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Web Mapping 2.0: The Neogeography of the GeoWeb

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Abstract

The landscape of Internet mapping technologies has changed dramatically since 2005. New techniques are being used and new terms have been invented and entered the lexicon such as: mash-ups, crowdsourcing, neogeography and geostack. A whole range of websites and communities from the commercial Google Maps to the grassroots OpenStreetMap, and applications such as Platial, also have emerged. In their totality, these new applications represent a step change in the evolution of the area of Internet geographic applications (which some have termed the *GeoWeb*). The nature of this change warrants an explanation and an overview, as it has implications both for geographers and the public notion of Geography. This article provides a critical review of this newly emerging landscape, starting with an introduction to the concepts, technologies and structures that have emerged over the short period of intense innovation. It introduces the non-technical reader to them, suggests reasons for the neologism, explains the terminology, and provides a perspective on the current trends. Case studies are used to demonstrate this Web Mapping 2.0 era, and differentiate it from the previous generation of Internet mapping. Finally, the implications of these new techniques and the challenges they pose to geographic information science, geography and society at large are considered.

1 Introduction

From an early start over 15 years ago, the use of the Internet to deliver geographic information and maps is burgeoning. However, within this period, there has been a step change in the number of users and more importantly in the nature of applications that, in their totality, are now termed 'The Geographic World Wide Web' or 'the GeoWeb'. The number of visitors to public Web mapping sites provides an indication of this change. In mid-2005, the market leader in the UK (Multimap) attracted 7.3 million visitors and, in the USA, Mapquest was used by 47 million visitors. By the end of 2007, Google Maps was used by 71.5 million and Google Earth by 22.7 million (*Wall Street Journal* 2007). Moreover, by mid-2007, there were over 50,000 new websites that are based on Google

Maps (Tran 2007) whereas in the previous era of Internet mapping, the number of mapping websites was significantly smaller due to technical and financial barriers.

This dramatic landscape change is accompanied by neologism of its own.[1] New terms are being coined to describe new techniques that are being used such as: map mash-ups, crowdsourcing, mapping application programming interfaces (API), neogeography, geostack, tags, geotechnologies and folksonomies. These rapid developments in Web mapping and geographic information use are enabled and facilitated by global trends in the way individuals and communities are using the Internet and new technologies to create, develop, share and use information (including geographic information), through innovative, often collaborative, applications. The term 'Web 2.0' is frequently used to describe these trends and was first coined by Tim O'Reilly on 30 September 2005 at the first Web 2.0 Conference. He later clarified his definition as:

> Web 2.0 is the business revolution in the computer industry caused by the move to the Internet as platform, and an attempt to understand the rules for success on that new platform. (O'Reilly 2006)

The term 'Geospatial Web' implies the merging of geographic (location-based) information with the abstract information that currently dominates the Internet. Notice that while the term 'Geospatial' has a long history (see Kohn 1970 for one of the first uses of the term), it has gained increasing popularity within the recent past to describe computer handling of geographic information. There has been an increased awareness by numerous Web 2.0 technologists of the importance of geography and location as a means to index and access information over the Internet. As a result, over the last few years, geographic information could be argued to have firmly entered the mainstream information economy. We will use the term 'Web Mapping 2.0' to describe this new phase in the evolution of the geospatial Web. As Goodchild (2007a, 27) noted,

> [T]he early Web was primarily one-directional, allowing a large number of users to view the contents of a comparatively small number of sites, the new Web 2.0 is a bi-directional collaboration in which users are able to interact with and provide information to central sites, and to see that information collated and made available to others.

The purpose of this article is to provide the non-technical reader with a review of this short period of intense innovation, which is rapidly changing the Web mapping landscape. This will review the historical growth of Web mapping and an introduction to the latest concepts, technologies and structures; explain the characteristics and trends of Web Mapping 2.0 supported by case studies; and discuss the implications and opportunities of these developments on geographic information science, geography, geographic information providers and society.

Noteworthy is the fact that the examples we are using are all UK-based. Development of Web 2.0 is happening across the globe, but several important activities have occurred in the UK over the past few years. For example, the open geographic information project OpenStreetMap started in London, and the Ordnance Survey is the first national mapping agency to release a Web-based open application programming interface for the use of its products.

Before turning to the body of the article, it is worth outlining the core of our argument. As the discussion below will show, the recent changes have not created new functionality in geographic information delivery. Internet-based information delivery has a 15-year history and, for example, the functionality that allows the integration of information from multiple websites (mash-up) was possible by utilising the Open Geospatial Consortium (OGC) standards since 2000. The concept of the geostack – the multiple technological components that allow collecting, storing and sharing geographic information – has been appearing in the literature for almost 40 years as geographic information system (GIS) (see Kohn 1970) or in its Internet incarnation in the OGC documentation. Thus, the change is not of increased functionality, rather how emerging technologies have created new approaches to geographic information distribution and, most importantly, in the usability and ease of application development. Previous reviews (Plewe 2007; Tsou 2005; Turner 2006) have provided a good introduction to the technical developments; however, they have not explained the consequences of these changes. The aim of this article is to combine the technical and societal analysis to explain the emergence of Web Mapping 2.0 and, more importantly, why the concept of neogeography emerged.

2 The GeoWeb – the First Decade

Internet mapping started early after the emergence of the World Wide Web (WWW or Web) with the introduction of the Xerox PARC Map Viewer in 1993 (Putz 1994). This application provided very rudimentary capabilities – the ability to present a map of the world, zooming at predefined scales and controlling the visibility of rivers and border features.

Technically, the ability of the WWW at this time was to create a Web page (a Hypertext Markup Language or HTML file) in which an image file is embedded. The interaction between the user and the map was implemented by a computer code (a Common Gateway Interface or CGI script), which ran on the Web server. Each time the user clicked on one of the links on the page, the user's Web browser sent a request to the server. The request encoded in it the coordinates of the area that the user was interested in and other options such as the layers that were to be displayed. Once the server received the request, it would execute the CGI script, which would produce the HTML page and the associated image

