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Monica Stephens

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Abstract The GeoWeb presents an opportunity to expand the array of potential contributors describing the earth through digital geographic information. However, the adoption of user-generated geographic information has not been uniform, resulting in an uneven distribution of content and more nuanced digital divides. This paper uses a survey of Internet users to measure the gender divide in the contributions of cartographic information to the Internet and examine the impact of this divide within the context of OpenStreetMap and Google MapMaker. This paper argues that in both publicly available basemaps the gender divide results in men serving as the gatekeepers of local knowledge leading to gendered user-generated representations. As these digital basemaps are reproduced and utilized by almost every mobile application or web-based map, the gender divisions in the creators and content are endlessly reproduced.

Keywords GeoWeb · Volunteered geographic information · VGI · Prosumer · OpenStreetMap (OSM) · Google maps · User-generated content · Gender

M. Stephens (✉)
Department of Geography, Humboldt State University, Arcata, CA, USA
e-mail: Monica.Stephens@humboldt.edu

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Abbreviations

VGI Volunteered geographic information
OSM OpenStreetMap

Introduction: The promise/problem of user-generated content

Geographic Information Systems are slowly evolving and adapting to new trends in data and technology. Harnessing collective intelligence through innovations in authorship and data distribution, GIS is slowly merging with Web 2.0. Web 2.0 has aided in a liberation of data with crowd-sourced collective information that is designed for linking with other content. Content in Web 2.0 is created and distributed in a social context with users producing information and data in the form of "user-generated content" for other users to consume (Ritzer and Jurgenson 2010). This data can be in the form of photos and videos (YouTube, Flickr, Picasa), or provide social information (Facebook/Twitter) and is created by users typically outside of their professional duties. As these websites incorporate geospatial or locational information they constitute "The Geographic World Wide Web" or "the GeoWeb" (Haklay et al. 2008). This "collective wisdom" generated by a crowd of peers developing geographic-content for basemaps includes biases within the data collection that results in authoritative and widely used maps that only represent the lived experiences a of small segment of users.

Some early rhetoric surrounding the GeoWeb and Web 2.0 focused on an unlimited potential for the democratization of information. O'Reilly (2007) envisioned Web 2.0 applications that would enable public access to existing data and create unique data sources by harnessing collective intelligence. These sites would include and trust users as co-developers and be intentionally designed for users to hack and remix data. This structure would allow citizens acting as scientists without specialized training to provide data and contribute to larger scientific discoveries in what Goodchild (2007) termed "Volunteered Geographic Information" or VGI. Millions of individuals without specialized equipment collect data and use Web 2.0 technology to create resources that rival the accuracy of those made by official top-down sources of information. Now these data volunteer-created sources include a plethora of information including basemaps with accurate roads and building locations that can compete with government-created map sources (Haklay 2010). By providing a system to host and manipulate data created by the people, for the people and available to the people, the GeoWeb was envisioned as offering an opportunity to democratize the structure of and access to information. This egalitarian potential for the GeoWeb, however, has not been realized.

The volunteers that contribute their geographic information to the GeoWeb are representing their local knowledge. This knowledge cannot be separated from the individuals that contribute it. As Haraway (1991) indicated, knowledge is imbued with the situated, embodied positionality of the subjects who produce it. These representations contributed as user-generated content can not be separated from the subjects that produce these ideas. Despite the subjective nature of online information, the way we perceive our material offline environments is partially determined by the way online information is indexed and ranked (Zook and Graham 2007). Despite the best intention of volunteers to document the world through contributing VGI, the result is a virtual world that only portrays the perspectives of the skewed demographics that create it.

This paper will identify the gender division in contributions of cartographic information to OpenStreetMap (OSM) and Google Maps. Particularly, this will examine the impact a majority of men contributing VGI and thus constructing the GeoWeb in their image. This paper will also address the features and attributes are left off of a from a basemap when all the information is provided by men. While women will provide social information through online social networks and photosharing sites they are less likely to provide geographic information. Women are less aware of OSM, the opensource basemap, than their male counterparts, and those who are aware of OSM are significantly less likely to contribute spatial data. As a result of low female participation, the features and attributes on OSM reflect a male view of the landscape. Google Maps, the proprietary basemap, while structured differently, suffers a related gender problem: as men dominate as contributors to the map, and men also dominate as reviewers of the information contributed by volunteers. On Google Maps, men serve as the gatekeepers of local knowledge and determine what is significant enough to be represented on the base map. These issues of representation in Web 2.0 become paramount as VGI is now the standard data source for information and base maps on mobile phones and web browsers and are used as a primary source of information about a geographic area.

Theoretical framework

As the GeoWeb harnesses data contributed by citizens everywhere and aggregates it into a useful form (such as a detailed base map), it begins to assume the authority as a resource for information. However, maps created through user-generated content are similar to their predecessors that are biased by the norms, traditions, assumptions and political biases of the map makers (Harley 1989). Map makers can never claim to be entirely impartial in their contributions to the map as objectivity would require a value-free view from nowhere (Haraway 1991). In other words, map makers are embodied and situated subjects who can not make claims to absolute truth, authority, and power (Haraway 1988; Pavlovskaya and Martin 2007). Despite increased numbers of distributed editors and measures to increase data accuracy through redundantly crowdsourced contributions to base maps (for more information about accuracy see: Haklay et al. 2010), the individuals that contribute data to the GeoWeb are not impartial or unbiased. This means that as maps emerge from distributed efforts at collecting data, the maps are colored by the demographics of the mapmakers.

