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Cartography: maps 2.0

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I Introduction

At 11.35 am PDT on 18 September 2007 at Vandenberg Air Force base in California, DigitalGlobe's new WorldView-1 satellite launched into orbit. The satellite is capable of collecting imagery over as much as three-quarters of a million square kilometers a day in resolution as fine as 0.5 m. A second satellite will be launched in 2008, capable of photographing nearly a million square kilometers daily at the same high resolution. The data are twice the resolution of the previous industry leader, the IKONOS satellite launched in 1999 and close to the military's own resolution of 10 cm (Monmonier, 2002).

What is significant about the launch is not only the extent and resolution of the imagery (which from all vendors now covers over half of the world's population) but also the fact that this imagery will be available commercially (look for it in Google Earth). Such imagery, alongside the tremendous possibilities of 'crowdsourced' geospatial data, represent interesting new developments in cartography.

In the first of three reviews assessing the current state of cartography, I focus on the explosion of new 'spatial media' on the web. This topic goes under a bewildering number of names including the geospatial web or geoweb (Scharl and Tochtermann, 2007), neogeography (Turner, 2006), locative media (Rheingold, 2002), DigiPlace (Zook and Graham, 2007a), spatial crowdsourcing or geocollaboration (Hopfer and MacEachren, 2007) and map hacking (Erle *et al*., 2005). Whatever it is called – and ironically 'cartography' does not seem to be one of the options (Wood, 2003) – all of these activities are based around and dependent on mapping. Furthermore, they are distinctly public and citizen orientated mapmaking efforts, which raises interesting questions not only about access and control of the geographic information but of the possibilities for counter-mapping and counter-knowledges (Harris and Hazen, 2006). Yet another question is the critical evaluation of the geoweb and whether it requires renewed map literacy or education. As with any technology, the particular systems of power and surveillance are unavoidable.

Despite the interesting messiness of this situation (Livingstone, 1996), it looks as if maps and mapmaking – once in danger of being made obsolete by GIS – are set to get more and not less important. What those maps look like and in whose service they are deployed, however, are unresolved questions.

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II The new spatial media: the geoweb and virtual earth

Go ahead and double click the Google Earth (GE) icon on your desktop (if you do not have a copy, you can download it for free). Spin the earth around a few times. Zoom in on New York City (type the city's name in the search bar). In the menu bar on the left, turn on a couple of options; say the 3D buildings and the Gigapxl service, which provides ultra-high-resolution photographs georeferenced to the spots where they were taken. You can 'enter' these photos and look around. I am looking at one for Times Square. It is so detailed that I can see the time on the clock at the far end of the block. Knowingly or not, you have just taken part in a vision of a digital earth articulated in 1998 by then Vice President Al Gore. Asking us to imagine a young child playing with this globe:

> she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses … having found an area of the planet she is interested in exploring, she takes the equivalent of a 'magic carpet ride' through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data with which she can interact. Using the systems' voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. (Gore, 1998)

It is staggering to think that Google Earth and Google Maps were only introduced in the summer of 2005 (Hanke, 2007). Since then the pan and zoom 'slippy maps' have become an everyday part of life for many computer users (Google claims GE has been downloaded over 250 million times). Gore admitted this all sounded a bit like 'science fiction,' but his vision captured several important details we take for granted today:

(1) data are displayed 'naturistically' as if on a planet seen from space (Cosgrove, 2001);
(2) the display is interactive, allowing zooming and rotation (the 'magic carpet ride', still an unfamiliar concept for geographical data in 1998) and querying by simply clicking on objects;
(3) data from different sources can be integrated and easily layered;
(4) time can be incorporated (this is done in GE by use of a simple slider tool, not quite as sophisticated as Gore's vision);
(5) the means of production of knowledge are in the hands of the public rather than accredited and trained professionals – either a deprofessionalization or a reprofessionalization depending on your position (see below).

Google Earth is only one example (if a particularly well-known one) of the geospatial web or 'geoweb' comprised of map and location-based services available on the web. As a metaphor of meaningful geographies for virtual data, the idea can be traced back 25 years to 'cyberspace' in the science fiction of Vinge and Gibson (Gibson, 1984; Vinge, 2001, first published in 1981); see also Kitchin and Kneale (2002). Stephenson's *Snow crash* (Stephenson, 1992) has been particularly influential; its vision of a 3D 'Earth' has been acknowledged by the founders of Keyhole (the precursor to Google Earth) in a recent interview as one of their inspirations (Bar-Zeev, 2008) alongside the 1978 'Powers of ten' movie (Boeke and Eames, 1978).