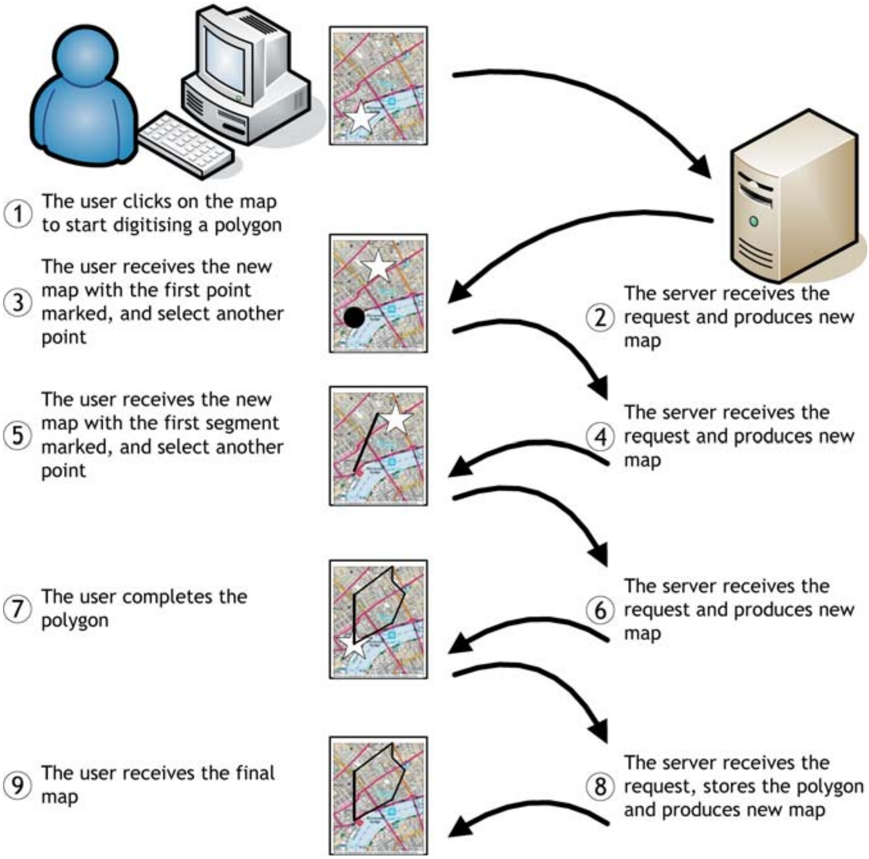

Fig. 1. Digitising of area over the Internet – transactions between client and server.

file that presented the new map, and then transfer these files over the Internet to the user's computer. Once the files were received, the user's browser would render them and show them on the computer's screen.

This interaction mode led to a delay of a few seconds between the user's action (the click on the map) and the rendering of the map on the screen, with a visible refresh of the whole browser window when the new page was downloaded. This interaction model was the core of most of the Web mapping applications for the next decade. Figure 1 provides an example of a process of digitising an area object on an Internet mapping site, using this interaction mode.

The early 1990s saw a very rapid increase in the development of delivery mechanisms for geographic information and mapping over the Internet and the WWW. While Doyle et al. (1998), Plewe (1997), and Peng and Tsou (2003) provide a comprehensive review of these developments, Plewe (2007) is especially valuable in identifying four technical eras in the

Fig. 2. Multimap website, early 2005.

development of Internet mapping. In order of increasing complexity, users accessed Web mapping by three main methods: public mapping sites, Web (or Internet) Mapping Servers, and more sophisticated Geographic Web Services.

The most popular mode of Web mapping provision was through public mapping sites. In the UK, Multimap.com was developed in 1995 to deliver maps to mobile phones, but ended with a highly successful public mapping site, which was launched in 1996 (Parker 2005). In the same year, MapQuest was launched in the USA (Peterson 1997). Other similar websites included Streetmap, Yahoo! Maps, Microsoft's MapPoint, and Map24. The main characteristics of all these services are that they provide access to simple queries about locations and directions. The user could explore the map image through options to scroll the map by clicking on areas at the edge of the map. A similar procedure enabled the user to zoom in and out. Figure 2 shows the Multimap website circa 2005.

By and large, the services were limited to information preloaded by the provider and allowed little customisation by end users. Furthermore, as Figure 2 illustrates, most of the maps were restricted in size due to limitations in the end user's computer monitor resolution and other demands on the design of a page such as advertisements. In addition, the image file containing the map tended to be bigger in size than the Web page that

Fig. 3. UK Environment Agency website 2002.

contained it. Therefore, network latency coupled with the limited data transfer capacity (bandwidth) of the end users' dial-up modems encouraged developers to minimise the size of the map.

Noteworthy is the impact of all these factors on the use of Web mapping sites – from the user's perspective, the process was slow and therefore the experience not especially pleasurable, so the websites were used in a limited way without detailed exploration of the map.

The ability to deliver maps over the Internet was also important for organisations who wanted to use their own datasets and create applications with sophisticated analytical capabilities. Here, most GIS vendors offered Web Mapping Server (WMS) software that could be installed on a local Web server. The way in which the mapping information was delivered to the user varied from relying on the capabilities of the browser similar to public mapping websites, to downloaded software that needed installation before the user could view the data and extended the capabilities of the browser (Peng and Tsou 2003). These applications borrowed their interaction metaphors from desktop GIS and, therefore, required the user to familiarise themselves with the application before they could use it. As Traynor and Williams (1995) noted, the terminology in GIS borrows from multiple disciplines, and this creates a major obstacle for new users. An example for this type of application is provided in Figure 3 which shows such an application from 2002, created by the UK Environment Agency to provide environmental information to the public. Notice the especially small area of the map and the use of GIS terminology in the interface (data layers, query layer, zoom in, zoom out, etc.). In order to query the map, the user needs to select the layer to be queried, and also the option 'What's that on the map?' – a rather complex operation.

While the Web Mapping Servers were designed to allow browsing, searching, downloading and rudimentary editing capabilities, the need for highly sophisticated services over the Internet was covered by Geographic Web Services software (such as ESRI's ArcServer). This class of software allowed the use of high-end analytical capabilities (for an example of such an application, see Simao et al. forthcoming). However, Geographic Web Services are beyond the scope of this article, and for a complete discussion, see Tang and Selwood (2003). What is important to note is that, similar to WMS, the end-user interface was complex and sophisticated.

The OGC standards are the final elements of the GeoWeb that it is important to understand before turning to Web Mapping 2.0.

With its origins in the mid-1990s, the OGC (www.opengeospatial.org) became a significant force in the GIS arena by setting standards for interoperability (Peng and Tsou 2003), thus allowing users of GIS to share data and processing, and use software and data from a wide range of providers. This is significant because of those high costs associated with data in terms of acquisition and manipulation for a specific task. Therefore, it is very important that an organisation can use software and data from different sources without costly and complex data conversion procedures. Common standards for integration of data and software provide the needed bridge that enables such interoperability.

Since 2000, the OGC has developed a set of standards for Web mapping. The first was the Web Mapping Service specifications (OGC 2000). These allowed WMS software to publish geographic information stored on multiple servers, often in disparate locations, and in a format that was suitable for further processing by multiple software that adopted the OGC standards. This ability was significant, as it realised the possibility of rapidly producing a map through the aggregation of readily available information to provide a new service. An example exercise used in the development of the standard focused on how information from meteorological remote sensing satellites could be integrated with information about population to provide an early warning of hurricanes (Gawne-Cain and Holcroft 2000). In the years that have passed since the introduction of the OGC Web Mapping Service specifications, many software products that are compatible with the standard have appeared in the marketplace. However, the utilisation of real-world complex WMS applications remains the domain of GIS experts in specialised areas. This lack of adoption can be partially associated with the technical complexity of the standards. From an end user's perspective, the standards are confusing and do not necessarily meet user needs. Finally, many of the implementations were slow and did not provide an effective experience.