In recent years scholars have begun to recognize ways critical geography can inform GIS and conversely how GIS can enrich feminist and qualitative understandings of space. Early conceptions of GIS that defined all relationships in terms of Cartesian and Euclidean spaces (Sheppard et al. 1999) and all subjects as "objects" or points, lines, and polygons in a class, detached GIS from research subjects and appeared antithetical to Feminist perspectives (McLafferty 2002). As Kwan (2002) identified, these "confrontational polemics" by feminists and critics of GIS did not change GIS practices, but provided a more nuanced reading of GIS in society.

Critics of GIS also introduced new practices of empowering women with GIS and through GIS and as well the development of new methodologies. Kwan (1999a) used GIS methodologies to visualize women's daily lives and experiences of space. Pavlovskaya (2002) used GIS within feminist practice to capture and reveal women's economic coping strategies at the household level in Russia., McLafferty (2002) described a group of women that were empowered by GIS to reveal the relationship between environmental toxins and incidents of breast cancer. Together these studies demonstrate a shift in the use of GIS from representing women as objects in GIS to capturing women's situated knowledges and including women as stakeholders with a voice in GIS-based knowledge.

As the stakeholders of GIS have diversified, GIS and Feminist research have both begun to reconceptualize the role of the expert in the production of data (Elwood 2008; Haklay et al. 2008). New tools available for spatial analysis through web-based technology have made GIS available to a broader audience. The GeoWeb is merging elements of GIS with elements of multimedia technologies that incorporate different types of knowledge across multiple scales, giving voice to research subjects (McLafferty 2005). Web 2.0 is providing new technologies, data models, and practices that could transform the processes and power relationships that have been embedded in GIS (Elwood 2010). In other words, through encompassing VGI the GeoWeb may be more inclusive of feminist thought and offer more ways of knowing to a broader audience than GIS could.

The GeoWeb offers many benefits to governments and private industries as they crowdsource the production, analysis and visualization of data to millions of users. These user-friendly tools that are often free and ubiquitously available on the web are extremely attractive to community groups, activists, and humanitarian organizations as non-experts can create maps to suit their varied purposes (Miller 2006; Zook et al. 2010). The GeoWeb has empowered new groups of users and provided outlets for users to create, construct, use and share geographic information in ways previous limited by the structures of GIS (Tulloch 2008).

VGI is transforming the relationships between individuals and geographic knowledge through including new ways of interacting with geographic data (Goodchild 2008). VGI extends beyond cartographic contributions to maps and includes social networking sites, blog posts, photographs, text, and citizen science collections. The collaborative nature of these collections of information are a growing resource of knowledge about the world. However, they are not without problems. Elwood (2008) outlined potential impacts of VGI to worsen existing inequalities through further excluding underrepresented people and places. Specifically, she writes: "when the epistemologies, vocabularies, and categories of data structures do not or cannot encompass the experiences, knowledge claims, and identities of some social groups or places, this produces their under-representation in digital data." Excluding information about and from these individuals becomes a cyclical process leading to further political and social marginalization of those left off the map (Elwood, 2008). Even as the VGI supplements traditional data sources and provides a rich source of information about the material world, when only specific demographic segments contribute information, viewpoints are unsaid, and places and people remain hidden and invisible (Graham 2010).

Understanding the biases of online user generated content

Given the biases associated with user-generated content it is necessary to examine the individuals who are contributing and accessing it. For example, Wikipedia is the largest and most trusted online encyclopedia, and has recently supplanted traditional print sources of encyclopedic knowledge. The wide array of topics and articles that represent historical/contemporary individuals, places, things, and current debates in society are all constructed and edited by volunteer contributors. However, recent research

indicates that Wikipedia contributors are primarily male with a growing gender gap that is leaving women behind in contributions and in content (Lam et al. 2011). Cohen (2011) identified that 13 % of Wikipedia contributors are female, leaving 87 % of articles generated by men. This suggests that topics of greater interest to women, as well as women's perspectives on events and issues, are less prevalent within Wikipedia's set of facts. In short, there is a gendered dimension to this online encyclopaedia.

The gender gap on Wikipedia parallels earlier findings that women lag relative to men in how they use computers and Internet communities. Wasserman et al. (2005) defined three aspects of the gender gap online as: access/opportunity to use the Internet, frequency of use, and scope of Internet use. Often the gender gap in accessing Information Communication Technologies are attributed to socio-economic inequalities as lower-income women are often tasked with childcare and other household responsibilities that do not lend themselves to tinkering with technology (Liff et al. 2004; Gilbert et al. 2008).

Gender asymmetry in contributing to technology begins with a culture that discourages women. Sørensen (2002) found women less likely to adopt technology as the assumption of a male audience alienates women, as does the prevalent assumption that women are uninterested in machines. A study of students conducted by Fisher and Margolis (2002) determined that women prefer to learn in the larger context and chose to major in Computer Science as a means to solve larger societal problems (health, education, etc…), while their male counterparts view the technology as a challenge itself. Perhaps women are not contributing user-generated content, as they do not see the results of their efforts contributing to resolve larger social problem.

Moreover, Wasserman and others (Bimber 2000; Jackson et al. 2001; Ono and Zavodny 2003; Imhof et al. 2007) found that in Anglo-American and European communities there is no significant difference in gendered access to the technology. However, women are slightly more likely to use the Internet in a public place, such as work, that limits the scope of their activities (Sørensen 2002). Liff et al. (2004) indicated that women are less likely to use the Internet while at home because of time and role conflicts. In short, men and women access the Internet at the roughly same rate, but there is an ongoing gendered divide in the scope of Internet based activities.

The reasons behind a gender divide in computing remain unclear. Corneliussen (2010) assumed the hegemonic discourse of men as computer "wizards" and women as disinterested non-users of technology has led to an ensuing assumption about the "nature" of each genders disposition to technology. For example, Bimber (2000) ascribed gender differences in use to "inherently 'gendered' technology embodying male values, content that favors men, sexual differences in cognition or communications, or other factors." Clarke Hayes (2010) attributed a lack of women in computing as a result of a combination of few female role models, a masculine "nerd culture," and negative stereotypes about the anti-social nature of those that embrace computing as a hobby. The gender divide in user-generated content likely stems from the broader gender disparity that pervades computing.

