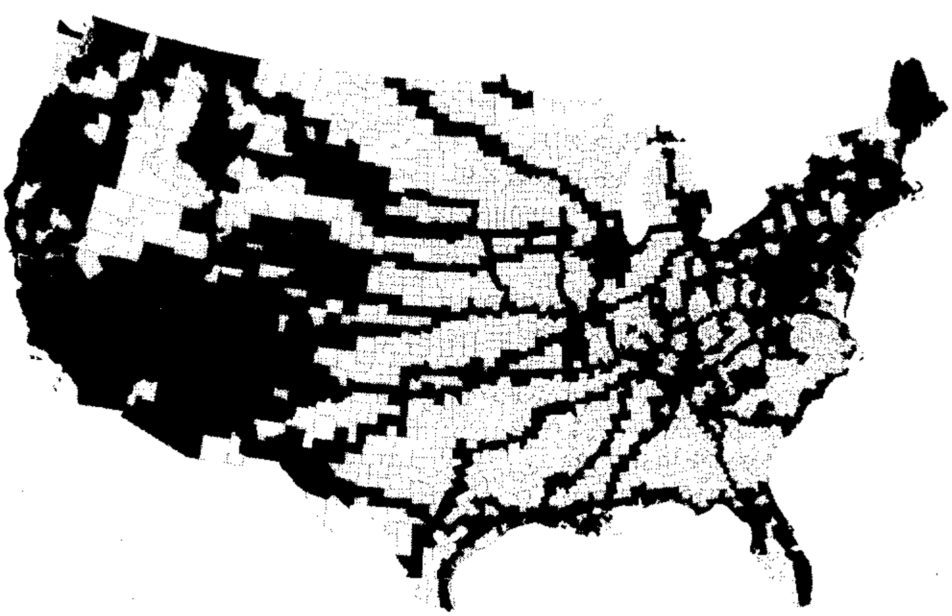

Figure 1. Map of the U.S. by county showing areas the author has visited in the past 46 years, where 'visit' is defined as entering the county on the ground at any point.

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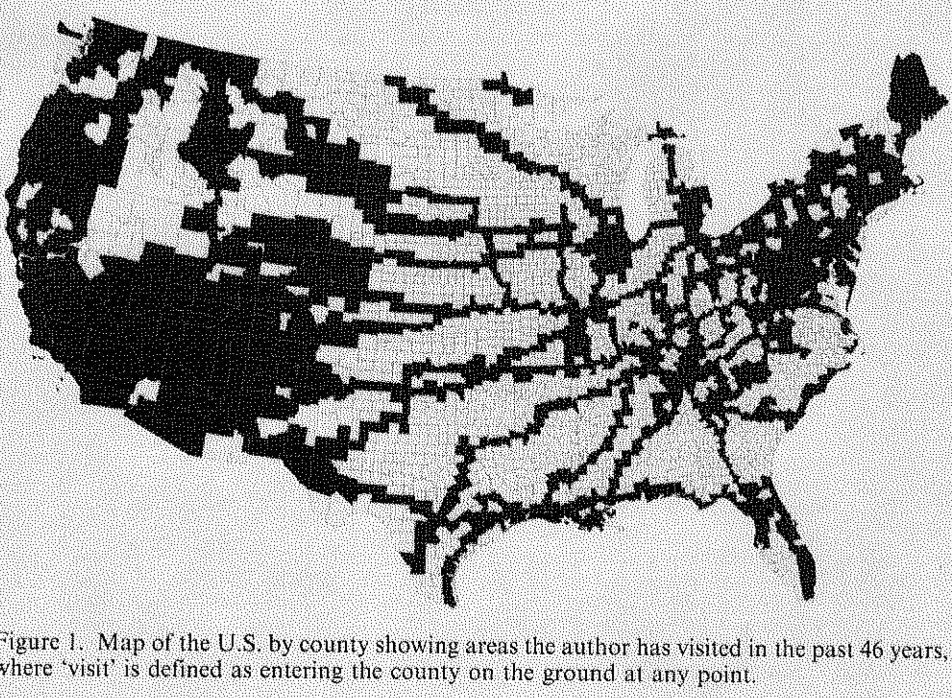