In summary, until about 2005, delivery of geographic information and GIS capabilities over the Internet was possible and increasingly more sophisticated but a combination of factors limited their use. Developing an Internet-based mapping application remained complex, and this limited the number of developers and kept the cost of Web mapping high. Importantly, as most of these Internet mapping applications rely on some background cartography, this required purchasing expensive background maps outside the USA, or, even where public domain geographic information are available (USA), a significant knowledge in manipulating these datasets and preparing them for delivery is required.

Finally, from an end user perspective, the delivery of geographic information in a graphical form was limited due to network bandwidth, especially as when these standards were first introduced many users were still using dial-up links to the Internet.

3 Global Positioning System and Web 2.0: The Technologies of Change

The increased availability of higher capacity domestic Internet connections, and the reducing costs associated with those devices, which enable quick acquisition of locational information, created the necessary conditions enabling a step change in the delivery of geographic information over the Internet. Many other factors would also have contributed, including increased computing power relative to price and continued development of Internet technologies such as eXtensible Markup Language (XML), Simple Object Access Protocol and others. Two groups of technologies have had special importance in enabling much of Web Mapping 2.0: global positioning system (GPS); and Web 2.0 technologies, particularly Asynchronous JavaScript and XML (AJAX) and APIs. This section describes these technologies, the characteristics of Web 2.0, and the profound contribution they are making to Web mapping. For further analysis of the enabling factors, see Friedman's (2006), Goodchild's (2007b), and Plewe's (2007) analyses.

3.1 GLOBAL POSITIONING SYSTEM

The 1 May 2000 should be celebrated as one of the most significant days for neogeography – maybe even its official birthday. On this day, the US President, Bill Clinton, announced the removal of selective availability of the GPS signal (Clinton 2000), and by so doing provided an improved accuracy for simple, low-cost GPS receivers. In normal conditions, this made it possible to acquire the position of the receiver with accuracy of 6–10 m, in contrast to 100 m before the 'switch off'. Attempts to develop location-based services predated this announcement (e.g. Giordano et al. 1995), and were based on information from mobile phone masts or other beacons. However, these methods had not gained much market share due to technical complexity or lack of coverage. By mid-2001, it was possible to purchase a receiver unit for about US$100 (Hightower and Borriello 2001). These receivers enabled more people than ever before to collect information about different locations and upload this information to their computers. However, until 2002, when an interchange standard (GPX) was published, the sharing of this information was a complicated task that required computing and data manipulation knowledge. The GPX standard has been rapidly adopted by most developers of GPS systems and by 2004 it had become commonplace (Foster 2004).

3.2 WEB 2.0 TECHNOLOGIES AND AJAX

The GPX belongs to a class of standards and technologies that provides the infrastructure for what came to be known as Web 2.0. The impacts of Web 2.0 can be considered in terms of the underpinning technologies and the characteristics of application development and use they enable. While initial popular use of the Web was characterised by websites that enabled the distribution of information in new ways but with a limited interaction, the technologies of Web 2.0 provide a far richer user interaction and experience. Several factors have provided a platform for these new applications. First, as a result of the Dot Com bubble of the late 1990s, a massive data transfer capacity became available at very low costs, enabling the proliferation of broadband services to home users. Second, technology companies developed standards that allowed the transfer of information between distributed systems in different locations. This family of standards (including OGC standards and GPX) were based on XML. Another innovation, which integrates XML-based standards and allows the development of sophisticated applications, is the AJAX (for an accessible explanation of these developments and their lineage, see Friedman 2006, pp. 51–93). As Zucker (2007) notes, the most important innovation in AJAX is in the ability to fetch information from a remote server in anticipation of the user's action and provide interaction without the need to refresh the whole Web page. This changes the user experience dramatically and makes the Web application more similar to a desktop application where the interaction mode is smooth. A decade earlier, this was possible through the use of additional software but, as the embedded application was not an integral part of the Web page, the experience of using the mapping application was not very satisfying because it forced the user to learn another set of interaction rules in addition to the main modes that are common on the Web (see also Tsou 2005). AJAX-based geographical applications look and feel very different. First, the area of the screen that is served by the map has increased dramatically, thus improving the usability of Web mapping significantly (Haklay and Zafiri 2007; Skarlatidou and Haklay 2006). Second, the ability to interact within the browser's window changed the mode from the 'click-and-wait-for-a-page-refresh' to direct manipulation of the map – a mode of interaction familiar in other desktop applications, and more akin to desktop GIS.

3.3 APPLICATION PROGRAMMING INTERFACE

A third technological difference that has direct relevance to the discussion here is the appearance of APIs. In the first decade of Web mapping, the development of a well-functioning WMS application (such as MapServer or ArcIMS) required significant knowledge in programming and server management. Even packages like Manifold GIS or Microsoft's MapPoint, which used a generic Web programming framework, required significant investment in developer time to learn how to use their functionality. In addition, through the API, users have access to centralised pools of very high-resolution background geographic data including maps, satellite data, street photography and building outlines. APIs are relatively easy to use and have made application development more accessible, thus enabling a far larger community of people who could create, share and mash up (geographic) information as illustrated in the examples we give in the next section.

We argue that the technologies outlined in this section have encouraged a far wider adoption of the use of geographic applications because finally, after a decade of development, Web mapping has been given simpler tools that, when deployed, enable a more pleasurable and effective user experience. Unlike the previous generation of Web mapping sites, the mode of interaction, the speed of the response and the ability to experiment with new ways of integrating geographic information with other types of information has encouraged many programmers and users to utilise geographic information in their applications. These technologies have provided the ingredients for a new type of Web mapping.

4 The Emergence of Neogeography

Central to Web Mapping 2.0 is the concept of neogeography. The term is attributed to Di-Ann Eisnor (2006) of Platial.com – 'a socially networked mapping platform which makes it easy to find, create, share, and publish maps and places' and the essence of neogeography according to Turner:

> Neogeography means 'new geography' and consists of a set of techniques and tools that fall outside the realm of traditional GIS, Geographic Information Systems. Where historically a professional cartographer might use ArcGIS, talk of Mercator versus Mollweide projections, and resolve land area disputes, a neogeographer uses a mapping API like Google Maps, talks about GPX versus KML, and geotags his photos to make a map of his summer vacation.
>
> Essentially, Neogeography is about people using and creating their own maps, on their own terms and by combining elements of an existing toolset.

> Neogeography is about sharing location information with friends and visitors, helping shape context, and conveying understanding through knowledge of place.
>
> Lastly, Neogeography is fun . . . (Turner 2006, 2–3)

The contrast offered in this definition is between perceived tedious, slow, boring and expensive practices of cartographers and geographers, and enjoyable, rule breaking and relevant uses of geographic information by laypersons. As will be discussed later, this disregard to past practices is part of the zeitgeist that is central to Web Mapping 2.0.

The advent of the above technologies and standards discussed in the previous section have led to the emergence of numerous neogeography applications which utilise the Google, Yahoo and Microsoft (GYM) mapping APIs to create rich geographic websites.