III Examples of geoweb applications

The use of the internet and, later, the web for cartographic and GIS purposes soon followed (Peterson, 2003; Taylor, 2005; Taylor and Caquard, 2006), but to a large extent the geoweb has developed outside academia. While there are conferences for the geoweb (eg, Where 2.0, FOSS4G and in the military sphere GEOINT), judging by the presentations these are largely orientated around practitioners. Perhaps this is good; not only are there are a lot of interesting

things going on, but the generally low barriers to access encourage participation and not just observation (the so-called 'read-write web' and the rise of citizen participation, including amateur mapmaking (Armstrong and Zúniga, 2006; Gillmor, 2006; Helft, 2007)). A recent report, for example, found that twice as many Americans got their political news from the internet in the 2006 Midterm elections compared to 2002, and that some 14 million people contributed to political discussion and activity (Rainie and Horrigan, 2007).

Partnerships with Google are becoming common. The US Holocaust Memorial Museum has used it to map out the Darfur atrocities (Labott, 2007) and make recent imagery available to the public. Location markers are also posted to the public discussion board for Google Earth.

Google Earth has also been used to track human rights violations in Burma/Myanmar (Butler, 2006a; Webb, 2006; Mejia, 2007; Zetter, 2007). By comparing satellite imagery in Google Earth over time, ethnic cleansing can be readily documented. The American Association for the Advancement of Science (AAAS) recently established a program on Geospatial Technologies and Human Rights which draws heavily from open source tools (AAAS, 2007). (To my knowledge, neither the AAG nor the RGS/IBG have similar initiatives.)

A recent article in *Nature* suggested that open source tools are well suited for scientific investigations such as avian flu infections (Butler, 2006b). Similarly, both NASA's World Wind and ESRI's new ArcExplorer are open source and designed for scientific data.

IV Remember to FOSS

Free and open source software (FOSS) is a major component and indeed philosophy of the geoweb. The idea of open source software is that it is 'configured fundamentally around the right to distribute, not the right to exclude' (Weber, 2004: 16). The philosophy has its roots in the free software movement associated with the development of the UNIX operating system, and later the Free Software Foundation founded by Richard Stallman. In 1997 the concept reached a wider audience in a well-distributed work 'The cathedral and bazaar' (Raymond, 1999; 2001). Histories and appraisals of open source are numerous (for a recent overview, see DiBona *et al.*, 2006). FOSS does not oppose a monetary culture with a gift culture (free means freedom: *libre* rather than *gratis*). This freedom includes freedom to run the program for any purpose; freedom to study and modify the program; freedom to redistribute copies or modified versions (Stallman, 1999). Stallman's implementation of these principles is encoded in the General Public License (GPL), 'copyleft', and Creative Commons licenses.

Many of these principles inform map hacking, for example Google Maps mashups, although not necessarily in such absolute terms. A map mashup is the combination of geographic data from one source with a map from another source (eg, Google or Yahoo) using an application programming interface (API) (Butler, 2006a; Miller, 2006; Anon, 2007). An API is used to 'hook' data into Google or Yahoo maps. But of course the companies have control. For one thing they require an end-user license agreement or EULA and only provide access to the API, not the source code. They could remove this capability, or more likely charge for it or pipe in advertising.[1] NASA World Wind, the third and least known of the virtual earths, might provide a viable alternative. US Federal data are not restricted by copyright.

A common view within the FOSS movement is that it offers a radical challenge to the information distribution and consumption models we currently have. By providing accessible and inexpensive mapping tools FOSS cartography may similarly reshape how mapping is done (MacEachren, 1998;

Fairhurst, 2005; Taylor, 2005; Miller, 2006; Hanke, 2007). For example, GRASS, the free open source GIS, has been around since 1982. One leading figure recently called open source a 'paradigm shift' and pointed out that it is about more than the software on your desktop; 'most of the "killer apps" of the internet, applications run by hundreds of millions of people [including Google] run on Linux or FreeBSD' (O'Reilly, 2006: 255). The corollary of this point is that the operating system of the future will not be Macintosh, Windows or Linux but the internet itself – the internet Operating System. If this becomes the case, one would like to know who and how the internet might be controlled (see the discussion below on net neutrality).

