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# Searching Through Silos:
## Assessing the Landscape of Participatory Mapping Research Using Google Scholar and Web of Science

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## ABSTRACT

As participatory mapping evolves encompassing new technologies and incorporating new terminology to describe varying approaches, it is important to examine whether all practitioners of participatory mapping belong to the same community of practice guided by shared principles. The researchers explore the narrative of participatory mapping as a coherent, unified discipline. They do this by assessing the landscape of the literature on participatory mapping practices across two scholarly search platforms – Google Scholar and Web of Science. In each platform, they searched the same terms that are commonly associated with participatory mapping. The researchers' findings suggest participatory mapping lacks coherence as a unified method. They note a lack of overlap in top cited publications, indicating that what counts as legitimate knowledge regarding participatory mapping and its practice differs depending on the platform. Implications for participatory mapping theory and practice are discussed.

## KEYWORDS

Digital Mapping, Evaluation, Google Scholar, Literature, Participation, Participatory Mapping, Web of Science

## INTRODUCTION

As Short (2003, p.1) observes, "Maps are central to the human experience… In many ways, the history of maps is the history of human society." He goes on to note that a broad diversity of people have made, and continue to make, maps and that we all hold the potential to be mapmakers. In other words, there are often opportunities and the need for non-experts, including citizens, communities and community organizations, to engage in the creation of maps. This is the essence of participatory mapping practice. Participatory mapping is, from this perspective, not new. What is new is the emergence of mapping as a process and tool in recent decades by members of the public to understand and communicate their own place-based relationships (Aberley, 1999) and in doing so, to challenge power and reconfigure who determines what is important (Ghose, 2001; Harley, 1989; Harris &

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Weiner, 1998). These initiatives seek to make visible physical and socio-cultural phenomena and relationships that would otherwise not be represented on most readily available maps (Bird, 1995; Tobias, 2000). Mapping practices have spread around the world, taken diverse forms, and have had a myriad of applications (Chambers, 2006; Cochrane et al, 2014). Mapmaking by individuals and communities - as opposed to technical experts - attempts to offer an inclusive process whereby a multitude of actors can be involved and their voices heard (Rambaldi et al., 2006).

Participatory mapping initiatives have been used to address a broad range of issues. These include advocating for Indigenous land rights (Peluso, 1995), tracking pollution (Cinderby et al, 2008), in humanitarian contexts (Cadag & Gaillard, 2012), control of resources (Parker, 2006) as well as sharing kayaking routes (Corbett & Cochrane, 2017), and promoting local community issues in undergraduate teaching (Corbett & Lydon, 2014).

Consistent with its many and varied applications, different terminology is used to describe participatory practices that incorporate a spatial dimension under the umbrella of ‘participatory mapping.’ These differences are not merely semantic. Some forms of participatory mapping have developed unique theoretical and methodological foundations upon which they draw. ‘Participatory mapping’ has the broadest meaning in these contexts, and hence is the term used throughout this article to encompass the literature that we assessed. While divisions are not this neat, one could contrast the community of practitioners and researchers engaging in ‘counter mapping’ with that of ‘public participation GIS’ (PPGIS). The former seeks to remake the map in a way that is sensitive to new worldviews and values and is counter positional to the toponyms and political sentiments represented in more readily available maps. Essentially, counter mappers are engaged in questioning normative acceptance of representation, power, and control. The community affiliated with PPGIS, on the other hand, has often utilized maps as a mechanism to facilitate community consultation and support land use planning.

As an outcome of participatory mapping being taken up in new ways, each with its own conceptual and methodological underpinnings, its scope and influence is broadening both as a distinctive research methodology and as a form of development practice. In this paper we do not seek to evaluate the application of participatory mapping across disciplines, but we do feel it is important to problematize the narrative of participatory mapping as a coherent, unified discipline defined by a consistent set of practices or methodological structure. In our assessment, what is needed is greater reflexivity regarding the supposition that as both researchers and practitioners of participatory mapping, we are members of the same community of practice with access to the same circles of knowledge; and that in calling our practice something different from that of another person or group, we are still fundamentally talking about and doing the same work, and importantly, guided by the same set of principles.