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If the subject matter of geography is the surface and near-surface of the Earth, then it is clear that every individual can claim familiarity with specific areas of that subject matter. In the past, of course, there were severe constraints on travel and the acquisition of geographic knowledge through the media and education. Europeans knew virtually nothing about the Americas until the late 15th century, and similarly the inhabitants of the Americas knew nothing about Europe. Even today certain areas of the planet, including caves, the highest mountains and the polar regions, remain unfamiliar to all but small numbers of specialists. In these latter domains the expert retains a distinct role, as he or she does in high-energy physics. One would not expect to hear of a breaking down of the distinction between an expert on Antarctica and an audience for Antarctic knowledge, any more than one would expect an emergence of neophysics. On the other hand increasing travel, and the familiarity that individuals have with local geography, seems to be a major reason for the blurring of the distinction between expert and non-expert that is reflected in the rise of NeoGeography.

3. Production of geographic information

Geographic information can be defined as information about the nature and locations of phenomena on or near the Earth's surface. More formally, all forms of geographic information can be conceptualised as composed of fundamental atomic tuples $\langle \mathbf{x}, \mathbf{z} \rangle$ where $\mathbf{x}$ is a location in space–time and $\mathbf{z}$ is one or more properties of that location (Goodchild *et al.* 2007). Maps are rich compilations of such information, as are globes, geo-registered images and even statements such as 'It is cold today in Calgary' or 'The elevation of Mt Everest is 8848m'. Vast amounts of geographic data were collected by explorers such as Cook and von Humboldt, and subsequently compiled and published as maps, atlases and books, albeit of highly variable quality. The expertise of a Cook or a Scott, however, was largely in navigation, leadership and endurance, all skills which are always in short supply. Today we associate no particularly advanced level of expertise with visiting such exotic areas as the Galapagos or Antarctica, and can imagine almost anyone with enough time, minimal sailing skills and GPS creating a map of the east coast of Australia that is far more accurate than Cook's.

Until recently the process of accurate map-making was long, complex and expensive. It required considerable skill in the use of photogrammetric techniques, expensive equipment for observation and analysis and substantial investment in large-format printing. Today, however, almost all of these constraints have been removed. The OpenStreetMap project (www.openstreetmap.org; Figure 2) is an impressive demonstration of what can be achieved by amateurs with minimal background in cartography or the acquisition and compilation of map data. Issues of style that so concerned cartographers in the past are addressed by standard software using algorithms that are now well known; no investment or expertise in printing is needed since all publication is on-line; and the complex cartographic specifications used by government mapping agencies are largely redundant in the case of familiar features such as streets, railways and rivers. OpenStreetMap is attempting to build a complete, open and free digital map of the world as a collaborative effort largely by volunteers, and provides a very clear demonstration