This gender divide in Internet use becomes particularly troubling as it impacts content generated by users. If the demographics of the contributors to Web 2.0 sites (e.g. Wikipedia, YouTube, OSM, Google MapMaker, Flickr, etc.) are unevenly skewed, the content of these sites—the content that is the basis for information in Google searches or the base-map for mobile web applications will represent the viewpoints of the few who contribute. While the GeoWeb has the potential to democratically collect and disseminate information, only those with the tools and the time to produce VGI will contribute.

Information, gathered under the rubric of "user-generated content," is collected by volunteers interested in aggregating, displaying or sharing information, and is accessed and utilized as a resource for information. The volunteers who collect and distribute these data are "citizen-scientists" or "neo-geographers" and use their senses and abilities to contribute information about the world around them to a larger data source (Goodchild 2008). To better understand the demographic divides in the volunteers who create geographic user-generated content, this paper seeks to understand who are the "voluntary sensors" who contribute user-generated content?

Demographic dimensions of the GeoWeb

The inequalities in access to technology and usage of technology that exist within society are reproduced in the geographic applications of Web 2.0. Of concern is

that these divides will become more pronounced and visible as the amount of geospatial Internet content contributed by users increases. Inequalities that exist within society offline, such as racial inequality, are digitally reinforced and recreated within "cyberscapes" through the presence of indexed content (Crutcher and Zook 2009). In a similar vein, Crutcher and Zook (2009) identified areas of New Orleans with a higher percentage of African Americans residents were less represented in the GeoWeb. Despite the promise of Web 2.0 liberating data by empowering individuals to contribute local knowledge, access to technology, income and race are still relevant factors to which spaces are described and annotated in the GeoWeb.

The use of Web 2.0 tools is allowing ordinary users to describe the material world by digitizing the places around them or ascribing qualities (metadata) to places in their neighborhoods. Much like early promises that the Internet would universally connect individuals without the constraints of geography (Negroponte 1995; Cairncross 1997) early promises of the GeoWeb envisioned cybercartography as a means for "changing power relationships and empowering previously marginalized groups" by adding themselves to the map (Tulloch 2007). Google demonstrated this goal by partnering with an Amazonian tribe[1] to provide resources to create maps protecting areas of importance to the tribe (Epstein 2007; Clendenning 2007; Reel 2007; Ustinova 2008). This example demonstrates the objective of community mapping projects to change the power dynamics by legitimizing the diversity of authorships and images by providing resources to alter the technical barriers to access (Parker 2006). However, even within indigenous maps and participatory mapping projects, women's spaces and perceptions of place are often excluded (Rocheleau et al. 1995).

These efforts towards community mapping has been most coherently manifested in Google Map Maker. Google MapMaker explicitly requests volunteers to "Enrich Google Maps with your local knowledge" and "use Google Map Maker to improve the map of places that matter to you. Update the actual map as seen by millions of people on Google Maps." See Fig. 1 for the splash start-up screen requesting local knowledge from volunteers. In a similar process, OSM (www.OpenStreetMap.org) enlists volunteers to update and annotate their wiki-style map, but appeals to an open source, democratic/participatory mapping (map or be mapped) mindset. The resulting cyberscapes—be they from Map Maker, OSM or other means—are still evolving as users contribute digital information about the places around them.

One of the key questions, however, revolves around who exactly is contributing this information. For example, in Fig. 1, GoogleMyMaps informs users: "Parts of your neighborhood may already be mapped on Google Maps. Improve these further using your knowledge of your locality." But Google does not provide data or information on *whom* updates these maps. What happens when one segment of the population contributes the places that matter in their community and another does not document their local knowledge? As gender/race/class are constructed and reconstructed, the rules are re-written in the terms of those who create it (Haraway 1991). In other words, those who take part in providing the knowledge about their neighborhood can reconstitute it in their own image. When one demographic segment does not document and share their local knowledge and observations with others (due to the digital divide, lack of access to content, digital privacy concerns or lack of interest in participating), they are left out of the information society, narrowing the "horizon of possibilities available" and lagging behind in other technological means (Crampton 2003). Consequences of this a lag in contributions is severe—large parts of the world remain unmapped and described (virtually non-existent in terms of the GeoWeb) because they are not of high interest to the world until an emergency happens (Zook and Graham 2007).

The dimensions of race and geographic inequalities of the GeoWeb have been explored, there is less work examining gendered divisions in GeoWeb content. Studies have shown that men and women have access to the Internet at the same level and Hampton (2011) determined that women are more frequent users of online social networks such as Facebook, MySpace, LinkedIn and Twitter. Another report indicated that men are significantly more likely than women to use location-based services such as Gowalla or Foursquare that record a user's location and shares it with their social network (Zickuhr 2010). Thus, while women are heavy users and contributors of Web 2.0 social networking activities, this participation is not

[1] Google Earth also describes this project with the Suri on their Outreach page: http://www.google.com/earth/outreach/stories/surui.html.