Given this potential divisiveness, the aim of this paper is to explore whether participatory mapping can be viewed as a coherent, unified discipline. We approach this by examining the published literature related to participatory mapping using keyword searches. We conducted analogous searches across two web-based scholarly search platforms (Google Scholar and Web of Science). The keywords used are common terms used to describe current and emerging participatory mapping practice across a range of technologies. Through this approach, we examine both research and practice that define themselves as using participatory mapping with attention to issues of methodological coherence and/or difference. We used the Google Scholar and Web of Science platforms because they are amongst the most extensive databases available globally (Chadegani, et al., 2013) and within relevant studies, are often compared because of fundamental differences between them, including the variance of user groups and content contained on each platform. By broadly assessing the literature on participatory mapping using Google Scholar and Web of Science, this research contributes to knowledge about the differences between the two platforms and the diverse ways of understanding participatory mapping each provides.

## METHODS

This research sets out to assess the literature on participatory mapping. Rather than pose a specific question of the literature, in this article we have opted to look at the big picture, to assess the landscape of literature related to participatory mapping. In doing so our intent is to better understand what information about participatory mapping is available to interested practitioners and theorists, and in turn, identify what counts as relevant knowledge within the discipline. Our review type and related methods are most consistent with an 'Overview' typology of literature reviews that consists of surveying and describing the research literature on a particular topic (Grant & Booth, 2009). Through this approach, which also involves by being explicit about the methods we used to search and analyze publications, we provide a means of testing the assumption that participatory mapping is a coherent, unified discipline. We conducted an analysis of the literature on participatory mapping and related keywords using two scholarly literature search platforms, Google Scholar and Web of Science. We selected these two platforms as a contrast, rather than affirmation or validation that might emerge through using platforms with similar algorithms and inclusion criteria. As such, we sought out difference. We also selected these two platforms for their widespread use, albeit not by the same communities of users.

One of the challenges in seeking to assess the landscape of the literature on participatory mapping across the various terms used to describe current and emerging spatially-based, participatory practices, is being inclusive of the diversity of terminologies that are used by both researchers and practitioners (see Cochrane et al., 2014). In searching for influential articles on both platforms, we used 18 keywords and terms. Our intent in selecting this breadth of keywords and terms was to be inclusive of the full range of possible practices related to participatory mapping. While this meant that some terms would be more directly or commonly associated with participatory mapping, such as collaborative mapping, participatory action mapping and community-based mapping, it also meant that others would be more peripheral to it, such as neogeography and digital geographies. We used the same search terms on the two platforms. The overarching objective was to identify sources that aligned with three criteria: (1) included one or more of the search terms, outlined in footnote 1;[1] (2) was spatial in nature and utilized or engaged with some form of cartographic mapping; and (3) utilized participatory processes or methods. Three levels of analysis were conducted on both of the platforms, which are outlined below. These levels of analyses narrowed the results ensuring the landscape being assessed was indeed the participatory mapping literature being sought. As we have primarily used quantitative methods to assess the macro-landscape, future research may draw upon qualitative methods to answer questions which we have not addressed.

The first level of analysis involved conducting searches on both platforms using the same identified keywords and related criteria. As our interest was in understanding the breadth of knowledge available through each platform, we did not limit searches of databases using date of publication. For example, limiting searches to only those publications occurring after a particular year. Instead, we opted to include all publications that were identified through search terms without date of publication restrictions. Because Google Scholar has broader inclusion criteria than Web of Science, different processes were used in assessing the results generated through the searches of each database using the same criteria (relevance and citations). In Google Scholar, findings were sorted by relevance and all literature that met the search criteria with *100 or more citations* at the time of the literature review (June/July 2018) were included in the initial review. The analysis of citations was done manually, as Google Scholar does not have an option to sort results by number of citations. When the relevance of an individual publication was unclear, a qualitative assessment was conducted to ensure that it met the search criteria. In order to make sure we captured all relevant literature available through Google Scholar, for each search term we reviewed up to *100 pages* of 10 results per page (most search terms did not include that many results). For the Web of Science, the search results are narrower, as it is not a full-text based search. Web of Science allows the results to be sorted by relevance and by citation. Since the results were fewer and we were able to be more inclusive, for the Web of Science, we started by sorting by citation and included all publications with *1 or more citation* in the review. In other words, all relevant results identified by Web of Science were included, so long as the publication had at least one citation as the inclusion criteria. As was done with Google Scholar process, a qualitative assessment was conducted to ensure that it met search criteria, although this was not needed as frequently on the Web of Science platform due to a higher degree of relevance in the search results.

As a second level of analysis, we identified the most frequently cited articles from the searches of each database (by search term) and ranked the publications by the number of citations from highest to lowest. Web of Science allows users to rank articles by number of citations through the platform automatically; for Google Scholar this was done manually by going through the list of articles and ranking them from highest number of stated citations to the lowest number. The 10 most cited articles for each platform (by search term) were analyzed. In cases where the search term resulted in less than 10 references, for example, if the search term only produced 7 total references, the total number of articles (whatever it was) was included in the ranking.