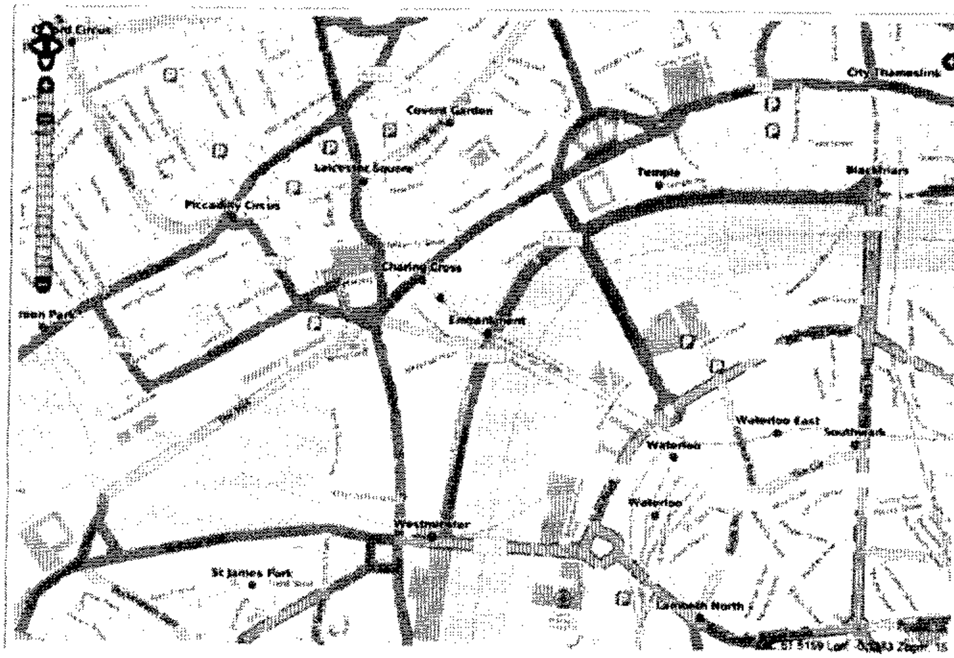
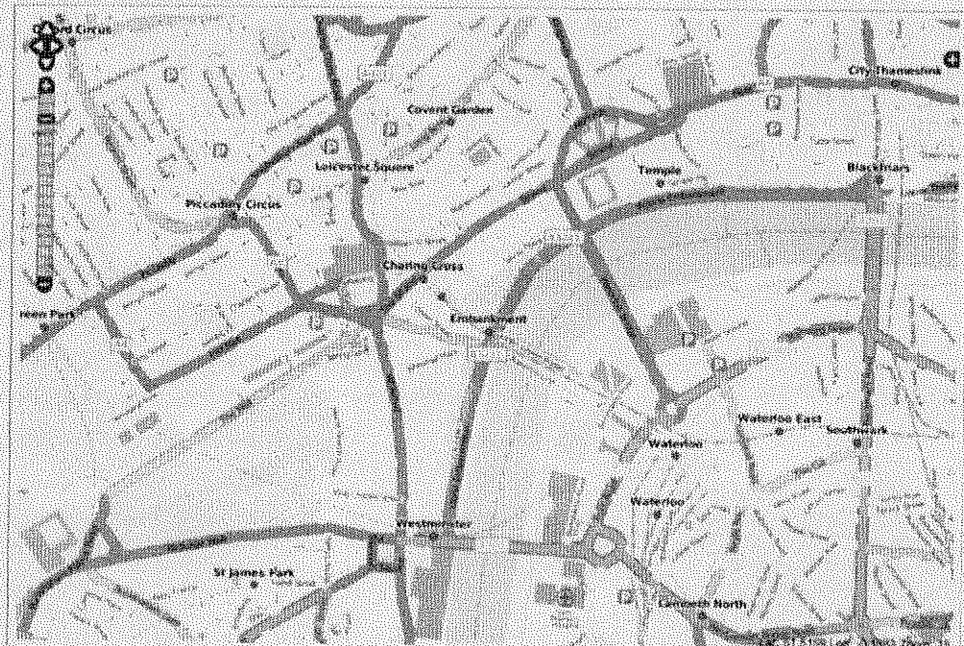


Figure 2. OpenStreetMap coverage of Central London, produced largely by the efforts of volunteers.

of what can be achieved by NeoGeographers in an arena previously dominated by large, expensive central mapping agencies such as the Ordnance Survey of Great Britain.

Mapping of streets and other well-defined features may require simple skills that almost anyone possesses: the ability to use GPS to determine location, and the ability to identify the names and other obvious characteristics of features. Similarly mapping of topography through the measurement of both location and elevation, together with the use of software to interpolate contours, is likely to open the field of topographic mapping to any suitably motivated amateur. In other areas, however, the levels of skill required for the production of geographic information are much more advanced, and the barriers to becoming a producer are substantial. To be a surveyor, for example, one has to undertake a lengthy process of training, and although the task of geometric measurement may now be much easier as a result of advances in technology, it is necessary also to be familiar with the complex set of legal and regulatory arrangements that exist to ensure the quality of a surveyor's work.