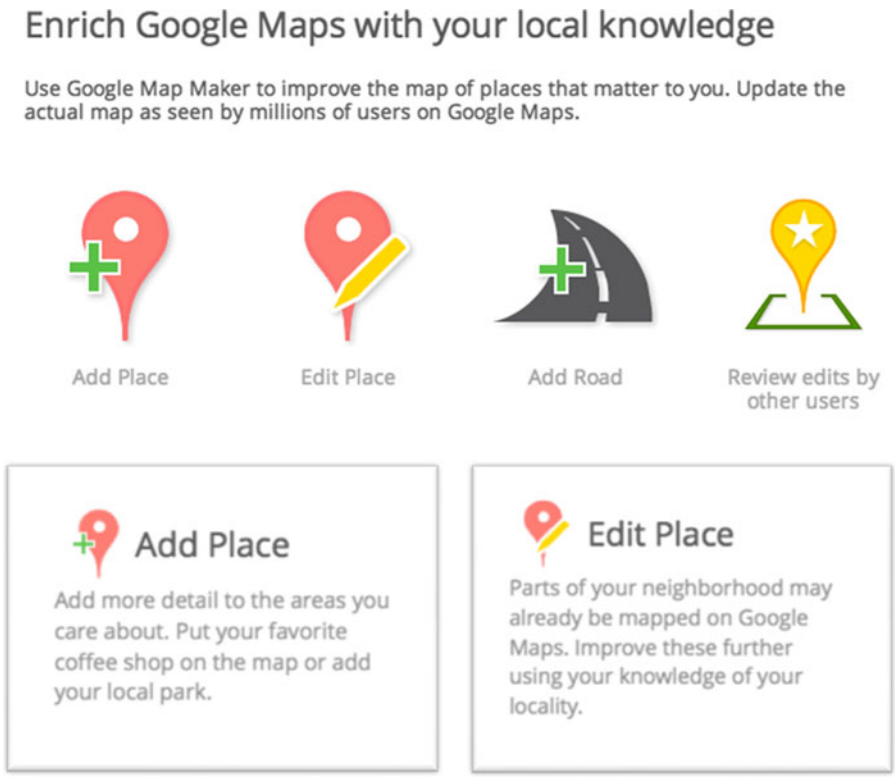

Fig. 1 Google Maps MapMaker splash screen requests users contribute "local knowledge" to the basemap by editing and adding features (from http://www.google.com/mapmaker)

propagated across the GeoWeb. And since geocoded information from social networks are a key source for the GeoWeb, this suggests yet another process which shapes the sources and biases of user-generated geographic information.

Surveying the generators of the GeoWeb

To better understand who is responsible for generating GeoWeb content—including the extent to which there is a gendered dimension—we conducted a survey using SurveyMonkey, an online survey tool.[2] Survey takers were asked to describe their contributions to web-cartographic applications (OpenStreetMap and Google Maps) and their use of any geo-social applications (geotagged photos and online social networks). We also asked questions regarding their intent to contribute geographic information, the reasons for providing (or not providing) geo-localizable information in social networking applications as well as basic demographic information (gender, age, education).

This survey intended to capture a broad international audience with varying degrees of familiarity and experience with the GeoWeb and volunteering cartographic information. It was distributed from October 17, 2011 through November 15, 2011. A link to the survey was posted on www.floatingsheep.org, distributed through social networks including Facebook, Google+, and Twitter, and distributed via relevant list services. By using a snowball method to solicit a wide-range of additional responses the survey received 1,113 responses from 48 countries.[3] Specific questions from the survey included:

[2] This survey was also distributed in an Italian language version. The Italian survey results are not included here as they are part of another project. However, the results of the Italian survey are consistent with the English version and support the findings presented in this paper.

[3] In order of number of survey responses received: United States, United Kingdom, Germany, France, Canada, Spain, Austria, Argentina, Netherlands, Finland, New Zealand, Switzerland, Australia, Israel, India, Belgium, Denmark, Ireland, Mexico, Portugal, Croatia, Estonia, Hungary, Norway, South Africa, Sweden, Brazil, Bulgaria, Chile, Czech Republic, Malaysia, Mauritius, Republic of Korea, Romania, Samoa, Serbia, United Arab Emirates, Zimbabwe.

- Have you ever heard of Google Maps?
- Have you ever used Google Maps?
- What do you do with Google Maps?
- How often do you use Google Maps?
- Have you ever heard of OSM?
- Have you ever used OSM?
- What do you do with OSM?
- How often do you use OSM?
- Do you participate in any social networks?
- Have you ever uploaded to a social network a picture taken with a smartphone or a camera that has an integrated GPS device?
- Have you ever tagged a picture on a social network?
- Have you ever geotagged a picture (geotag refers to tagging a place name) on a social network?

The survey also asked respondents for demographic information including gender,[4] age, "do you work in the fields of Geography, Urban Planning or information sciences?" and "what is the highest level of education you have attained?" The relevant demographic information of respondents is presented in Table 1 below.

Table 1 demonstrates the demographic differences between responses. The responses came from a well educated population (63 % with graduate degrees). Additionally, 48 % have degrees or work in the fields of Geography, Urban Planning, or Information Sciences implying they may be familiar with the content of the survey. We assume that individuals working in Urban Planning, Geography or Information Sciences or who have achieved degrees in this field are more likely to be aware of OSM, Google MapMaker, and the ability to geotag data on social networking sites.

Table 2 demonstrates the responses from the survey for questions relating to online social networks and geotagging information. The results of the survey upheld previous literature indicating that gender has no effect on participation in online social networks. There is no difference between women and men in participation or in the tagging of photos on social networks (79.7 % vs. 78.4 %, respectively).[5] However, as geographic information is introduced by geotagging locations in images and posts on a social network, female participation drops off substantially. When respondents were asked: "Have you ever geotagged a picture (geotag refers to tagging a place name) on a social network?" 23.1 % of women said

Table 1 Demographics of survey population imply that the majority of survey respondents are 26–40 and hold a graduate degree

