Mapping Sense of Place: Online Participatory Mapping for Indicating Landscape Values

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Abstract. The past decade has witnessed the immense growth of online geographic information technologies and crowdsourced geographic information. The increasing involvement of non-specialists in the Geoweb has been interpreted as dismantling elite Cartography and re-empowering every human's innate mapping ability. But this assertion may belie the multitudinous and even conflicting goals of different uses of crowdsourced geographic information, which can be disempowering as well as empowering. This paper explores the potential of online participatory mapping as an empowering use of Geoweb technology. It describes a case study that employed user-centered design to create a crowdsourced web map for community-driven mapping of places and landscape values.

Keywords: Volunteered Geographic Information, Crowdsourced Geographic Information, Participatory Mapping, Geoweb, Wikimap

1. Introduction

The past decade has witnessed explosive growth of the Geoweb, the aggregate of adaptable and integratable mapping technologies and applications available over the Internet. Based on two-way information transfer enabled by Web 2.0, these technologies have created new forms of interactive mapping and vastly expanded the ability of internet users with little formal knowledge of Cartography to contribute geographic information and make maps (Corbett 2012).

This change has been celebrated by some as a "democratizing" influence on Cartography, reviving recognition and empowerment of every human's innate mapping ability (Wood 2003). Online maps promise to represent a far greater range of interests than the narrow set of values embedded in maps created by business and state institutions (Harley 1989). They may even

make it easier for grassroots groups and Indigenous communities to assert sovereignty over local territory and resources (Corbett 2012).

This optimism should be tempered by the significant obstacles to technological empowerment that remain for a large portion of the world's population: 'digital divides' between the Global North and Global South, the urban and rural, the young and old, the wealthy and poor (Crampton 2010). Uncritical claims of empowerment from so-called 'Volunteered Geographic Information' have also been questioned, and an ethical distinction drawn between information that is truly volunteered and empowering versus locational data that is involuntarily contributed and could be extremely disempowering (Harvey 2012).

More discussion is needed to determine how Geoweb technology can fulfill its promises of democratization and empowerment. Even what constitutes this fulfillment has been ill-defined to date. Is it enough for internet users to simply make a map expressing their concerns, as the Ushihidi Crowdmap[1] platform now allows? Or should we evaluate the technology's success based on its users' ability to retain and expand sovereignty over their rights and resources, as is the stated goal of many participatory mapping practitioners (Corbett 2009)?

To explore how Geoweb technology might be used to empower local sovereignty over resources while avoiding ethical pitfalls, I conducted a case study using online participatory mapping in the Bad River Watershed of rural northern Wisconsin, USA (*Figure 1*). The study occurred in the context of intense public debate over a mining proposal within the watershed. The proposed open-pit mine has drawn staunch opposition from a Native American tribe (the Bad River Band of Ojibwe) and white environmentalists. It has been supported by mining equipment manufacturers as well as some local business owners and blue-collar workers (Gedicks 2011). Much of the debate has revolved around conflicting landscape values, defined by Brown (2004) as "operational bridge[s]" between places and how they are perceived in the context of land use decision-making. Those in favor of the mine promote the values of jobs and economic development, while those opposed focus on ecological, historical, spiritual, and other values that could be harmed by environmental impacts.

The case study employed a user-centered design process to develop a *wikimap*, a web map displaying user-volunteered places and their associated landscape values in the Bad River Watershed. I sought guidance from local land use and natural resource experts, and conducted user testing with area

[1] http://www.ushahidi.com/products/crowdmap

residents. The goal was to create a highly usable crowdsourced web map that could influence mining and other land use policy decisions in favor of the values held by the people who could be most impacted.