As the value of any database is arguably the extent to which it produces articles not found through other databases (Martin-Martin et al., 2018), in the final level of analysis we examined the crossover or overlap between search terms for the most frequently cited publications within each database and across the platforms. This was done manually using the database we created. We focused on the topmost cited articles from highest to lowest, by platform and by keyword. This ensured that the top articles from each keyword were included (as opposed to overall citations in the aggregate, since not all terminologies are used by the same size of research community). The objective of this process was to assess the degree to which there was an overlap within a platform using the different terms as well as between the platforms.

## Limitations

While we have attempted to be systematic throughout the processes outlined above, there are a number of limitations to this research method. The research assessed is limited to the English language, and undoubtedly, we have missed important material published in other languages. Both of the search platforms used are not static, but dynamic and change on a daily basis – in content as well as the number of citations. As such, the findings pose challenges for replication, but the method can be reproduced. For the Web of Science, not all subscriptions are equal, and the searches are reflective of what is made available via the subscriptions. We used the Web of Science subscription by the University of British Columbia. This limitation is further exacerbated by the fact that Web of Science uses a fee-based system, while Google Scholar is free to use to anyone with access to the internet. Another limitation of this approach is the variations in the functionality of each platform that meant we had to conduct the review processes across platforms somewhat differently to compensate for these dissimilarities. For example, Google Scholar does not allow users to search by number of citations, only relevance or date. To overcome this difference, we recorded the number of citations for each publication manually, which in effect, was the same treatment done automatically by Web of Science. The other main difference is how we applied the inclusion criteria of *citations*. As previously noted, for Google Scholar, relevant publications with 100 or more citations were included; and for Web of Science, those with 1 or more citation were included (Web of Science citations are much lower, as it only counts citations that are indexed within its own platform, while Google Scholar counts citations in a much broader way). While consistency in approach across platforms is important, this was necessary to ensure we were identifying the most relevant, highly cited publications in each platform based on how each function.

## FINDINGS

The two platforms differ in functionality and as confirmed by the findings of this review, they also differ in their results. Before delving into a comparative assessment of the differences in the results, it is worth noting some of the opportunities and barriers for conducting analyses using these two platforms (be that systematic reviews or broad, descriptive assessments). For the purposes of this study, we found that filtering through Google Scholar a time-consuming undertaking (we did not employ any third-party software to filter, manage or analyse the findings). Google Scholar is a valuable asset because it includes a broader set of material, such as reports, which is also reflected in citation assessments. As the practitioner community is both highly active and vibrant, we felt it important to include the Google Scholar search platform, and thus be able to assess if there were differences. A single study cannot offer any definitive assessment of false positives in search results. However, our finding resonates with other research (e.g. Cochrane & Zerihun, 2018; García-Pérez, 2010; Jacsó, 2008) which demonstrates that Google Scholar returns more false positives than Web of Science. As a result, the analysis requires more time to verify the accuracy of the results using qualitative assessment. The results in Google Scholar, although listed by relevance, related to this challenge. For example, even highly cited publications meeting the search criteria did not necessarily appear in the earlier pages of the search findings and were only found closer to the end of the search. This emphasizes the importance of including a wider set of material in Google Scholar searches, when sorting the results by relevance. As outlined in the methods section, this is why every publication on every page had to be reviewed to ensure relevant documents were not missed, making it a significantly more laborious and time-consuming process.

Web of Science has multiple filters that allow users to search by either relevance, times cited, usage count, date, as well as other subject matter filters that can be used to further refine searches. Google Scholar only allows users to sort search results by date or relevance, and as mentioned, searching by relevance does not mean that highly cited publications that meet the search criteria appear earlier than less cited, or less relevant ones, do (this appears to be related to way in which these platforms categorize by relevance, with Google Scholar placing a greater emphasis upon textual relevance, meaning matches to search terms). Most filters are not additive or cumulative in Google Scholar, meaning that you can only search by relevance or date, not both simultaneously; whereas Web of Science allows users to combine subject filters with higher-level filters, such as relevance and times cited. This provides users with more control over the search, allowing them to incrementally refine search results. Even without applying additional filters beyond those described above, the keyword searches of Web of Science were easier to conduct and make sense of, compared to Google Scholar because, with few exceptions, only relevant publications were included in search results. We do not believe this is a product of publication inclusion criteria differences, as many of the same publications were listed on both platforms but were ranked differently. Rather, this appears to be related to the search algorithms used on each platform, and specifically the ways in which relevance is determined. An assessment of the composition of these algorithms is beyond the scope of this study, and these are speculative findings based on our experiences conducting this assessment. Further study is required to make more conclusive claims.