		Gender		Total
		Female	Male	
Age				
Under 25	Count	55	71	126
	% of Gender	17.6	21.6	19.7
26–40	Count	185	201	386
	% of Gender	59.3	61.1	60.2
41 or older	Count	72	57	129
	% of Gender	23.1	17.3	20.1
Education level obtained				
Less than a secondary-school degree	Count	2	4	6
	% of Gender	.6	1.2	.9
High School degree or equivalent	Count	20	57	77
	% of Gender	6.4	17.3	12.0
Undergraduate degree (Associates, Bachelors or equivalent)	Count	68	89	157
	% of Gender	21.7	27.1	24.5
Graduate degree (Masters, PhD or equivalent)	Count	223	179	402
	% of Gender	71.2	54.4	62.6
Have a degree or work in the fields of Geography, Urban Planning or information sciences	Count	161	149	310
	% of Gender	51.6	45.3	48.4
Total number of respondents for each Survey category	Count	312	329	641

Responses were roughly divided evenly between men and women

[4] Of the 11 individuals that used the "other" category for their gender, only three completed the survey. As this was not statistically significant at any level, only the results for those classifying themselves as "male" or "female" are provided in this paper.

[5] Significance based on a Chi Squared test. Chi-Square compares the frequency of two or more groups to determine the significance of the accuracy between the expected distribution and the observed distribution. Healey (2011) defined Chi-Square as follows: $x^2 = \sum \frac{(f_o - f_e)^2}{f_e}$ where f_o is the observed frequency and f_e is the expected frequency.

Table 2 VGI contributions to online social networks (SN) by gender (Bold indicates significant)

		Gender		Total
		Female	Male	
Do you participate in any social networks?	Count	281	268	549
	% of Gender	90.6	86.5	88.5
Total number of responses		310	310	620
Tagged a picture on a social network?	Count	220	207	427
	% of Gender	79.7	78.4	79.1
Total number of responses		276	264	540
Geotagged a picture on a social network?[a]	Count	**64**	**109**	**173**
	% of Gender	**23.1**	**41.3**	**32.0**
Total number of responses		**277**	**264**	**541**
Uploaded to SN pic from GPS device[b]	Count	**113**	**141**	**254**
	% of Gender	**40.8**	**53.4**	**47.0**
Have not uploaded to SN a pic from GPS[b]	Count	**157**	**118**	**275**
	% of Gender	**56.7**	**44.7**	**50.8**
Unsure if device had GPS[b]	Count	**7**	**5**	**12**
	% of Gender	**2.5**	**1.9**	**2.2**
Total number of responses		277	264	541

Male respondents were more likely to have contributed geotagged images to a social network

Bold indicates significant, total number of responses differs as not every respondent answered every question

[a] Gender dependency significant with a Pearson's Chi Square of 20.546, df = 1, Asymp. Sig. (2-sided) = .000

[b] Gender dependency significant with a Pearson's Chi Square of 8.643, df = 2, Asymp. Sig. (2-sided) = .013

"yes" compared to 41.3 % of men who said "yes." The same relationship exists for those taking photos with a device (camera or cell phone) with an integrated GPS unit and automated geotagging capability. To the question: Have you ever uploaded on a social network a picture taken with a smartphone or a camera that has an integrated GPS device? 40.8 % of women answered yes, compared to 53.4 % of men who answered yes (see Table 2 for complete responses). Even as women use online social networks to describe the social relationships among individuals by tagging photos that link images to other users' profiles on social networks, women do not describe location by tagging photos or uploading photos that link to places in the material world.

As with online social networks, when describing the material world requires providing explicit locational information, female participation drops off. In examining who contributes cartographic information to the GeoWeb—or in the rhetoric of Google, who is enriching GoogleMaps with their local knowledge (see Fig. 1), the survey results imply it is primarily men contributing their knowledge through both Google MapMaker and OSM. These results should be understood in the context of the survey population we questioned—individuals with computer access who could be aware of OSM. Most survey respondents (99.1 %) have used Google Maps without a gender distinction. When respondents were asked, "Have you ever heard of Open Street Map?" the difference between genders was significant. While 61.6 % of men had heard of OSM, only 23.5 % of their female counterparts had heard of the site (see Table 3 for details). Of those who had heard of OSM, there was an additional gender divide in those who had used the site (56.9 % of women and 84.8 % of men) and those who had contributed data or information to the site (20.8 % of women and 40.1 % of men). These findings strongly indicate that men outnumber women on OSM.

These findings, demonstrated in Table 3, imply that OSM is subject to a large demographic bias with significantly more men contributing geographic information. While open source and available for anybody to contribute information about locations anywhere in

Table 3 VGI contributions to cartographic applications by gender

		Solicited survey responses		
		Gender		Total
		Female	Male	
Heard of Google Maps	Count	311	322	633
	% of Gender	99.7	98.5	99.1
Used Google Maps	Count	296	310	606
	% of Gender	95.8	97.5	96.7
Contributed data to Google Maps	Count	81	88	169
	% of Gender	26.0	26.9	26.4
Total number of responses:		312	327	639
Heard of OSM[a]	Count	**73**	**196**	**269**
	% of Gender	**23.5**	**61.6**	**42.8**
Total number of responses:		311	318	629
Used OSM[b]	Count	**41**	**167**	**208**
	% of Gender	**56.9**	**84.8**	**77.3**
Contributed to OSM[c]	Count	**15**	**79**	**94**
	% of Gender	**20.8**	**40.1**	**34.9**
Total number of responses:		72	197	269

Male respondents were more likely to have heard of, used and contributed to OpenStreetMap

Bold indicates significant, total number of responses differs as not every respondent answered every question

[a] Gender dependency significant with a Pearson's Chi Square of 93.553, and (296.610 for the total survey), df = 1, Asymp. Sig. (2-sided) = .000

[b] Gender dependency significant with a Pearson's Chi Square of 23.286, (39.532 for total survey), df = 1, Asymp. Sig. (2-sided) = .000

[c] Gender dependency significant with a Pearson's Chi Square of 8.611, (16.244 for the total survey), df = 1, Asymp. Sig. (2-sided) = .003

the world, women are not as aware of OSM. Of those who are aware of the platform, women are also less likely to contribute than their male counterparts. Gender is a factor that substantially shapes the contributions of information to OSM.