Consider, for example, the process of mapping soils. Soil mapping is a complex and lengthy process in which every point on the landscape is assigned one of a set of soil classes, each of which is described in detail in a legend. The definitions of classes are to some degree vague, and it is inevitable that two soil scientists mapping the same area will not produce identical maps, however advanced their expertise and experience. Soil mapping is clearly not for amateurs. On the other hand the users of soil maps – farmers, developers, regulators or gardeners – often lack the expertise



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Perhaps the following is the appropriate counter-argument. Soil scientists must make maps for as wide a set of applications as possible, in order to justify the high cost of observation, compilation, printing and distribution. Although none of the users is likely to need soil information for a wide area, soil mapping programs also emphasise broad spatial coverage, in order to again ensure the largest possible set of users. While amateur users may be familiar with such narrowly defined applications as horticulture, only soil scientists have sufficient expertise to understand and accommodate the much broader set of uses that soil maps must address if they are to justify their costs, or to interpret soil maps in the context of specific applications. However, we noted earlier that the fixed costs of map production have fallen dramatically. Moreover, modern technology is capable of organising geographic information so that it can be used to respond to single queries such as 'What is the soil type at x?' without delivering an entire tile of a map series; and capable of creating cheap, special-purpose maps that characterise soil in ways that address the needs of specific users. So while amateurs may lack the expertise needed to participate in the traditional process of soil mapping, it may nevertheless be possible for them to create, share and use information about soils that is useful in certain contexts.

4. Quality and authority

In the case of surveying and the creation of cadastral information, there is a longstanding tradition that the products of professional surveyors are of high quality. Terms such as *professional* convey an immediate sense of care, attention to detail and adherence to rigorously applied standards, whereas the very term *amateur* suggests poor quality and is even used pejoratively. This same association of quality with authority holds for mapping agencies in general: information obtained from such agencies as the U.S. National Ocean Service or the U.S. Geological Survey (USGS) is immediately assumed to be of high quality. At the same time no geographic data can be perfect, since it is based on measurements and observations and subject to innumerable sources of uncertainty. So it is useful to ask why such agencies are associated with quality, and by what process the efforts of amateurs might acquire the same reputation.

Figure 3 shows a Google Earth mashup of the base imagery, the roads layer (supplied in this case by Navteq), and a piece of high-resolution imagery that has been carefully registered to better than 1 m using several control points and GPS measurements. Note the approximately 15 m shift between the high-resolution imagery and the Google base, and note also that the roads layer agrees much better with the high-resolution imagery than with the Google base. Navteq data is known to be positionally accurate to better than 10m, and in this case it appears that it is the