FOSS cartography (if I might use yet another descriptor!) has taken a number of forms. Besides self-made map hacking and map mashups there are now increasingly sophisticated tools offered by the corporate online mapping companies – Microsoft, Yahoo, and Google – for making maps. Google, for example, introduced a feature in 2007 called 'My Maps' while Microsoft has 'Collections'. These evolved from the kinds of map mashups people were creating through the API. This suggests that map mashups have become trivially easy to make, and more importantly, much more visible. This is because they can be shared and embedded in other webpages as 'live' map services (ie, not just as images of map, but with the ability to zoom, pan and query) through the use of keyhole markup language (KML). KML is a file for sharing geospatial data, along with GeoRSS, both of them based on a common standard web format known as XML (extensible markup language). Many of these standards are coordinated through the Open Source Geospatial Foundation (OSGEO).

There are also dozens of independently developed cartographic tools online that provide functionality only previously available as part of commercial software packages. Tools exist to make map projections, decide on color schemes, make animated maps, convert files, make cartograms, overlay map layers and of course upload and visualize GPS tracks (many of these are listed at Leszek Pawlowicz's excellent blog 'Free Geography Tools').

Perhaps more fundamentally are the ongoing projects that truly exploit the FOSS cartography approach in quite intriguing ways. One of these is OpenStreetMap (OSM). OSM's goal is to provide free (*libre* and *gratis*) global geographic data such as roads, streets, railways, and so on. OSM proceeds from the realization that you cannot just derive maps from Google or Microsoft because those companies in turn have purchased and licensed data from mapping companies (contrary to popular belief, Google does not operate any satellites or collect data itself). These companies, such as NAVTEQ and Tele Atlas (both subject to recent acquisition bids), have copyright on Google Maps and any derivatives that are made from it. In the UK the Ordnance Survey (OS) has well-known restrictive licensing contracts. OSM therefore collects its own data – its members drive, bicycle or train around the country with GPS units and upload their waypoints into the project's main map. These waypoints are then symbolized and labeled. The community of amateur cartographers is facilitated through a 'wiki' to ensure quality control.

How successful could a project like this be? I must admit I am quite skeptical but must grant the tremendous strides the project has taken. Several European countries are now completely mapped. A related campaign by the British newspaper *The Guardian*, called 'Free our Data', seeks to loosen restrictions on access to publicly funded data and has often cited the OS as a primary case in point (Arthur and Cross, 2006). If the campaign is successful, copyright would be abandoned on OS maps, mirroring the US situation. It would also reduce the need for the OSM in

the UK. However, there are few signs that the campaign will succeed and for the moment OSM continues.

V Crowdsourcing and geocollaboration

Crowdsourcing is a form of emergent collaboration in which multiple people work together on a common project (the word was coined as a pun on outsourcing (Howe, 2006). The participants may be widely distributed and each person's contribution may be only a fraction of the total effort, but through facilitated collaboration a common result emerges. Social networking and bookmarking sites, such as MySpace or Digg, are an example of how people are connected together or to information they find useful (this journal uses it on its website). Participants may not even be explicitly aware that they are part of a collective whole. While crowdsourcing is being proposed as a way to improve business (Rheingold, 2003; Surowieki, 2004; Tapscott and Williams, 2006; Libert and Spector, 2008) it also has some interesting implications for mapping.

Group collaboration is not new. It is central to many political movements and labor organization inspired by Marxism (and it is ironic that much of the recent attention to it is directed at business management). The underlying principle is that the whole is greater than the sum of the parts. It is also used in many applications, including intelligence and problem-solving (Page, 2007). Amazon runs a site called the Mechanical Turk in which problems can be posted and collectively solved – they call it 'artificial artificial intelligence'. Some observers have suggested this as a new model for the workplace (with 'turkurs' instead of workers!).