An early example appeared a few weeks after Google released their mapping service in 2005. Paul Radamacher developed a new site that merged information from the San Francisco-based free small-ads website Craigslist with Google information in a site called HousingMaps (Tran 2007). This process of combining information from several websites and sources to produce a new Web service became known as a mash-up. Importantly, the speed of broadband connections allowed his server to connect to Craigslist and Google Maps servers and deliver the combined information so quickly that from the end-user perspective the interaction was seamless and pleasing. The simplicity of the Google Maps implementation enabled him to reprogram it for his needs. Shortly afterwards, Google released an official API which made it even easier to develop and implement mapping applications. As of June 2007, there were over 50,000 Google Maps mash-ups (Tran 2007). Importantly, most of the mash-ups are the equivalent of push pins that have been located on a map, with some multimedia information – mostly text but sometime images or video clip – attached to the pin.

The APIs are a very significant enabling factor of Web Mapping 2.0 applications, both in terms of providing mapping functionality and high-resolution background data. This was exemplified immediately following Hurricane Katrina in the USA in 2005. While OGC WMS specifications provided at least the same technical functionality as map mash-ups, it was the latter that were rapidly developed and used (Miller 2006). In the event of this real disaster, the OGC specification languished: '. . . many, many [Geospatial] applications were built, only a handful support OGC standards' (OGC 2005). This admission was of particular irony considering, as noted early, that the OGC specifications testbed scenario was a response to a hurricane in southeastern USA (Gawne-Cain and Holcroft 2000). This failure can be attributed to the ease of use of Web Mapping 2.0 APIs compared to the relative complexity and obscurity of OGC standards.

Several different categories of neogeography mash-ups have emerged, which are differentiated by their methods of data collection: whether they integrate data or services from other sources through an API, or whether they supply data back to the community through their own API.

Neogeography websites do not necessarily rely on user-generated content to supply innovative services and instead some supply data which they collect from disparate or difficult to access sources. The core innovations in these websites are the methods by which they collect and package information to enable other uses. An example of this type of website is Nestoria (www.nestoria.com), which gathers information from numerous estate agents about the spatial location of properties for sale or rent in the UK and Spain. Visitors to the Nestoria website can enter their property search requirements and the Nestoria application returns a list of properties for sale matching these criteria and displays them as push pins on top of a Google map. Nestoria also provides an API to allow other websites to use their property database or integrate it with a Geobrowser like Google Earth.

Neogeography examples also include innovative uses of non-mapping websites to display spatial information. Flickr (www.flickr.com) is a photo-sharing website where users can upload pictures and add metadata to a picture such as a description and 'tags'. Tags are much like keywords for a journal article, describing the main topics covered within a paper. In Flickr, these can refer to the content of a picture, for example, a photograph of a bowl of fruit may have a tag of 'fruit', or can be created by drawing boxes around elements within a picture. These tags appear when a viewer of an image hovers their cursor over a tagged area. A novel use of tags has appeared in the development of the 'Memory Maps' group within Flickr. In this, users upload screen shots taken from Google Maps and then annotate them with tags detailing memories people have about these areas (Figure 4).

Another way to use tags is by georeferencing an image with geographic coordinates, in a process called geotagging. On Flickr, this can be done by dragging the image to a location on a map, or through the use of GPX files. As with other neogeography jargon, geotagging is not adding anything new, apart from being Web specific, as the term *geocoding* has been widely used for over 40 years to describe the association of a piece of information with a location.

Tags form an important characteristic in Web 2.0 and allow users to create their own semantic categorisation of online content. These 'Folksonomies' (Vander Wal 2007) decentralise the formal classification of objects into fixed partitions, and instead use virtual classification schema based on meta-information defined by users. Although this decentralisation of information organisation may appear progressive, Weinberger (2007, 165) warns that these classifications can, however, mislead because 'tags have no context'. These folksonomies contrast to top-down taxonomies of spatial information (ontologies), which are created by experts (Fonseca et al. 2000). Tags have been utilised in neogeography applications in a number of

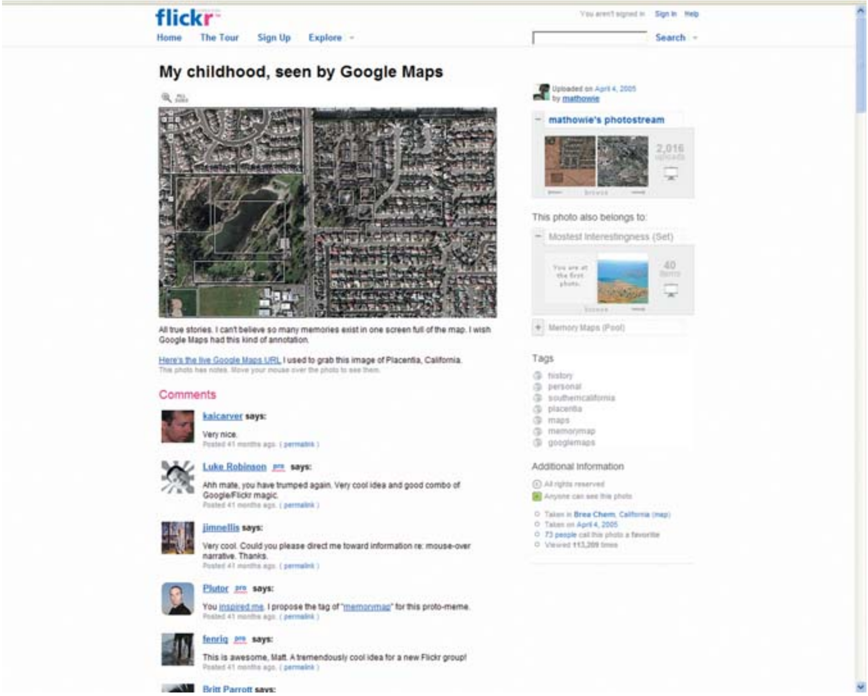

Fig. 4. The First Flickr Memory Map (URL: http://www.flickr.com/photos/mathowie/8496262/).

innovative ways: for example, the concept of Tag Clouds, which demonstrate the popularity of tags as a graphic visualisation where words scaled by their popularity have been extended through the development of 'Tag Maps' (Slingsby et al. 2007) that represent the 'importance' and location of geographically referenced text. The applications developed by Slingsby et al. (2007) display a range of spatiotemporally referenced search engine search terms (Figure 5) on top of Google Earth. The purpose of this visualisation technique is to present a summary of those activities being conducted by users of the Internet across space and time by geographic areas.

5 Technologies of Cooperation and Web Mapping 2.0

Before turning to case studies that demonstrate specific applications that draw on Web Mapping 2.0-related technologies and characteristics, it is important to understand the social context of these developments.