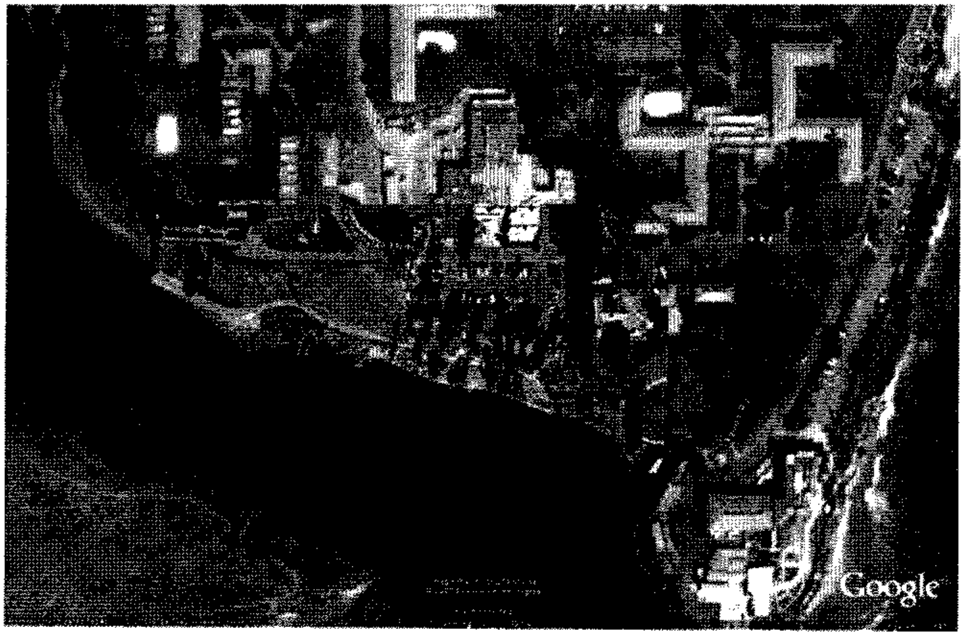

Figure 3. Google Earth mashup of a high-resolution image of part of the campus of the University of California, Santa Barbara, illustrating the inferred misregistration of the Google Earth base imagery.

Google base that is most substantially misregistered. However, a 15m shift is quite acceptable for many of the purposes for which Google Earth was designed.

The USGS operates in a very different environment from Google, and one in which quality is of major concern. One might expect, therefore, that problems such as these would not exist with the National Map, the USGS's main engine for dissemination of its vast resources of geographic information. Yet Figure 4 shows a very similar degree of misfit between its main imagery and streets layers. It is of course impossible to measure location perfectly, and unlike Google the positional accuracy of every USGS product is defined by the product's specifications and subject to frequent test. The USGS streets coverage has been obtained from 1 : 24,000 topographic mapping, with a published positional accuracy of ~12 m, and the USGS digital orthoimagery has a published positional accuracy of ~6 m. To the average user, however, who has not examined USGS specifications in detail and may lack the basic training needed to interpret them, both Google Earth and the National Map display similar levels of positional uncertainty.

Until recently national mapping agencies such as the USGS were the only extant source of geographic information. The processes they developed are well documented, and over time users came to trust their products. In part this may be because of the extensive *metadata* available for such products, in the form of documented specifications, test results and mandates. By contrast no comparably extensive metadata exist for projects such as OpenStreetMap, for Google Earth or for Navteq data. But in recent years the user base for such products has grown to include large numbers of individuals with little or no training in the geospatial sciences,

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Figure 4. Misregistration of digital orthoimagery and roads in the US Geological Survey's National Map service.

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A quite different argument is often used regarding the quality of sources such as Wikipedia, the on-line encyclopedia. Like OpenStreetMap it is an effort by thousands of volunteers, and relies on the willingness of individuals both to contribute entries and to edit entries for errors. The *crowdsourcing* or *collective intelligence* argument suggests that entries created by large numbers of people are likely to be more accurate, or more likely to be accurate, than entries created by individuals. Wikipedia also maintains a hierarchy of volunteer editors with responsibility for checking and accepting entries and edits. Given the breadth of material, however, it is difficult to ensure that every entry is reviewed by an editor with a high level of familiarity with the subject. Nevertheless, the consensus appears to be that Wikipedia entries are of high quality, particularly the more important entries on topics for which substantial shared expertise exists.

If one were to extend this argument to the geographic case, it would suggest that local expertise can provide the basis of a powerful mechanism for quality control. A hierarchy of editors might be defined on a purely geographic basis; any new entry concerning a place would be referred to the first-level editor whose expertise covers that place; and entries would then move up the geographic hierarchy. The arguments for crowdsourcing as a mechanism for quality control clearly work better in areas

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It is interesting to compare this approach to the traditional one employed by national mapping agencies, which have traditionally made very little use of local expertise in the mapping and editing process. Of course the organisation of mapping at the national level was driven originally at least in part by the need for economies of scale in an enterprise with a very high cost of entry. But with the cost of entry now close to zero such economies of scale are no longer needed.