Some studies suggest that the results of Google Scholar are comparable to other commonly used search platforms when conducting systematic reviews (e.g. Shultz, 2007; Gehanno, Rollin & Darmoni, 2013); however, those studies tend to focus on the health sciences, while other studies suggest the differences can be significant (e.g. Falagas et al, 2008). Alternative platforms to Google Scholar have been recommended given their improved usability as well as their methodological clarity, such as shifts due to uncertain Google Scholar updates (e.g. Anders & Evans, 2010; Falagas et al, 2008). While there are some third-party software options available to filter Google Scholar results (e.g. see one approach used by Cochrane and Zerihun, 2018), the built-in features of platforms like Web of Science (as well as other field-specific platforms such as PubMed) make is more usable, and perhaps therefore more commonly utilized by academics.

The option of using Web of Science is, however, not a choice available to all academics. Many institutions in the Global South do not have access to the costly, subscription-based platforms, thus the choice of platform may also be shaped by other resource contingent decisions. Similarly, practitioners without academic affiliations may not have access to Web of Science, regardless of where they are located. Google Scholar, while free to use, does not enable access to publications without the user holding the prerequisite subscriptions. Effectively, those who are without access to subscriptions for the corporate owned publishers (e.g. Elsevier, Springer, Wiley-Blackwell, Taylor & Francis and Sage), are barred from access. Google Scholar does search for copies of the article that exist online, which might be made available by other websites. However, the majority of academic publications remain behind paywalls. This has implications for the research landscape: scholars from the Global South are severely under-represented in academic journals. One study found that only 3% of academic articles were written by scholars based in the Global South (Medie & Kang, 2018), and this is partially because they are excluded from accessing research and thus, encounter significant challenges in contributing to the academic discourse on an equal footing as their colleagues based at institutions in the Global North. Academic publishing systems, which are largely profit-driven and corporate owned, privilege the privileged. The issue of access is especially poignant given the popularity of Participatory Mapping research and practice in the Global South.

The initial Google Scholar keyword searches produced significantly more publications than Web of Science. This however, changed markedly once the findings from keyword searches were assessed against the search criteria. Google Scholar had significantly more false positives than Web of Science. Consistent with previous findings, it also had a large number of multiple copies or duplicates or triplicates of the same source publication (Jacsó, 2008). As a result, the larger quantity of information generated through the initial Google Scholar searches did not translate into more publications meeting the search criteria, as a sum of searches (in total, 574 results were found in Google Scholar and 746 in Web of Science; Table 1). Web of Science produced more relevant publications for more search

**Table 1. Number of publications by search term for each platform**

| Search Term | Google Scholar | Web of Science |
|---|---|---|
| Participatory Mapping | 104 | 243 |
| Counter-Mapping | 46 | 27 |
| Community Mapping | 87 | 107 |
| Community-Based Mapping | 20 | 12 |
| Collaborative Mapping | 29 | 47 |
| Conflict Mapping | 7 | 9 |
| Participatory GIS/PGIS | 38 | 34 |
| Public Participatory GIS | 11 | 13 |
| Public Participation GIS/PPGIS | 92 | 92 |
| Digital Geographies | 6 | 5 |
| Community Information Systems | 55 | 22 |
| Crowdsourced Cartography | 1 | 3 |
| Indigenous Mapping | 17 | 10 |
| Neogeography | 33 | 77 |
| Qualitative GIS | 27 | 45 |
| **Total** | **574** | **746** |

terms than Google Scholar; for a few keyword searches, for example 'participatory mapping' and 'neogeography', the results of Web of Science were more than double the amount of publications meeting search criteria of Google Scholar. The nature of the difference in the number of publications produced through the different search terms across platforms is examined in greater detail below. The point here is that the broader breadth and scope of findings from Google Scholar searches versus Web of Science did not result in more relevant publications meeting the search criteria.