Openness of contributors to OSM

Evidence of male dominance in OSM is also evident by an examination of the amenities that have been proposed and approved as features on the map. Features are defined by the tags that contributors assign to elements (nodes/points, ways/lines/polygons, and relationships) to describe and annotate the earth's surface. Amenities are features that provide a service or a facility for map users; for example, they include ice cream parlours, police stations, public toilets, schools, and many other features. OSM users propose features and vote to approve what will appear as "map features" (http://wiki.openstreetmap.org/wiki/Map_Features) that will be rendered on the basemap. While many approved amenities, such as a cinema, veterinary clinic, or a vending machine are not inherently gendered, other approved amenities such as brothel or baby hatch[6] have clear gendered dimensions. Baby hatches are explicitly described as spaces for a "mother" to surrender an unwanted child, and brothels are assumed to have a male clientele. Thus, it is illuminating to review the way in which amenities are categorized.

[6] OpenStreetMap.org describes a baby hatch as "A baby hatch is a place where mothers can bring their babies, usually newborn, and leave them anonymously in a safe place to be found and cared for. A baby hatch is also known as 'safe haven'."

For example, OSM users approved features to delineate between a restaurant, pub, bar, biergarten, nightclub, stripclub, swingerclub and brothel with detailed descriptions to delineate the differences. This includes keys for each feature to provide more information (for example restaurant keys include cuisine, diet restrictions, opening hours, smoking, organic, etc.; brothel keys include details such as: escort services, street prostitution, gangbang, flat rate, etc.[7]). While sexual entertainment venues are not exclusively male spheres, these are public spaces that that rely on sexual inequality, female objectification, and male privilege (Jeffreys 2008).

Once a feature is proposed by an OSM user, it is then voted on by a minimum of eight users before it can be used to tag points or areas on a map. Strip club and brothel, for example, have existed since 2009 before all voting was public, and swinger club was voted on and approved in 2012 without any dissenting votes.[8] A review of the proposed definition of swinger club provides a sense of the detailed distinctions made: "Swingerclubs can be referred to as amenity = nightclub, but this tag should referre [sic] to discotecs and other forms of nightclubs. Not to be confused with amenity = brothel—there is no paid sex in a swingerclub. There are sites named FKK-clubs or similar, that are not swingerclubs. In a swingerclub adult people meet to have a party and group sex, usually they pay an entrance fee for drinks, food and using the facilities." The strong distinctions made between a swinger club, a nightclub and a brothel imply a keen awareness of these as different institutions among the contributors to OSM.

In contrast to the brothel/swinger club/nightclub distinction, proposals for features that are feminized or 'nurturing spaces' are subject to a less distinct debate. In April 2011 the feature "childcare" was proposed as a "place for children to do homework, play and spend time otherwise after school or kindergarten."[9] This proposal was heavily debated and rejected 3 weeks later by a 9–5 vote. Users opposed to the measure argued that "childcare" would be the same as the [already approved] feature "kindergarten."[10] Specifically, one (French male) user wrote:

> *I oppose this proposal. for [sic] the same reason explained above. I understand this proposal as the same thing as amenity = kindergarten with sometimes different opening hours, there's no need to use another tag for that.*

To which the author of the original proposal, an Austrian man, responded:

> *so 10 year old children go to kindergartens after elementry school in france?* [sic]

Other voters[11] responded along the same lines by voting with[12]:

> *I oppose this proposal. As already stated in the comments: age is highly ambiguous and will normally be refered [sic] to the feature and not to the people for which the feature is intended.*
>
> *I oppose this proposal. We already have amenity = kindergarten, what is that new tag usefull [sic] for?*
>
> *I oppose this proposal. The existing amenity = kindergarten is good enough.*

All voting took place in English among English speaking users from various countries (including Italy, France, and Germany).

[7] http://taginfo.openstreetmap.org/search?q=brothel.

[8] See: http://forum.openstreetmap.org/viewtopic.php?id=2614 for more discussion on "Bordelle, Kondomautomaten, Swingerclubs, Strichertreffpunkte" (a German OSM forum on "Brothels condom vending machines, swingerclubs and hustler meeting").

[9] http://wiki.openstreetmap.org/wiki/Proposed_features/childcare.

[10] It should be noted that while a large number of OSM contributors come from German speaking countries this debate is not simply about linguistic differences. "Kindergarten" is a German word but in both German and English speaking countries there are different words that classify the age-range for child-care providers (such as day-care, after-school program, pre-school, nursery or kindergarten in English and Kindertagesstätte, Tagi, Crèche, Kita, Horte, Kinderkrippe, Schulhort, Schülerläden or Kindergarten in German). From http://www.expatica.com/de/education/school/The-ABCs-of-the-German-school-system.html.

[11] Unfortunately there is no way to determine the gender of all those who voted on the proposal as only their username is visible and linked to self-made user page with limited demographic information.

[12] See http://wiki.openstreetmap.org/wiki/Proposed_features/childcare for comments and complete voting results.

These users all identified that there is no need for more than one amenity that describes a place that cares for children. A similar proposal for "pre-school" (defined as: "Education of young children before they go to school"[13]), was proposed in 2007, discussed in 2008, and abandoned in 2010 without a vote. Like pre-school, "hospice,"[14] "a place to reduce symptoms and care for those at the end of their lives," was proposed in 2008 and abandoned without a vote. In contrast, proposals for sexual entertainment facilities were approved and implemented on OSM early in the service's existence (2009). On OSM spaces of care and nurture that are associated with feminized skills garner less attention than the facilities where women are commodified (strip clubs, brothels, etc…), and therefore do not obtain the votes necessary to become features.