Since the early 1990s, developments in computer-mediated communication (CMC) have enabled groups of people to use networked computers to accomplish collaborative activities. Rheingold (1994, 110) discussed in relation to early developments on the Internet that CMC enables people to 'rediscover the power of cooperation, turning cooperation into a game,

Fig. 5. Interactive timelines for exploration. Tags are constrained to Friday night (top) and Saturday morning and early afternoon (bottom) (Source: Slingsby et al. 2007).

a way of life – a merger of knowledge capital, social capital and communion'. Rheingold was not alone – books like *The Cluetrain Manifesto* (Levine et al. 2000), articles such as 'Computer Networks as Social Network' (Wellman et al. 1996) and many others called for, and emphasised, the role of the Internet and the Web in creating and sustaining social networks and social activities. Significantly, the interest in the use of networked computers for accomplishing collaborative geographic tasks has been an integral part of GIScience over the same period, and there is now a substantive body of literature on collaborative GIS and geographic applications (see Balarm and Dragicevic 2006; Jankowski and Nyerges 2001) and discussion about the geographic aspects of these virtual communities appear in numerous geographic literatures since the 1990s (Batty 1997; Graham 1998; and many others). Yet, until fairly recently, large-scale collaborative systems in which millions of users could share information were slow to emerge.

One infamous and early example is the Geocities website created in 1994, which allowed users a free account to create a personal website. At its height, it was one of the most popular websites on the Internet, with over 3.3 million users (Bassett and Wilbert 1999; Brown 2001). Due to a range of technical and organisational reasons combined with blunders such as overwhelming the sites with pop-up advertisements, the site quickly deteriorated towards the end of the 1999 (see detailed analysis in Brown 2001). Geocities promoted claims of establishing a community online, and encouraged users to interact through online chat rooms and bulletin boards, but, at the end, the community had withered.

Increased bandwidth and connectivity options have increased the number of people with access to the Internet and ushered a new era in digital collaboration over the last 4 years. As Saveri et al. (2005) note, it is possible to identify a series of 'technologies of collaboration'. These technologies are categorised as:

- *Self-organising mesh networks*: software and hardware objects that create networks through self-organisation and link between themselves autonomously. Examples for these are peer-to-peer networks, in which different nodes in the network are using the resources of other nodes in order to accomplish a task. For example, file-sharing networks that are used to exchange multimedia files such as music or video.
- *Community computing grids*: situations where people share computing resources among a group by voluntarily running applications on their computers, and exploiting unused computing capacity. The Barkley Open Infrastructure for Network Computing is one of the most common software systems that allow such activities, and it has been used to integrate thousands of home computers for modelling climate change in an experiment which was run by the BBC and Oxford University or in the search for extraterrestrial life in the SETI@home project. In both cases, by breaking up the tasks and spreading them over many computers, it becomes possible to complete a computationally intensive task within a reasonable time.
- *Peer production networks*: enabling people to work together on a specific task, often without monetary remuneration. For example, these are often used in the development of open source software projects, which involve groups of programmers and software designers working cooperatively, such as the creation of an operating system (Linux) or a GIS (GRASS). The term 'volunteers' has been used to describe the participants in such activities (see Goodchild 2007a).
- *Social mobile computing*: technologies allowing coherent activities among a group of people, some of whom are complete strangers. An example is 'smart mobs' (Rheingold 2002) – groups of people gathering in a given place at a given time through coordination via Short Messaging Service on their mobile phones. The medium is used to coordinate an activity by passing a message among groups of acquaintances, and the final gathering creates a specific social activity such as a public pillow fight or a more purposeful activity such as a political demonstration.

- *Group-forming networks*: technologies that allow subgroups to be formed and interact. Examples include groups of collectors on eBay, or users of local bulletin board systems. Both social and personal interests are supported through this technology.
- *Social software*: probably the most common sites classified as Web 2.0. Social networking sites such as Facebook (www.facebook.com) have enabled users to build profiles that can be shared through 'friend requests', linking people from often disparate geographical locations into virtual places. These networks of individuals are dichotomous between real and virtual acquaintances. Real acquaintances are those networks of people built from real-life associations such as friends, family or work colleagues. Virtual acquaintances are made through a shared interest (e.g. the Facebook group 'GIS rules and so do we') or a common motivating goal.
- *Social accounting tools*: offering methods of establishing trust between users. For example, the way in which sellers and buyers are rated on eBay to create confidence between strangers.
- *Knowledge collectives*: technologies that allow people to share information and set the structures and rules of managing common resources. Examples include wikis such as Wikipedia – shared areas where people can write and keep information or Web logs (blogs) where people are sharing opinions about various issues.

In the description of these collaborative technologies, it is important to note that the emphasis is moving away from isolated technology into the embodiment of technology within social activities. The following sections provide three cases that demonstrate both the social and technological aspects of Web Mapping 2.0. In each case, we provide a description of the application, followed by a concise analysis that places them within this framework.

6 OpenStreetMap (http://www.openstreetmap.org/)

Virtual associations that can exist in social software have led to 'crowdsourcing' (Howe 2006), which has proven to be one of the most significant and potentially controversial developments in Web 2.0 and neogeography. This term developed from the concept of outsourcing where business operations are transferred to remote cheaper locations (Friedman 2006). Similarly, crowdsourcing is how large groups of users can perform functions which are either difficult to automate or expensive to implement. Tapscott and Williams (2006) discusses that 'in many peer production communities, productive activities are voluntary and non-monetary'; content is created for free, for the development of the community.

The neogeography example of crowdsourcing is the project OpenStreetMap (OSM). OSM is a project to create a set of map data that are free to use, editable and licensed under new copyright schemes (Figure 6). A key motivation for this project is to enable free access to current

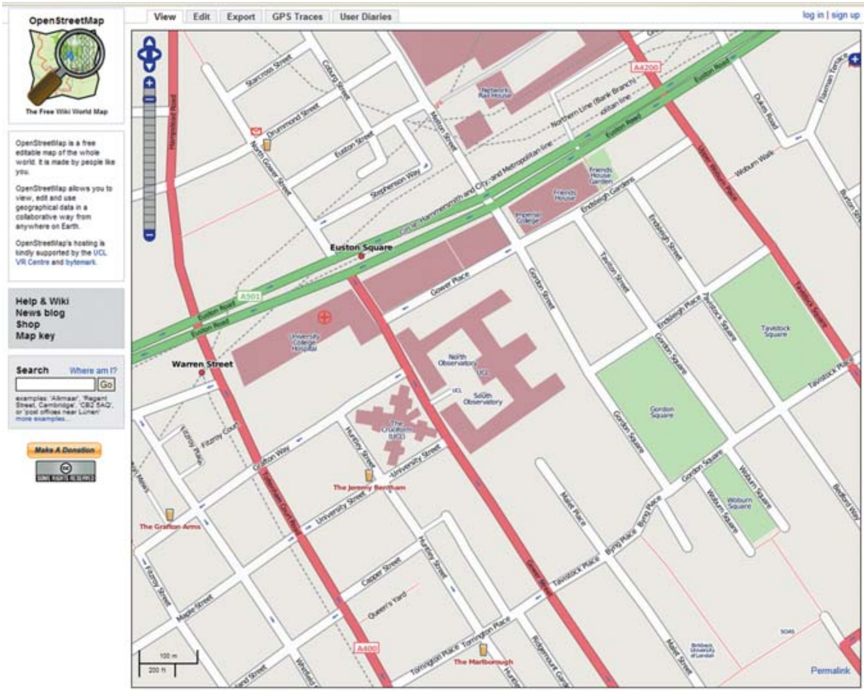

Fig. 6. High resolution map from OpenStreetMap of the area near University College London.

geographic information in European countries where geographic information is considered to be expensive. In the USA, where basic road data are available through the US Census Bureau TIGER/Line programme, the details that are provided are limited (streets and roads only) and do not include green space, landmarks and the like. In addition, due to the cost of updates, the update cycle is slow and does not take into account rapid changes.