Keyword searches of both platforms produced publications from academic journals, books, and conference proceedings. However, Web of Science produced more publications from academic sources alone, while Google Scholar identified a broader range of publications, including reports, dissertations, and other sources outside of academic journals. After the findings were assessed against the search criteria, the Web of Science keyword searches resulted in more highly cited, relevant publications not appearing in Google Scholar searches (which calls into question the comprehensive nature of Google Scholar, despite studies finding similar results; e.g. Shultz, 2007; Gehanno et al., 2013). Even without narrowing keyword searches through the use of date filters, the Web of Science platform produced more recent or timely publications than Google Scholar. For example, the top cited publications from Web of Science for the keyword 'participatory mapping' are all from the year 2004 onward, with the majority being from within the last seven years (2004-2014); for Google Scholar, five publications are from the 1990's and the remainder are from the 2000's, with the most recent being from 2009. For 'digital geographies', the difference in the recency of publications produced through each platform is even more pronounced. Web of Science publications are all from within the last four years, with two from 2018, while the most recent publication from Google Scholar was 2012 and the oldest from 1998. This trend is not limited to the top cited publications and is consistent with the broader findings across the different search terms for each platform irrespective of number of citations. For Web of Science the newest publication is from 2018 and oldest is 1995, but for Google Scholar, the newest is 2017 and the oldest from 1980.

Rather than exhibit a consistent trend across the results when comparing the platforms, we see inconsistency. For example, Google Scholar identified more relevant publications for seven keywords (counter-mapping, community-based mapping, locational crowdsourcing, participatory GIS, digital geographies, community information systems and indigenous mapping), while Web of Science found more relevant publications for eight keywords (participatory mapping, community mapping, collaborative mapping, conflict mapping, public participatory GIS, crowdsourced cartography, neogeography and qualitative GIS). This contests the idea that Google Scholar is comparable in results to other platforms, as some literature indicates (Shultz, 2007; Gehanno, Rollin & Darmoni, 2013), and instead suggests that the results are quite distinct, each with respective strengths and limitations (Shah, Mahmood, & Hameed, 2017).

## Overlap Within Platforms

In order to assess the range and forms of publications available to different user groups available on each search platform, we examined the prevalence of overlap in publications by keyword search *within* as well as *between* platforms. This was done in two ways. The first way was by looking at how many times each top cited publication appeared *within* each platform, across the different keywords. Table 2 summarizes the number of publications that overlap two or more search terms within each platform broken out by number of search terms overlapped.

By analyzing the overlapping papers within the results of each platform, we were able to identify relatively distinct user groups for each keyword, or what might be called 'knowledge circles' (as these are not necessarily disciplinary divisions, but groupings of researchers have adopted a certain terminological use). For example, we found that 'community mapping' was used more consistently within the health sciences community. In contrast, the keyword search term 'participatory mapping' produced far more publications on both platforms (243 for Web of Science and 104 for Google Scholar) than 'community mapping' (107 for Web of Science and 87 for Google Scholar), yet it only generated

**Table 2. Top cited publications by number of search terms overlapped**

| # of Search Terms Overlapped | Publication |
|---|---|
| **Google Scholar** | |
| 5 | Public participation geographic information systems: a literature review and framework (Sieber, 1998) |
| 5 | Mapping indigenous lands (Chapin, Lamb, & Threlkeld, 1997) |
| 4 | Critical issues in participatory GIS: Deconstructions, reconstructions, and new research directions (Elwood, 2006) |
| 3 | The credibility of volunteered geographic information (Flanagin & Metzger, 2008) |
| 3 | Participatory GIS – a people's GIS? (Dunn, 2007) |
| 2 | GIS-based land-use suitability analysis: a critical review (Malczewski, 2004) |
| 2 | Participatory action research approaches and methods: connecting people, participation and place (Kindon, Pain & Kesby, 2007) |
| 2 | GIS and public health (Cromley & McLafferty, 2011) |
| 2 | Web mapping 2.0: the neogeography of the GeoWeb (Haklay, Singleton & Parker, 2008) |
| 2 | Researching volunteered geographic information: spatial data, geographic research, and new social practice (Elwood, Goodchild & Sui, 2012) |
| 2 | Empowerment, marginalization, and "community-integrated" GIS (Harris & Weiner, 1998) |
| 2 | Citizen science and volunteered geographic information: overview and typology of participation (Haklay, 2013) |
| 2 | Mapping: a critical introduction to cartography and GIS (Crampton, 2011) |
| 2 | Cartography: Maps 2.0 (Crampton, 2009) |
| 3 | Cartography, territory, property: postcolonial reflections on indigenous counter-mapping in Nicaragua and Belize (Wainwright & Bryan, 2005) |
| 2 | Key issues and research priorities for public participation GIS (PPGIS): a synthesis based on empirical (Brown & Kytta, 2014) |
| 2 | Public participation GIS: a new method for national park planning (Brown & Weber, 2011) |
| 2 | Methods for identifying land use conflict potential using participatory mapping (Brown & Raymond, 2014) |
| 2 | Empirical PPGIS/PGIS mapping of ecosystem services: a review and evaluation (Brown & Fagerholm, 2015) |
| 2 | The spatial politics of affect and emotion in participatory GIS (Young & Gilmore, 2013) |
| 2 | Environmental justice radar: a tool for community-based mapping to increase environmental awareness and participatory decision making (Wilson et al., 2015) |
| 2 | Indigenous people don't have boundaries': rebordingings, fire management, and production of authenticities in indigenous landscapes (Sletto, 2005) |