5. Citizen science

The term *citizen science* is often used to describe the engagement of amateurs in the scientific process, particularly in the observational sciences. The Christmas Bird Count (http://www.audubon.org/bird/cbc/index.html), managed by the Audubon Society, is a major effort to engage amateur ornithologists (*birders*) in the collection of a comprehensive census of bird populations. Extensive protocols exist to ensure that the results are consistent through time and across space and scientifically useful as observations, and participants must possess a substantial level of skill in the identification of bird species. Project Globe (http://www.globe.gov/r) is managed by the University Consortium for Atmospheric Research as an international effort to engage schoolchildren in the observation of local environmental conditions, particularly weather. Data are uploaded from thousands of schools around the world, synthesised and redistributed for use by their originators and by scientists. Again detailed protocols exist, and teachers are subjected to extensive training. Astronomy is another discipline with significant engagement with amateur observers, some of whom have made many significant discoveries in recent years.

These examples seem to focus on those sciences with substantial focus on observation. In each case the cost of entry is much lower than it is for professionals in the science, both in the training required of observers and in the cost of observational equipment. Nevertheless one would not expect the average participant in the Christmas Bird Count to be engaged in the development or empirical testing of sophisticated mathematical models of population ecology, or expect amateur astronomers to be making significant advances in theoretical cosmology. The amateur in both cases is limited to engagement in the process of raw observation, and to the inductive rather than deductive role of empiricism.

Yet this distinction between citizen and professional scientist is remarkably recent, and many of the great scientists of the past lacked all, but the most basic training in observation. If one takes professional qualifications as the distinguishing characteristic of the professional, Darwin was by modern standards an amateur ornithologist, Banks was an amateur taxonomist and Galileo an amateur astronomer. Their observational methods might even fail to meet the standards we require today of our students (Waller 2002). What in most cases distinguished the now-famous scientist from the amateur observer was not the observations *per se*, but the ability to draw inferences and to develop theory from those observations.

By extension, then, the flaw in the NeoGeography argument is not that geographic observation requires the skill of a professional, or even that professional expertise is needed to compile observations into maps. Instead, the professional geographer is distinguished by his or her ability to reason beyond observation – to develop new generalisations and theories, to test theories by comparing their predictions to observations, and to possess the sophisticated analytic tools needed to reveal insights that are not immediately apparent. In the widely accepted view Martin Waldseemüller and Vautrin Lud chose to name their new continent America after Amerigo Vespucci because they believed his claim to have been the first to recognise that the new lands discovered west of the Atlantic were a previously unknown continent (Fernández-Armesto 2007) – in other words, Vespucci's contribution was an inference from observation that Columbus had failed to make. Similarly the widespread recognition accorded such geographers as von Thünen, Christaller, Hagerstrand, Tobler and Bunge stems from their contributions to general principles. While Tobler's observation that 'nearby things are more similar than distant things' (Tobler 1970) may be blindingly obvious on reflection (and no more so than Newton's Laws of Motion), and while similar ideas have a long history in other disciplines, his statement was nevertheless a powerful advance in geographers' ability to generalise about the world around them.

However, the popularity of NeoGeography suggests that unlike physicists and ecologists, academic geographers have generally failed to convince the average citizen that a substantial body of theory exists about the distribution of phenomena over the Earth's surface, or that analytic tools can greatly extend the value of raw observations. Too often, it seems that the task of the geographer has been perceived as no more than *geo graphics*, in other words the graphical portrayal of the Earth's surface in the form of maps. Services such as Google Earth reinforce this view, with their excellent capabilities for presenting the Earth in recognisable visual form, but almost complete lack of the kinds of analytic capabilities that are abundant in a GIS. The NeoGeography definition suggests a perception that geography as a discipline is still largely descriptive, and still locked in the familiar 'capes and bays' or 'corn and hogs' parodies of geographic education.