The OSM data can be edited online through a wiki-like interface where, once a user has created an account, the underlying map data can be viewed and edited. A number of sources have been used to create these maps including uploaded GPS tracks, out of copyright maps and, more recently, aerial photographs through collaboration with Yahoo! Unlike Wikipedia, where the majority of content is created at disparate locations, the OSM community also organises a series of local workshops (called 'mapping parties') which aim to create and annotate content for localised geographical areas (see Perkins and Dodge 2008). These events are designed to introduce new contributors to the community with hands-on experience of collecting data, while positively contributing to the project overall by generating new data and street labelling as part of the exercise. The OSM data are stored in servers at University College London (UCL) and Bytemark which contributes the bandwidth for this project. While over 18,000 people have contributed to the map as of December 2007, it is a core group of about 40 volunteers who dedicate their time to create a viable data collection service. This includes the maintenance of the server, writing the core software that handles the transactions with the server in adding and editing geographic information, and creating cartographical outputs. The project includes two editing tools that participants have developed as part of it with a lightweight editing software package that is working within the browser and another stand-alone version, more akin to a GIS editing package.

Involvement in the project requires the participants to be knowledgeable about computers and GPS technology, in order to know how to collect GPS tracks, upload the GPX files to their computers and then edit them and upload them to the OSM server. The use of the data also requires knowledge on how to extract the information from a database and convert it into a usable format.

The OSM project provides a good example for the social and technical aspects that were highlighted in the previous section. First and foremost, OSM is a knowledge collective that is creating a meaningful geographic data collection as its main objective. At the same time, it includes a peer production network, as different groups within the organisation are focusing on the development of different aspects of the project – digitising tools, rendering software to display the maps, server software to host and coordinate the production and delivery, and running activities such as mapping parties. It is utilising community computing grids in the process of rendering the various tiles through the programme Tiles@home, in which about 100 volunteers use their computers to render OSM tiles. OSM uses Social Mobile Computing to an extent during the process of data collection, especially during mapping parties where participants coordinate the work using mobile GPS receivers and mobile phones. The group-forming network can be seen on the main wiki, which contains information about the project, and also through an array of active mailing lists, Internet Relay Chats and other modes of CMC. Finally, social accounting is occurring in OSM: for example, in highlighting the contribution of various members of the OSM community through publication on a website of the amount of computing they have contributed or the number of edits they have carried out over the last week, month and year.

OSM also demonstrates some of the aspects that are significant in neogeography. First, the API for downloading the data is very simple – all that is required is latitude and longitude coordinates. This is in sharp contrast to OGC APIs, which require multiple parameters. Second, the OSM map itself is using AJAX technology and it is easy to integrate it into other applications, as Nestoria has done in parts of the UK. On the other hand, OSM data are not complete or consistent across the world, or even across London, where the project has started. The accuracy of the data is unknown, as there are no systemic and comprehensive quality assurance processes integral to the data collection. Furthermore, there is no intention of universal coverage or social equality as Steve Coast, the founder of OSM, said in an interview: 'Nobody wants to do council estates. But apart from those socio-economic barriers – for places people aren't that interested in visiting anyway – nowhere else gets missed' (GISPro 2007).

7 London Profiler (http://www.londonprofiler.org/)

Another example of the power of the new generation of Web mapping to contribute to quick assembly of maps is the London Profiler (Gibin et al. 2008), which was created by the Centre for Advanced Spatial Analysis, UCL. Unlike the majority of GYM mash-up websites, the London Profiler site presents geographic information as series of choropleth maps on top of Google Maps rather than as simple points (push pins). Although the Google Maps API enables vector shapes to be overlaid on their map data, this is limited to a fairly small dataset, and as such not for extensive geographical areas. To circumnavigate this problem, the vector data can be transformed into an image format similar to the Google background map, thereby enabling this information to be integrated seamlessly with Google Maps information. The London Profiler website displays multiple public domain datasets from a variety of sources for the Government Office Region of London. The purpose of the website is to engage with decision- and policy-makers from a variety of audiences and encourage them to make more informed choices based on publicly available spatial information. By overlaying these data onto Google Maps data, this enables contextual information to be taken into account when making decisions (Figure 7).

Data layers include: the Multicultural Atlas of London (Mateos et al. 2007); E-Society Classification (Longley et al. 2006); HEFCE POLAR Classification and Associated HE data (Corver 2005); National Statistics Output Area Classification (Vickers and Rees 2007) and several others.

The website navigation uses the Google Maps interface. Users can add or hide different data layers by clicking on the relevant tabs. A final feature which enables users to incorporate their own data into London Profiler is the ability to load publicly available files in Google Earth standard (known as KML) onto the map. For example, using KML feeds from Nestoria, discussed earlier, property information can be added to the London Profiler website, thus enabling contextual information to be considered when searching for a property (Figure 8).

The London Profiler is helpful in understanding some of the advantages and problems in Web Mapping 2.0. The use of the application is very smooth and rapid, so changing the map from one topic to another usually takes less than 5 sec; hence, the user feels that the application is truly interactive. The use of the map is based on the Google Maps interface, and, therefore, the amount of learning required from the user is minimal. The user is also able to select the topics that are of interest to them from the list on the map, and view the information instantly. Furthermore, the