five health focused studies for Web of Science and four for Google Scholar. In contrast, 'community mapping' produced 17 health-based research studies for Web of Science and 12 for Google Scholar. These studies used participatory_cartographic approaches to promote understanding of a range of health-related issues, including for example, the cardiovascular effects of noise (Babisch, 2008; 2011), Hepatitis C infection rates (Abdel-Aziz, et. al., 2000), patients access to health services (Zuvekas, Nolan, Turnaylie, & Griffin, 1999), and breast cancer (Potts, 2004) and HIV/AIDS risk assessment and prevention (Edberg, Collins, Meredith, & Santucci, 2009; Sweat et al., 2011).

The analysis of overlapping publications identifies focal papers that overlap search terms within platforms. For example, a literature review and framework by Sieber (1998) was identified under five keyword searches in Google Scholar. Interestingly, however, this same paper did not overlap on the search results of multiple keywords on Web of Science. In other words, using the same keywords on the two platforms did not result in the same overlapping papers. While this is somewhat unexpected, it is reflective of the topical versus textual search processes of the two platforms. What is notable about the papers that crossed over the bounds of keyword searches within databases is that they tended to be reviews, methodological or theoretical publications, rather than empirical ones. While this is not unexpected, it also posed challenges in relation to our initial interest, which was to identify exemplary cases of participatory mapping. The cases of participatory mapping are far more bound by their 'knowledge circles' and usage of keywords than the reviews, methodological or theoretical ones. Thus, it is possible to identify exemplary cases from within a particular keyword, or within a particular knowledge circle, but much more challenging to identify an exemplary participatory mapping case for the practice generally.

Among the top cited publications found on each platform generated through the different search terms, Google Scholar produced more publications that overlap different keyword search terms than Web of Science. For example, Google Scholar has 14 publications that overlap keyword search terms a total of 38 times, with two articles (e.g., Sieber, 1998; Chapin, Lamb, & Threlkeld, 1997) each overlapping five different keyword search terms. For Web of Science there are eight publications that overlap keyword search terms a total of 17 times, with the maximum being three keyword search terms overlapped by any one publication. In terms of total number of distinct top cited publications across all search terms. Of note in this regard, the most overlapped keyword search term for both platforms was "PPGIS participation", with seven different overlapping publications for Google Scholar and three for Web of Science. As somewhat of a catch-all category for the other search terms, other keyword search terms appeared more often in searches using "participatory mapping" than any other search term. For example, research publications on "community-based mapping", "community mapping", "collaborative mapping", "PGIS" and "PPGIS" are commonplace among the searches using keyword search term "participatory mapping". Given the breadth of publications generated through keyword "participatory mapping", it is makes sense that it is the most productive keyword search term for both platforms in terms of total numbers of publications produced.

### Overlap Between Platforms

Assessing overlap within each of the platforms enabled an assessment of which terminologies are being used, and how frequently those terminologies cross distinct knowledge circles of users. However, we also wanted to compare the platforms and thus looked at how many times top cited publications (the top 10 for each keyword, for each platform) overlapped search terms *across* the platforms. Table 3 summaries the results of this analysis. The most striking result is how few overlapping publications there are, using the same keyword, on the two platforms. In the matrix below, there are a potential for 256 cells to identify papers with relatively high citation rates across the platforms; only 20 did (8%). Of the publications that were highly cited on both platforms, a few papers stood out, as appearing three or more times: Brown & Kytta, 2014; Chapin, Lamb & Threlkeld, 2005; Dunn, 2007; Wainwright & Bryan, 2009. As with the overlapping results within a search platform, the publications that appeared multiple times on the matrix, as being identified as highly cited by both Google Scholar and Web of Science, are reviews, reflections and syntheses.