The low access barriers to the internet have enabled crowdsourcing on a previously unachievable scale. Perhaps the best-known crowdsourced project is Wikipedia. Originally known as Nupedia and based on a closed model of hiring experts to write articles, the encyclopedia struggled to grow. Growing dissatisfied with the progress, Jimmy Wales decided to start an alternative project based on an open access model in which anybody could contribute. Despite frequent criticism of this model that it would lead to errors or deliberate vandalism, a recent investigation by the science journal *Nature* revealed that its error rate was roughly equal to that of the *Encyclopedia Britannica's* online material (Giles, 2005). Additionally Wikipedia's content has far outstripped that of Britannica, with over two million articles in English alone.

An interesting cartographic application of Wikipedia is Wikimapia, which locates entries on a Google map mashup and as a Google Earth layer. Users can add their own places, but with four million Wikimapia places the bulk are created automatically from Wikipedia. A similar mapping of geographic content is offered by Google Books, which can 'scrape' the georeferenced data out of books and map it. For example, one could view a map of all the places mentioned in the *Dictionary of human geography* (Johnston *et al.*, 2000), novels such as *A tale of two cities* (Dickens, 1980), or histories such as *The history of cartography* (Harley and Woodward, 1987). If one treats books as elements of the crowdsource, you could also compare all the places mentioned in books published in say the eighteenth century compared to the twentieth century, or all the places mentioned in books published in Europe versus North America.

Another fascinating example with obvious cartographic application is Microsoft's Photosynth technology. Photosynth is a way of seamlessly integrating visual data such as photographs. These photos can originate from a multitude of different sources from cell phone cameras to high-end digital cameras and taken under different conditions. They can be stitched together by detecting commonalities between pictures (a window in the Notre Dame cathedral for example). With the proliferation of photo-sharing websites such as Flickr you do not even have to take the pictures yourself; they can simply be

gathered from there. The result is a place or object that can be navigated in three dimensions (the BBC created a number of Photosynth buildings for its series 'How we built Britain'). Perhaps in the future we will be able to create Photosynth landscapes as a new form of mapping.

MacEachren and colleagues at the Penn State GeoVISTA lab have long been interested in the possibilities of what they call 'geocollaboration' or using distributed mapping tools in scientific or crisis contexts (MacEachren and Brewer, 2004; Cai *et al.*, 2005; MacEachren *et al.*, 2005; 2006a; 2006b; Hopfer and MacEachren, 2007).

The crowdsourcing approach is part of something Google calls the 'geoindex'. This is not an application (although it could be), but an idea or plan whereby the world's information becomes tied and searchable by place. So, for example, as we move through the environment we could draw upon place-relevant information from a multitude of different sources – or, as Peter Morville puts it, we will live in a world of 'ambient findability':

> We will use the Web to navigate a physical world that sparkles with embedded sensors and geospatial metadata, even as we diminish the need to move our bodies through space. Mobile devices will unite our data streams in an evolving dance of informed consumers seeking collective intelligence and inspiration. And in this ambient economy, findability will be a key source of competitive advantage. (Morville, 2005: 13)

Offered uncritically, such a vision will raise a few eyebrows. These tools by themselves do not ensure a more democratic playing field. The conflicting possibilities of mapping have been noted by Pickles:

> They provide more powerful tools for local planning agencies, exciting possibilities for data coordination, access and exchange, and permit more efficient allocation of resources, and a more open rational decision-making process. (Pickles, 2004: 148)

Yet it is also true that these systems are taking place in a larger context of economic production and a 'culture of military and security practices' (Pickles, 2004: 152). A short story called 'The watched' written 30 years ago by the British writer Christopher Priest (Priest, 1978/1999) explores implications of surveillance. Priest imagined Morville-like ambient sensors called 'scintillas' the size of confetti, which transmitted audiovisual information wherever they were scattered (and could be crowdsourced together, although Priest did not use that term).

One might also raise other objections. For example, is ubiquitous and pervasive computing a modern descendant of the panopticon (Misa *et al.*, 2003; Dave, 2007; Kitchin and Dodge, 2007)? In an age where information is insistently recorded, perhaps we need to develop an 'ethics of forgetting' (Dodge and Kitchin, 2007). Much work in this vein has emerged from the critical cartography tradition, but one of its lessons is that open-source tools can be used by the traditionally disempowered for counter-knowledges and counter-mapping (Wood, 1992; Harris and Hazen, 2006). (Pickles and his colleagues have founded a 'counter-cartographies collective'.) The emphasis on 'multitude' in crowdsourcing has suggestive links to the collective action envisaged by Hardt and Negri (2004). I hope to say more about these topics in a future review.