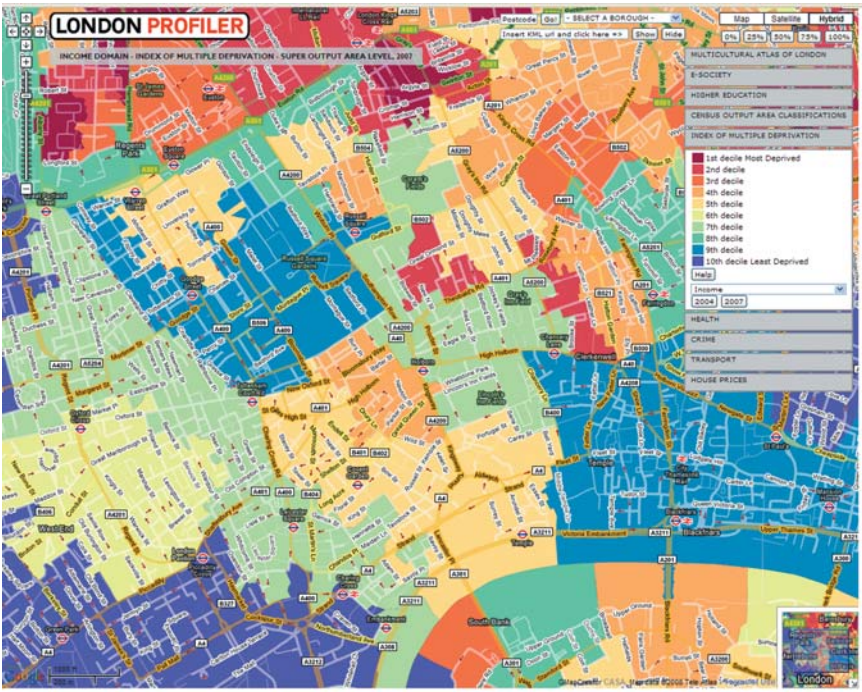

Fig. 7. The London Profiler interface displaying the income dimension of the lower super output area for an area of London.

use of external information providers (Google for the background map, Nestoria for property) means that a single person can effectively manage the site as the focus is solely on the added value layers. On the negative side, the map is using static ranges of colours and classification, and, therefore, the user cannot explore the information in more detail. Furthermore, the application is inherently cartographical and void of any analytical capacity. However, it effectively demonstrates that Web Mapping 2.0 approaches can be used very effectively as a means of disseminating results of research to a wider audience. For example, the site has featured on the BBC online (BBC 2008) website in a story about recent research conducted at UCL into the ethnic composition of London neighbourhoods. Additionally, over 18,000 people have visited the site since it launched.

8 Ordnance Survey OpenSpace (http://openspace.ordnancesurvey.co.uk/)

Ordnance Survey (OS) OpenSpace provides an API to access a range of Ordnance Survey data that enable anyone registered for the service to start building new applications which integrate other third-party information (Figure 9). Additionally, the OS OpenSpace website provides a supporting

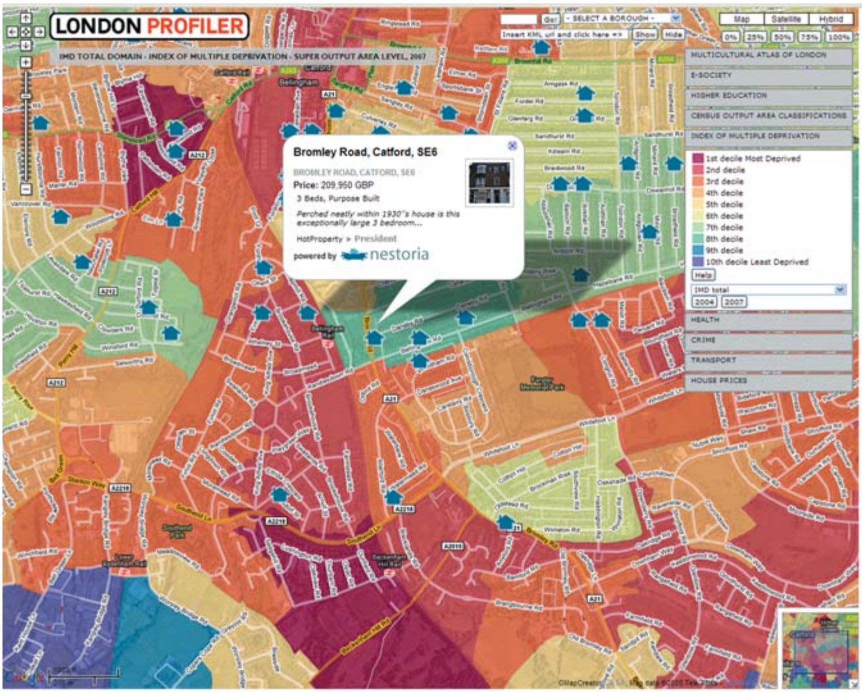

Fig. 8. Nestoria-generated KML for 'SE6' in London displayed on the Index of Multiple Deprivation Hybrid Map with 75% visibility.

Fig. 9. Ordnance Survey OpenSpace.

community forum and developer information where users can share resources and seek information. The site is the only mapping API to support the British National Grid and additionally includes support for different data formats such as OGC WMS and Web Feature Service standards. The provision of Ordnance Survey data in an accessible API form aims to stimulate community applications and involvement and was also recognised as an important objective in the Power of Information Review (Mayo and Steinberg 2007), which called for the opening up of public information for the use of wider society. OS OpenSpace provides the rich cartographic and contextual details of Ordnance Survey data that enable a raft of rural community and outdoor exploration activities not possible using the GYM offerings. Additionally, higher-resolution street details, which include building outlines, also provide potential for different types of urban- and neighbourhood-based applications. Given that the driving forces of neogeography include community involvement, a resurgent sense of place and collective ownership, the provision of such content may yield interesting new applications.

The OS OpenSpace has the potential to drive the use of OS geographic information across the Web by a wide community of independent developers, small Web and media companies, social groups and organisations as well as large corporate and government organisations. However, it is unclear how these latter groups engage with the accompanying aspects of community building, crowdsourcing, etc. Furthermore, although some community groups and non-governmental organisations have the capacity to utilise Web technologies as part of their activities, many organisations and groups are not capable of taking advantage of this development due to lack of technical skills and resources. The introduction of neogeography-type services by OS may prove significant in fostering these types of developments into the more mainstream geographic information market.

In terms of our overview of Web Mapping 2.0, OS OpenSpace is raising some important aspects. First, it demonstrates how major providers of geographic information, who are part of the traditional 'geography' to which neogeography is positing itself against, are adopting the innovations of Web Mapping 2.0 within their current offering and infrastructure. Second, the use of a local grid reference, and not the ubiquitous latitude/longitude which is common in neogeography, provides an accessible reference that answers the needs of the specific locality. This is significant, as the approach that the GYM is promoting is of an imaginary globalised and ubiquitous data provision. Third, OpenSpace is demonstrating how governmental and commercial organisations can build on Peer Production Network – OpenSpace is based on OpenLayers, an Open Source library developed to provide a framework for accessing geographic information over the Internet. The adoption of OpenLayers enabled the OS to develop OpenSpace – for example, in terms of documentation and examples.

Finally, the need for OpenSpace itself came about from the growing interest in location and geography sparked by Web Mapping 2.0.

9 Implications and critique

The three case studies demonstrated how Web Mapping 2.0 and neogeography concepts are influencing the development of geographic information applications in a voluntary environment, at a university and in a national mapping agency. In this part, we turn to the implications of these rapid, open, innovative, collaborative, and interactive developments.