In total, there are 135 top cited publications across the search terms for Google Scholar and 137 for Web of Science. There are only 13 publications that overlap both platforms across all search terms, which amounts to around 10% of the total number of top cited articles from the searches on each platform. The minimal overlap between the most cited articles in Google Scholar and Web of Science reflects both a disparity in the information available through the two sources and the different processes of searching those literatures. The matrix also highlights the distinct nature of terminological

**Table 3. Matrix of overlap across platforms for most cited publications**

| Google Scholar – Web of Science | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Keywords | Participatory Mapping | Counter Mapping | Community Mapping | Community–Based Mapping | Collaborative Mapping | Conflict Mapping | Locational Crowdsourcing | PGIS | Participatory GIS | PPGIS Participation | Digital Geographies | Community Information Systems | Crowd-sourced Cartography | Indigenous Mapping | Neogeography | Qualitative GIS |
| Participatory Mapping | | | | | | | | Brown & Kytta, 2014 | | | | | | Wainwright & Bryan, 2009 | | |
| Counter Mapping | | Peluso, 1995 | | | | | | | | | | | | Wainwright & Bryan, 2009 | | |
| Community Mapping | | | | | | | | | | | | | | Parker, 2006 | | |
| Community-based Mapping | | | | | | | | | | | | | | | | |
| Collaborative Mapping | | | | | | | | | | | | | | | | |
| Conflict Mapping | | | | | | Brown & Raymond, 2014 | | Brown & Kytta, 2014 | | | | | | | | |
| Locational Crowd-sourcing | | | | | | | | | | | | | | | | |
| PGIS | | | | | | | | Dunn, 2007 | | Dunn, 2007 | | Dunn, 2007 | | | | |
| PPGIS Participatory | | | | | | | | | | | | | | | | |
| PPGIS Participation | | | | | | | | Brown & Kytta, 2014 | | Bugs, Granell, Fonts, Huerta& Painho, 2010 | | | | | | |
| Digital Geographies | | | | | | | | | | | | | | | | |
| Community Information Systems | | | | | | | | | | | | | | | | |
| Crowdsourced Cartography | | | | | | | | | | | | | Dodge & Kitchen, 2013 | | | |
| Indigenous Mapping | | Chapin, Lamb & Threlkeld, 2005 | | Chapin, Lamb & Threlkeld, 2005 | | | | | | Chapin, Lamb & Threlkeld, 2005 | | | | Chapin, Lamb & Threlkeld, 2005; Wainwright & Bryan, 2009 | | |
| Neo-geography | | | | | | | | | | | Graham, 2010 | | | | Goodchild & Glennon, 2010; Elwood, Goodchild & Sui, 2012 | |
| Qualitative GIS | | | | | | | | | | | | | | | | Evans & Jones, 2011 |

uses within participatory mapping. As an additional point of comparison that further emphasizes the knowledge or informational divide between the platforms, there is absolutely no crossover between the top cited publications overlapping two or more search terms *between* Google Scholar and Web of Science. In other words, there is no alignment in the publications appearing most often in each platform across all search terms. The most prevalent articles across all search terms for each platform are completely different from each other.

## DISCUSSION

We conducted an analysis of Google Scholar and Web of Science using 'participatory mapping' and 18 related keyword search terms to assess the types and quantity of publications available through each platform for the scope of participatory mapping practices. Through our review, we examined the degree of overlap in publications for each search term within and across Google Scholar and Web of Science for the top cited articles in each platform. The limitations to our research, including a focus on English language publications, are outlined in the methods section above. The results from this analysis have important implications for participatory mapping practitioners and theorists. Key implications are briefly examined here.

The findings suggest that participatory mapping lacks coherence from a multi-disciplinary perspective, but still has clear unified and distinguishable elements with marked boundaries. There is evidence of distinct 'knowledge circles' tied to different terminologies reflective of their specific application within certain disciplines. For example, the term 'community mapping' is increasingly being adopted by health researchers to describe a health focused, community-based approach to participatory mapping. The low levels of interaction between these knowledge circles indicate that specialized practices are emerging in relation to specific terms/terminology and not across participatory mapping more broadly. These applications of participatory mapping practices vary methodologically, but also in terms of the ideologies underpinning their uses. Given this, it is increasingly important for practitioners of participatory mapping to be explicit about what is being done under the guise of participatory mapping for others to know and understand how practices are similar and differ.