6. What academic geographers know

If the central notion of NeoGeography, the sweeping away of distinctions between professional and expert, is founded as I have argued on a misperception of what it is academic geographers know and do, it might be worth elaborating a little on that theme before attempting a reconciliation. In essence the argument concerns reasoning, assisted perhaps by tools and techniques, that can reveal insights from the analysis of data and observations, and theories that can account for and explain those data and observations. Collectively they constitute the means by which academic geographers extract higher-level knowledge from raw geographic data. The means by which they do so varies enormously, from the qualitative and conceptual methods that dominate cultural geography to the quantitative methods implemented in GIS. The following two subsections focus on that latter context, which is where the process of reasoning is most clearly and conspicuously articulated and formalised, but the same arguments can be found in conceptual form throughout the enterprise of academic geography.

6.1. *Analytic tools*

Over the years statisticians, geographers, economists and others have developed a host of techniques for the analysis of geographic data, all of them aimed in one way or another at the extraction of insights that are not otherwise apparent. By emphasising the geographic aspects of data, in other words by linking observations to specific locations on the Earth's surface, geographers employ what is often termed a *spatial perspective* or *spatial lens*. When GIS appeared as a commercial product in the late 1970s it was immediately hailed as a powerful platform for this kind of analysis, and over the years numerous functions have been implemented. Today it is possible to assert that GIS is capable of virtually any conceivable operation on geographic data; that it represents a comprehensive operationalisation of the spatial lens.

The analytic functions implemented in GIS go by various terms, including *spatial analysis*, *spatial data analysis*, *geographic analysis*, *geographic data analysis* and *spatial data mining*, but all imply essentially the same thing: a collection of powerful tools for the precise analysis of geographic data. Some authors distinguish between those techniques used primarily for exploration and hypothesis generation and those used primarily for hypothesis testing and confirmation. De Smith *et al.* (2007) have recently published a comprehensive guide that includes pointers to the GIS products that implement each of the techniques.

Several efforts have been made to systematise what is otherwise a confusing mass of methods. Tomlin (1990) developed *Map Algebra*, which organises all analytic functions into four categories, but is only applicable to raster data. Longley *et al.* (2005) use six categories that are designed to organise techniques in ascending conceptual complexity. Most recently de Smith *et al.* (2007) have proposed an organisation based on the fundamental spatial concepts explored by each technique. For example, there are many techniques designed to search for spatial clusters and to test the statistical significance of each, based on the notion that points in space often form clusters, either because conditions there are particularly favourable (*first-order* clustering) or because an initial infection spread through its immediate neighbourhood (*second-order* clustering).

6.2. *Spatial theory*

A spatial theory can be defined as one in which spatial concepts such as location, distance or adjacency appear as terms in the theory and share in its explanatory power. The argument that theories can exist in geography – in other words that there can be theories about the distribution of phenomena on the Earth's surface – has a long history in the discipline dating back at least as far as Varenius (Warntz 1989), and has often been the subject of extensive debate (Bunge 1966). Central Place Theory (Christaller 1966), which uses assumptions about the behaviour of entrepreneurs and consumers to explain the locations of settlements in agricultural landscapes, is one of the best known. Spatial interaction theory (Fotheringham and

O'Kelly 1989) addresses the systematic decline of human interaction with distance in such phenomena as migration, shopping behaviour and telephone traffic. Reference has already been made to Tobler's First Law of Geography (Tobler 1970), which is based on the observation that many phenomena vary smoothly over the Earth's surface, allowing locations to be aggregated into approximately homogenous regions, and allowing reliable estimates to be made of properties such as air temperature at locations where such properties have not been measured (*spatial interpolation*).

7. Reinventing geography

Like any empirical discipline, academic geography needs a reliable source of observations both as a source of insight and as a testbed for its theories. In the past academic geographers have relied on direct observation through field work, and on such secondary sources as the census and the products of mapping agencies. It has become increasingly apparent, however, that many of those secondary sources are drying up. Government is less and less willing to foot the bill for map-making efforts that serve the needs of small minorities of voters, while the costs of entering the mapping business have fallen almost to zero, allowing virtually anyone to make a map. This sea change is reflected in the emergence of the National Spatial Data Infrastructure (National Research Council 1993), a set of national policies based on the belief that map-making is becoming a community enterprise that must be supported by effective standards and access mechanisms.