9.1 GEOGRAPHIC INFORMATION PROVIDERS

As with other media content providers (e.g. music and news media), the general information provision model has now changed. It has changed from a linear, publishing 'push' model where data and information is collected and brought together centrally, turned into product and published to an inter-networked, participatory model where users also collaboratively create, share and mash-up data and where information can be accessed through many channels, almost anywhere, when the user wants it. Additionally, the role of the traditional information provider may change (Parker 2007). The increased prevalence of user-generated content (including products and services) is blurring the difference between producers and consumers in what is sometimes termed *prosumer*. There is also a realisation of users as innovators, experimenting with new products and services on open innovation platforms, such as OS OpenSpace.

However, these changes are challenging current conceptions and practices in data provision. When all can potentially capture and distribute data through access to GPS, the Internet and mobile devices, what information can users trust? Another profound change is in the business models of data providers as, for many applications, data can be accessed freely either from voluntary sources or from commercial providers through their APIs. This can also have an impact on software vendors, at least in some WMS applications. An emerging role for the traditional information provider is to perform a data verification function, to facilitate ease of use of and ease of access to the required information, and to ensure a good user experience, and it might be these roles that will become central to the activities of data providers (Parker 2007).

9.2 GEOGRAPHY AND GISCIENCE – CULT OF THE AMATEUR OR MASS COLLABORATION?

In a commentary on the wider Web 2.0 debate, Keen (2007) questions what he calls the 'Cult of the Amateur' encouraged by Web 2.0. He questions the consequences of blindly supporting a culture that endorses plagiarism, piracy and fundamentally weakens traditional media, creative and scholarly institutions. Keen cautions that 'we [need to] use technology in a way that encourages innovation, open communication, and progress, while simultaneously preserving professional standards of truth, decency, and creativity'. Tapscott and Williams (2006) describe a growing economy driven by mass collaboration based on the principles of openness, peer production, sharing and acting globally. Through different examples they tease out the guidelines by which to succeed in this environment. One suspects the answer lies with the appropriate use of both approaches to varying degrees according to the challenge being faced.

A similar debate has started in the geographic information community where it is apparent that the notion of neogeography contains within it certain disregard to existing geographical and cartographical traditions, and an even more overt disregard to the whole area of GIS and GIScience. The following example, from one of the core activists of OpenStreetMap:

> There's also a darker side to the complexity of traditional GIS. The fact that someone needs a master's degree in GIS to work as a GIS Technician should set alarm bells ringing. By maintaining the complexity of GIS, vendors like ESRI or Oracle are able to justify the costs of their products and consultants are able to justify their high fees and trade organisations justify their [sic.] existence. (Black 2007)

A similar derogatory disregard to the efforts of researchers of GIS/2 can be found in Miller (2006).

Importantly, naïve conceptualisations of geography as the location of factual objects in space, a lack of understanding of spatial analysis and a dismissive attitude to geography, cartography and GIS were identified by Unwin (2005) among general GIS users ('accidental geographers' as Unwin calls them). However, within neogeography they are seen by some as part of the core ideology. Similar to Wikipedia's core values, these are based on strong techno-libertarian politics (Keen 2007), which are especially common with high-tech and Internet culture (Borsook 2000; Hodgkinson 2008). Thus, the concepts of collaboration, cooperation, sharing and openness should be seen within a context of a capitalist mode of production where the collaboration is done from personal motives and in advancement of personal wealth, and less as an altruistic activity.

Regardless of these ideological undertones, it is important to acknowledge how neogeographic techniques and collaborative ways of working have demonstrated reduced development time and improved usability. They have raised general awareness of geographic information, the earth and the relationships between people and processes to potentially millions. These new techniques do not negate the importance of spatial analysis or cartography or surveying used in traditional geography and GIScience. It is not either one or the other, and there is clearly a space for both, so a synergistic approach is required.

Web Mapping 2.0 can influence GIScience by raising new questions and can offer novel data sets. For example, this will include data interoperability between neogeography data sets and traditional GIS ones, including semantic interoperability or maintaining the quality, integrity and currency of (crowd) sourced content. It also provides large quantitative and qualitative data sources that can be used to answer long-standing research questions.

These new developments are also providing a fruitful area for geographic research. Some of the questions that are emerging include: what kind of participatory practices are emerging with the support of these technologies and how do they influence the relationship between people and places? What kind of cultural and conceptual understanding of space, scale and geography are being used and how are the human concepts of geographical space emerging through these systems? In what ways are computer systems constraining the geographical imagination of their users?

The current wave of technologies provides a rich source of empirical evidence at a scale that was not available before. These are relevant for all current research frameworks in geography from the positivist to the critical.

GIS has provided a number of powerful techniques to add to the geographer's toolbox. Web Mapping 2.0 and neogeography have added more and made the former easier to use and information easier to access and convey to millions. The potential of these open, collaborative techniques to address challenges, be they local or global, is very significant.

Through neogeography, satellite navigation systems and similar technologies, many people are exposed to geographic information and may be fascinated with the concepts behind these technologies. There is clearly a large pool of enthusiastic amateurs with significant interest and willingness to invest their time and effort into the use of these technologies. As Massey (2006) noted, it is time to put the geography back into global thinking and this is an opportunity that should be seized by geographers.

Short Biographies

Mordechai (Muki) Haklay is a Senior Lecturer in GIScience at UCL, where he is also the director of UCL Chorley Institute – an interdisciplinary research centre, with an aim to provide computer visualisation and modelling for UCL strategic research activities. He has written on issues of public access to environmental information, usability of GIS and other aspects of geographical information science. He has published in *Area, the International Journal of GIScience* and in several edited books. As part of his research, he is interested in Participatory GIS and been following Open Street Map over the last 3 years. He holds a BSc and MA from the Hebrew University of Jerusalem and a PhD from UCL.

Alex Singleton is the Spatial Literacy Research Officer at UCL. He recently completed a successful Knowledge Transfer Partnership at the Universities and Colleges Admissions Service where he developed geodemographic profiling tools and techniques to enable UK Higher Education institutions to target and engage with under-represented groups. Alex's recently completed PhD explored the geodemographic analysis of access inequality in Higher Education, including the modelling of neighbourhood participation rates, prior performance and progression. His research has involved collaboration with numerous data partners including the Universities and Colleges Admissions Service, the Higher Education Statistics Agency, the Learning and Skills Council and the Department for Children, Schools and Families. He holds a BSc in Geography from the University of Manchester and a PhD from UCL.

Chris Parker headed Research & Innovation at Ordnance Survey, Great Britain's national mapping agency, and is now engaged in the Organisation's product and service strategy. He has written and presented on research challenges and future trends for geographic information providers, and the use of geographic information in emergency management. He has published in *the Cartographic Journal* and several edited books. A practising geographer and land resources scientist experienced in the public, private and third sectors, at home and overseas, he has a keen interest in designing for ease of use and collaborative use of geographic information applied to societal challenges. He holds a BA from Nottingham University and a MSc and PhD from Cranfield Institute of Technology.

Notes

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[1] Noteworthy is that the invention of words and the Internet is nothing new, and the first wave of applications developed in the 1990s had its own neologisms such as 'new economy', 'cyberspace', 'dot.com', 'ecommerce', 'information superhighway' – many of which are now common parlance, but others were short-lived.

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