VI Net neutrality and the digital divide

Net neutrality is the idea that content on the internet should not be differentially processed; for example, access to a website should not be slowed down or accelerated according to how much it has paid. Proponents of net neutrality argue that it would create a tiered content model based on price control, with access to say MSN.com much more speedy than to a 'mom and pop' website. Telecoms argue that such a pricing model is a logical extension of differential access pricing (for example, the internet connection

speed you buy). Currently both the US Federal Trade Commission (FTC) and Congress are examining the implications of net neutrality regulation.

A related issue is the digital divide (Chakraborty and Bosman, 2005) or the unequal access to the information economy. Not only are there spatial variations in internet access, for instance (Crampton, 2004; Zook, 2005; 2006), but there are also knowledge archipelagos, such as in the political blogo-sphere where the left predominantly links to the left and the right to the right (Adamic and Glance, 2005). Not all information is equally accessible in a world where one billion people have never made a phone call.

VII Conclusion: deprofessionalization or reprofessionalization?

The fields of new spatial media and GIS are being torn in two distinctly different directions. On the one hand is the FOSS geoweb, and on the other hand are efforts to accredit mapping expertise through professional certification and 'bodies of knowledge' (DiBiase *et al*., 2006; 2007). These competing directions mirror the larger tensions between open and closed source, or between traditional news media and political blogs. For example, in his new book journalist Andrew Keen excoriates the 'cult of the amateur' enabled by the internet as a dangerous deprofessionalization (Keen, 2007). In this light there is no doubt that this debate is but the latest chapter in the 'GIS wars' of the 1990s (Schuurman, 2000).

The confrontation between the geoweb and traditional GIS has recently blossomed into a more overt debate, though one as yet taking place largely outside academia. During the summer of 2007 several conferences about the geoweb brought together players from both the GIS industry and the online mapping industry. One conference attracted the attention of *Computerworld*, which wrote:

> The debate about whether GIS is a domain for experts or the rest of us raged throughout last month's Geo-Web 2007 conference in Vancouver, British Columbia. According to Michael Jones, Google Earth's chief technologist, by giving everyone access to GIS tools, you'll end up with 'a big number of users converging on a truth.' Locals, he insists, are closer to most GIS data than experts and have a vested interest in its accuracy. (Hall, 2007)

The magazine noted that, while Vint Cerf (now the chief internet evangelist at Google, but previously responsible for inventing the packet switching technology behind the internet) reckoned this democratization to be 'a good news' which could lead to an online geospatial portal of knowledge he dubs the 'Geopedia', Jack Dangermond (ESRI's CEO) was more skeptical about user-provided content. 'He worries that even the best-intentioned amateur could provide inaccurate data that could lead to a disaster. "Who wants to dig a hole and run into a pipe?" Dangermond asks' (Hall, 2007). While ESRI does recognize the power of the geoweb (ESRI, 2006) and in 2007 released an open source virtual earth called ArcExplorer, there appears little chance that they will embrace the open source model by releasing their source code.

If the geoweb is to be understood not just as the amateur version of what the professionals do, it will need to gain recognition of its own professionalism. How can it do this? I would suggest the following inherent factors advantage the geoweb:

(1) 'crowdsourced' data as, for example, in Wikipedia;
(2) open source tools and services;
(3) participation and syndication (the web as platform).

A remaining issue concerns users. Will they become more discerning and critical of the geoweb? What forms of map literacy are required?

Much of the innovation surrounding the geoweb is occurring online in blogs. Although only a few articles about the geoweb are in journals (Miller, 2006; Ellison, 2007; Pearce *et al*., 2007; Zook and Graham, 2007b) it is easy enough to see that this situation will change rapidly as geographers and others use virtual earths and mashups to visualize their data. Therefore, I conclude with a very useful online resource for tracking geoweb developments. Planet Geospatial (http://planetgs.com) is a blog plus RSS feed run by James Fee that can be read in news aggregators such as Bloglines or Google Reader. It is a one-stop subscription to dozens of blogs covering the geoweb.

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Note

1. John Hanke, Director of Google Earth and Maps, stated at the 2007 Where 2.0 Conference that Google 'sees location-targeted ads as being a very, very large business opportunity' (Hanke and Seefeld, 2007).

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