In an earlier paper (Goodchild 2007) I proposed the term volunteered geographic information (VGI) to describe the actions of thousands of individuals who are now contributing user-generated geographic content in the Web. There are now literally hundreds of Web services that collect, compile, index and distribute VGI content. Wikimapia encourages users to 'describe the whole world'; OpenStreetMap is developing a free digital map of the world; and Flickr is compiling a vast resource of georeferenced photographs. But while the growth of VGI is clearly blurring the distinction between the traditional authoritative sources of geographic information and the assertions of amateurs, it falls far short of replacing the activities of academic geographers as outlined in the previous section.

Unfortunately we lack a word in English that would clearly distinguish the VGI enthusiast as an acquirer of geographic data from the role of the academic geographer. The term *surveyor* is generally used to refer to someone who employs accurate instruments to capture the geometry of features on the Earth's surface, notably to delimit property boundaries and in support of construction. A *cartographer* is someone who studies the science of map-making, working to improve designs and to understand better how people use and react to maps; but while a VGI enthusiast might help to make a map, the cartographic designs of projects like OpenStreetMap are already locked into software. Moreover, it would be a mistake to think of all VGI as being presented in map form since there are many types of geographic data for which the traditional map is not a feasible or practical display mechanism. The term *explorer* is often used to refer to collectors of geographic data, but it has gone out of use as the Earth's surface has become better known. Nevertheless *neo-explorer* might be a more accurate way of describing the contributor of VGI; although the areas being described are already well known, the great value of VGI is in making that familiarity vastly more useful and accessible through the mechanisms collectively known as Web 2.0. The role of contributors to OpenStreetMap is not to provide the kinds of new geographic knowledge that academic geographers might extract from data, but to provide an alternative to an older authoritative source of geographic data that has become too expensive for governments to maintain, and too expensive and difficult for the average person to use. That alternative is by its nature asserted, because it comes with none of the mechanisms for quality control favoured by mapping agencies – but as we have seen other mechanisms associated with amateur efforts may well provide suitable assurances of quality.

Hybrid solutions to the production of geographic data may well represent the best of both worlds. There is clearly a role for central management and coordination, but the local expertise that VGI builds on is also very valuable. Increasingly we are seeing mapping agencies and private companies relying on networks of local volunteers and even paid part-time employees to acquire and maintain their geographic data resources. For example, the Ordnance Survey of Great Britain is a sponsor of the Geograph project, which invites people to volunteer photographs of local areas and other geographic data to a communal Web site (http://www.geograph.org.uk/), providing a useful resource both for the agency and for the public at large. Local volunteers can provide early warning of changes in local geography as well as effective error correction.

To conclude, the world of authoritative geographic data is being rapidly augmented and to some extent replaced by a new world of asserted geographic data. The old distinction between the non-expert amateur and the expert professional is quickly blurring in this arena, since few if any of the arguments that built and sustained the traditional system of map production are now viable. But unfortunately English lacks an appropriate term for the producer of geographic data – geographer, surveyor, cartographer and explorer are all inappropriate. As Taylor argued (Taylor 1990), it is easy to confuse the process of collecting geographic facts with the process of geographic research. At worst, the definition of NeoGeography cited at the outset reflects a common misunderstanding of the work of academic geographers for which academic geographers themselves are most to blame.

At the same time the changes that NeoGeography echoes, in a growing willingness of amateurs to be involved in the mapping process, and a growing recognition that we are all experts in our own local communities, has much to offer to improving the relationship between humans and the world around them. A greater engagement between NeoGeography and academic geography can provide a powerful new source of data and observations; and it can also lead to greater public awareness not only of how the world looks, but also of how it works, and how it may look in the future.

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