The pronounced difference in the publications accessible through each platform also has important implications for participatory mapping theory and practice. Although it is not uncommon for Google Scholar and Web of Science keyword searches to each produce their own unique set of publications relative to the other (García-Pérez, 2010), in this review only about 10% of the most cited publications for each search term overlap on both platforms. This finding is in contrast to those of Martin-Martin et al. (2018), who found that Google Scholar produces a "superset" of information compared to Web of Science that envelopes and significantly expands upon the information produced through Web of Science searches. For the most cited publications in each platform crossing over two or more search terms, the difference is even starker, in that there is absolutely no overlap occurring in these publications. Ultimately, this means that how participatory mapping is conceptualized and what counts as legitimate knowledge about participatory mapping, changes based on the platform being accessed as well as the terminology used. An obvious implication of this finding is that the use of diverse platforms is required to conduct a comprehensive, systematic review of participatory mapping practices. Less obvious, yet equally important implications stem from the nature of this difference between platforms.

According to the findings from this analysis, it can be said that for participatory mapping and related search terms, on the whole Web of Science produced more relevant, timely, academic publications with fewer errors and less effort than Google Scholar. However, in assessing the value of each platform in relation to the information on participatory mapping each produces, it is important to look beyond content to the process for determining top cited publications, as well as issues of accessibility. This is particularly important given that searches of each platform produce such markedly different publications. As data collection and management platforms, Google Scholar and Web of Science rely on algorithms to parse or breakdown data in order for it to make sense to users. The term 'algorithmic governance' is used to describe the trend toward the use of algorithm-based decision-making systems. Sometimes human-assisted, but oft not, increasingly these systems are being used to "nudge, bias, guide, provoke, control, manipulate and constrain human behaviour" (Danaher et al., 2017; p. 2). As a result, there is a growing need to critically evaluate the effectiveness and legitimacy of these algorithmic systems (Peter, 2017) and how they privilege certain types of academic publications when searching for them using online platforms.

As participatory mapping practitioners and theorists, it is necessary to consider what factors we prioritize in determining the legitimacy of one search platform system over another. Fundamentally, our choice of which search platform we use dictates what counts as relevant knowledge and in this way, profoundly shapes participatory mapping practice and research. For this reason, it is necessary to clearly identify how we decide what knowledge is most relevant and important and how it is shared and/or accessed. An important determinant of social and political legitimacy of these systems is the degree of human involvement (Danaher et al., 2017). Web of Science is human curated database, but because it is a subscription-based service, it is less accessible and inclusive of different user groups than Google Scholar. Google Scholar is open to anyone with an internet connection, but it relies on opaque algorithms that compile search results in fully automated fashion (Google, 2015). While Google Scholar is more accessible than Web of Science, and in this respect, is more reflective of the emancipatory intent of participatory mapping, it relies on algorithms with minimal to no human involvement or oversight. These are important implications underlying the use of these platforms that need to be more thoroughly explored within the context of participatory mapping practices more broadly. This study offers comparative results from two platforms, analyzing a specific set of literature. Additional research is required to assess the extent to which the trends we have identified are consistent with other fields of research as well as in relation to other platforms. More importantly, however, we feel there is a need to draw upon these critical studies to enable new forms of critical inquiry, particularly in areas of knowledge production, dissemination and emphasis in relation to the greater role that algorithms play in prioritizing not only forms of knowledge but also producers of it. This has the potential to create academic 'echo chambers' whilst marginalizing voices and perspectives.

## CONCLUSION

In this paper, we assessed the landscape of the literature on participatory mapping across two commonly accessed and contrasting scholarly search platforms – Google Scholar and Web of Science. Findings indicate that participatory mapping lacks coherence as a multi-disciplinary endeavour, but still has a clear set of unified principles. The marked disparity or lack of overlap between the publications on participatory mapping and related practices produced by each platform has implications regarding the legitimacy of how publications are selected by each platform. Fundamentally, the choice of which search platform we use as practitioners of participatory mapping is not benign – it is laden with potential social and ethical implications. They are raised here as a starting point for further discussion.

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## ENDNOTE

[1] These included: Participatory Mapping, Counter-Mapping, Community Mapping, Community-based Mapping, Collaborative Mapping, Participatory Action Mapping, Participatory Mapping, Counter-Mapping, Community Mapping, Community-based Mapping, Collaborative Mapping, Participatory Action Mapping, Citizen Cartography, Conflict Mapping, Locational Crowdsourcing, Participatory GIS/PGIS, Public Participatory GIS/PPGIS, Public Participation GIS/PPGIS, Digital Geographies, Community Information Systems, Crowdsourced Cartography, Indigenous Mapping, Neogeography, and Qualitative GIS.

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