The lack of attention by OSM users to spaces of care while embracing features for sexual activity creates questions of representation and democracy in the knowledge constructed through VGI. Feminized spaces, such as those that largely associated with nurturing and care for another person (such as childcare) are undervalued and invisible in material space (Pratt 2003; Lawson 2007). As the democratic process on OSM requires eight approving votes to become a feature, features must garner attention with the dominant demographic constructing the map. Spaces of care are less exciting to the daily lives of the constituency necessary to approve these features than spaces of alcohol consumption and/or sexual activity. These virtual spaces of caring, like those they represent in the material world are undervalued and the discourses surrounding these centers differs by country (England 1996).

Thus, while OSM may prove a utopian vision of the potential of VGI with open access, collective ownership and democratic decision makers, this poses problems for the platform as the decisions are based on the relatively homogenous group of users who volunteer their time to map their community. These users are very aware of the complexities of sexual entertainment categories, but oblivious to the age specific limits of childcare providers. As users map their local knowledge they include intricate details about the local features they know and interact with while disregarding the features they bypass in the material world. The lack of childcare features on the map adversely affects mothers as women are still primarily responsible for childcare and the lack of these services on the map can reduce their access to urban opportunities (Kwan 1999a, b). Despite the importance of these facilities, those that rely on childcare are unlikely to participate in the democratic process on OSM and as a result it is likely they will continue to be underrepresented on the map.

The democratic nature of representing local knowledge within a global taxonomy of feature classification is precarious. In the case of OSM there is a discounting of features that would be useful to a subset of individuals (those responsible for providing care to young children), but a great deal of attention towards features related to sexual activity. This has important implications as popular platforms such as Foursquare and Apple's iPhoto abandon the expensive and proprietary Google Maps and rely on OSM data (Hardy 2012; Gilbertson 2012). Moreover, a similar process of disregarding the spatial interests of those who do not create the map is replicated in various forms on Google Maps.

Google maps and the gatekeepers of local knowledge

The apparent gender equality (both in use and contribution) on Google Maps, determined by the survey in Table 3, is likely the result of individuals creating maps with Google for driving directions. Just as many people are not aware of OSM, many are not aware of the basemap building options on Google-MapMaker. Google Maps collects contributions, edits and map corrections from volunteers for the basemap through the Google MapMaker platform with a separate web interface (www.google.com/mapmaker). It is possible that individuals replied that they "contribute to existing maps" to indicate that they contribute directions or other amounts of information using the Google Maps product and are not contributing to the basemap of Google Maps. This hypothesis is driven by an examination of "Map

[13] http://wiki.openstreetmap.org/wiki/Proposed_features/Pre-School_(early_childhood_education).

[14] http://wiki.openstreetmap.org/wiki/Proposed_features/Hospice.

◀ **Fig. 2** Screen capture of Google Map Your World community indicates many male icons and 'R' reviewer icons with very few female icons

Yourself" a site where Google MapMaker users and reviewers interact around mapping (see Fig. 2).[15]

This site requires users to opt-into share their location and the database contains 857 users.[16] It is, however, the most complete and publicly available database of Google Map Makers as well as the "Regional Expert Reviewers" (RERs). RERs are set up by Google as local knowledge volunteers who review changes to the basemap before it is incorporated. The RERs in Fig. 2 are indicated with an "R" icon, while the other volunteers are indicated with a symbol to denote their gender (Male, Female or a question mark for Other). The icons are placed in the centroid of the location a user indicates they are mapping (the database also collects where they "live").

A cursory look at the map (Fig. 2) indicates an abundance of male icons and reviewer icons. Only when the underlying data is examined does the gender dimension of these users emerge. The vast majority of users (93 %) are men. The regional experts, who accept or reject proposed changes, are even more disproportionately male (96 %). In this sense, on Google MapMaker, men are not only making the maps, they are also the gatekeepers of local knowledge. Choosing to display information on Map Yourself is an option where users must opt-into contribute their information to the site. While it is possible for women who contribute to the map to choose not to map themselves on the site, the survey results indicate that women are unlikely to opt-into contribute cartographic information or data about themselves.

These data suggest that within Google Maps men are the more involved individuals. The RERs can control which content is displayed and distributed on the Google Maps basemap, and 96.2 % of these are men. Table 4 demonstrates a wide gender gap in who is volunteering local knowledge to Google MapMaker. There may be a larger group of women (more than 5.6 %) that participate in generating content who were unwilling to publicly "put themselves on the map." This example demonstrates that men are both generating more content and are not privately protecting data that they do generate.

Table 4 Gender dimension of GoogleMapMaker users and regional expert reviewers (RER) implies both are more frequently men (figures as of May 22, 2012)

Female	Male	Other	Total
Users			
48	798	10	856
5.6 %	93.2 %	1.2 %	
RERs[a]			
5	178	2	185
2.7 %	96.2 %	1.1 %	

By March 31, 2013, 7 % of the 1,182 users of MapMaker identified as female and 4 % of the 641 RERs identified as female

[a] By definition all RERs are also users

Frequency of contributions

It is possible that the few women who contribute to OSM and Google Maps are the most frequent users and create an enormous amount of content in the GeoWeb. This possibility was considered by asking users "How often do you use OSM?" and "How often do you use GoogleMaps?" Responses were recoded to "less than a few times a year," "monthly" and "weekly or more" (see Table 5). On OSM, not only do more men contribute to the platform (Table 3), but also contribute more frequently (Table 5). The differences in use of Google Maps were not significant between genders, but men were more frequent users of Google Maps. In addition to assuming the majority of map reviewers are male, men are also more frequently using and updating Google Maps than women. If men are the users who contribute to the basemap of Google MapMaker, and do so with more frequency than women, then Google MapMaker may soon suffer similar gender discrepancy and representation issues as OSM faces.

Findings

This paper upholds and expands on findings that Web 2.0 and the GeoWeb reproduce and exacerbate

[15] https://sites.google.com/site/mapyourworldcommunity/map-yourself.

[16] This only includes users who volunteered for this site and also agreed "I am okay with Google sharing all of the above information publicly."

Table 5 Frequency of cartographic contributions across gender and platform

		Gender		Total
		Female	Male	
Frequency of Google Maps use[a]				
Yearly or less	Count	**22**	**9**	**31**
	% of Gender	**7.4**	**3.0**	**5.1**
Monthly	Count	**88**	**71**	**159**
	% of Gender	**29.5**	**23.3**	**26.4**
Weekly or more	Count	**188**	**225**	**413**
	% of Gender	**63.1**	**73.8**	**68.5**
Total number of responses		**298**	**305**	**603**
Frequency of OSM use[b]				
Yearly or less	Count	**15**	**31**	**46**
	% of Gender	**34.9**	**19.3**	**22.5**
Monthly	Count	**17**	**56**	**73**
	% of Gender	**39.5**	**34.8**	**35.8**
Weekly or more	Count	**11**	**74**	**85**
	% of Gender	**25.6**	**46.0**	**41.7**
Total number of responses		**43**	**161**	**204**

Men are more frequent users of OpenStreetMap

Bold indicates significant results

Total number of responses differs as not every respondent answered every question

[a] Gender dependency significant with a Pearson's Chi Square of 10.504 (solicited responses only), df = 2, Asymp. Sig. (2-sided) = .005

[b] Gender dependency significant with a Pearson's Chi Square of 7.274 (9.490 for all respondents), df = 2, Asymp. Sig. (2-sided) = .026

existing representational asymmetries by uncovering the asymmetries in gender representation on the GeoWeb. The survey indicates that there might be a gendered difference in the quantity of contributions of geospatial information to the Internet. This discrepancy on OSM leads to a significant difference in how features are categorized and which features are approved as amenities on the basemap. On Google Maps this gendered differentiation manifests with women as users of the maps and men as expert reviewers of local knowledge. The basemaps that define features and represent the material world in a virtual earth are constructed by a democratic process where decisions are collectively made and users have the option to be authors. Unfortunately this democratic process, like many before it, excludes and marginalizes those who do not take part in building it. Across all cartographic platforms, men are determining for which features will be defined and identified in the digital base map that represents earth.

At this time, information about women's location is archived, just not voluntarily. The data profiles for Google products and universal logins for social networks combine with smart-phones to create traces of data that link users to locations and provide an unvolunteered record of that user's movement through space (Elwood and Leszczynski 2011). Applications have begun to capitalize on these traces of locational information in space. The geo-social application "GirlsAroundMe" is a stark example; male users could use the application to find data about nearby women who have checked in or updated data to Facebook, Twitter, or Foursquare. Many women were unaware of this use of their data or unaware that they provided locational information. These unintended traces of location were obtained without the woman's intention to place herself on the map.

While women have the same access to this technology as their male counterparts, they are only represented by traces of their interactions with technology and not by democratic participation on the GeoWeb. Overwhelmingly men are volunteering to put themselves on the map by contributing to cartographic applications (such as OSM and Google MapMaker). In a map or be mapped world, men are mapping and women are being mapped. The men who document their local knowledge in Web 2.0, are documenting their own norms, traditions and biases as the mapmakers. In this light, it is unsurprising that the inequalities in the representation of places online mimics and potentially reproduces the inequalities of those who produce the data.

In addition to making maps and annotating the (digital) earth's surface with their local knowledge, men are also in a privileged position as the gatekeepers of local knowledge. In Google MapMaker, men are the Regional Expert Reviewers who accept or veto changes to the basemap made by non-experts to document their local knowledge. In OSM, men exercise their democratic privileges by vetoing amenities that do not serve their immediate purposes and needs (such as childcare). Both OSM and GoogleMapMaker provide a resource that does not document

women's local knowledge, but is used as a basemap for most mobile applications and websites. Google Maps is used as the predominant map application on Android mobile phones and OSM is used as the data source for Apple Maps (the default application iPhone and iPad operating systems).

These findings have important implications for understanding inequalities in our basemaps. As Haraway (1988) indicated, each of these technologies are inscribed with the gender preferences, skills and relations of those that create it. As prosumers of this technology, we need to create a space where women can be both designers and users. Both gender and technology are intertwined in such a "socially constructed and socially pervasive" way that they can not be fully understood independently (Bray 2007).

Inequality in user-generated content is not an easy problem to address by the platform alone. Larger cultural issues that discourage women from contributing, such as women's reserve to assert opinions in public lessen the likelihood of achieving a representative basemap. When women do contribute, they are still subject to a competition-oriented platform where their edits may be discarded by the RER or they may receive unwanted attention from men editing in same region. The spirit of openness that guides many crowdsourced projects resists setting goals for one type of contribution over another or beneficial treatment for one type of contributor over another. In other words, it is doubtful any type of affirmative action will enhance the visibility of women in user-generated content.

As discouraging as these findings are, they are mutable. Women can transform this dynamic by mapping their local areas, by proposing features and voting on the features that will benefit their lives. Women need to extend their online participation beyond describing social relationships through Facebook, Twitter, and photo-sharing sites to contribute details about their lives and livelihoods in the material world to the archive of spatial features online. Lastly, the prosumers of the GeoWeb need recognize the limits of user-generated content when the perspectives, interests, and spatial patterns of those who are unwilling or unable to contribute information are absent.

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