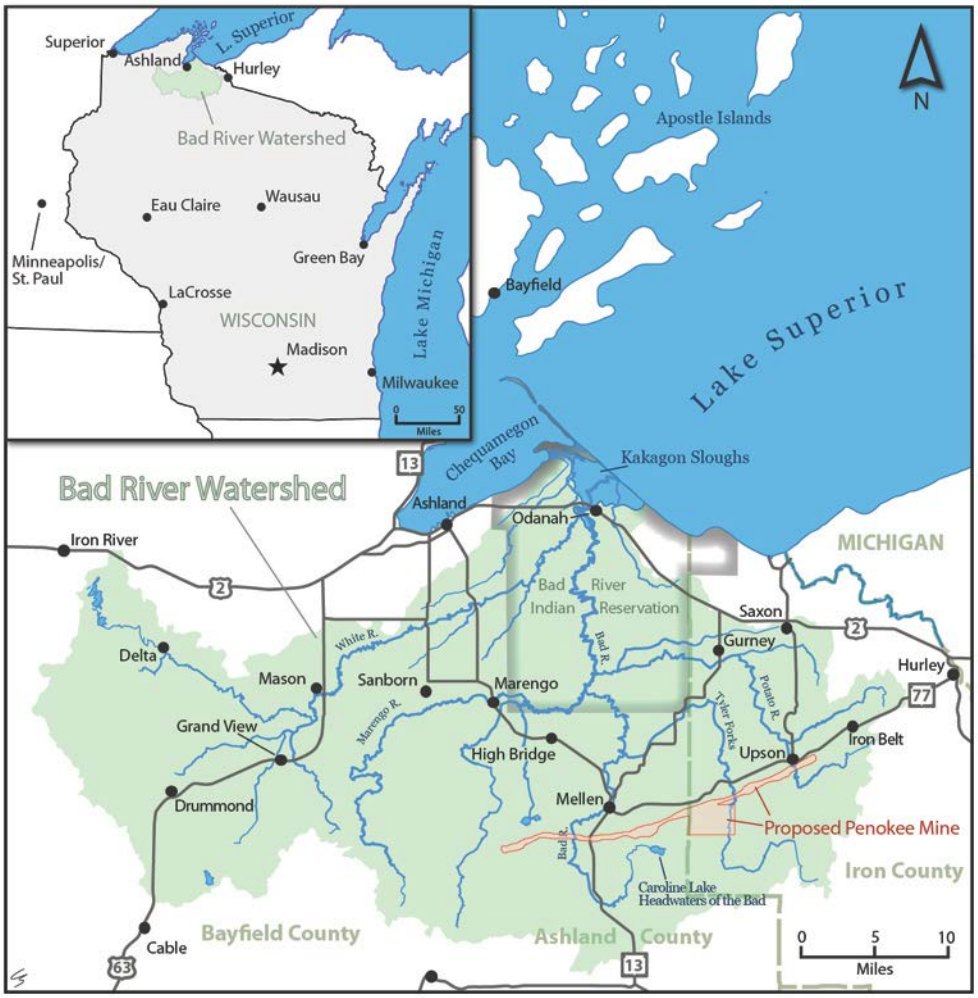

Figure 1. Geography of the Bad River Watershed in Wisconsin, USA.

2. Case Study Procedure

Building a highly usable website is critical for generating use of a web-based application by non-experts. Further, the ethical principles of participatory mapping demand a transparent and community-driven software development process (Corbett 2009). *User-centered design* is an iterative, multi-

stage development process that involves user input at each stage. It has been shown to increase the efficiency of use, reduce the need for training and support, and improve adoption of computer applications by the public (Maguire 2001).

The user-centered design process for the Bad River Watershed Wikimap was modeled on six stages recommended by Robinson et al. (2005), with modifications to fit the wikimap scenario (*Figure 2*). The six stages were: 1) a *needs assessment* to determine requirements and guidelines for the application, 2) a *conceptual design* document detailing the wikimap specifications, 3) *prototyping* partially-working instances of the application, 4) a formative *usability assessment* to test for problems and bugs with the initial version of the application, 5) *debugging and release* of the application, and 6) a *summative evaluation* to determine the utility of the final application and draw lessons for future development.

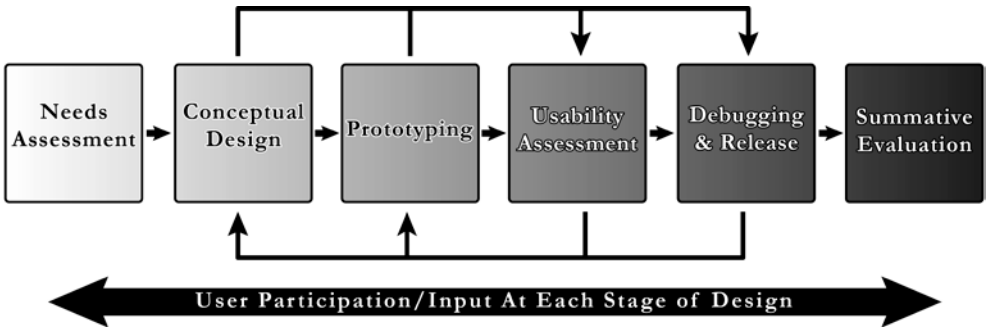

Figure 2. The six stages of the user-centered design process employed to create the Bad River Watershed Wikimap.

The needs assessment was planned to elicit ideas from domain experts to guide application development. It took the form of semi-structured interviews with members and employees from a range of state, federal, and tribal government agencies and non-government organizations working within the Bad River Watershed. Semi-structured interviews start from a set of predetermined questions in a given order, but allow interviewer discretion to probe potentially interesting responses (Robinson 2009). This approach created a constructive dialogue with the domain experts rather than a rigid question-answer session, enhancing both the quality of the answers and the buy-in of the stakeholders to the process. Eight interviews were conducted in Ashland, the largest population center near the Bad River Watershed, over a four-day period in April, 2012. Each lasted between

45 and 70 minutes and was audio-recorded for later transcription and analysis.

The themes and ideas expressed by interviewees were recorded and analyzed to show which responses extended across multiple participants. This documentation was then used to produce a conceptual design for the application, which detailed the website objectives, interface components, and Geoweb technologies to be used. A static mock-up of the web interface was created and sent with the conceptual design through electronic mail to the interview participants for feedback (*Figure 3*). Four participants, or 50% of those interviewed, responded with specific comments and suggestions.

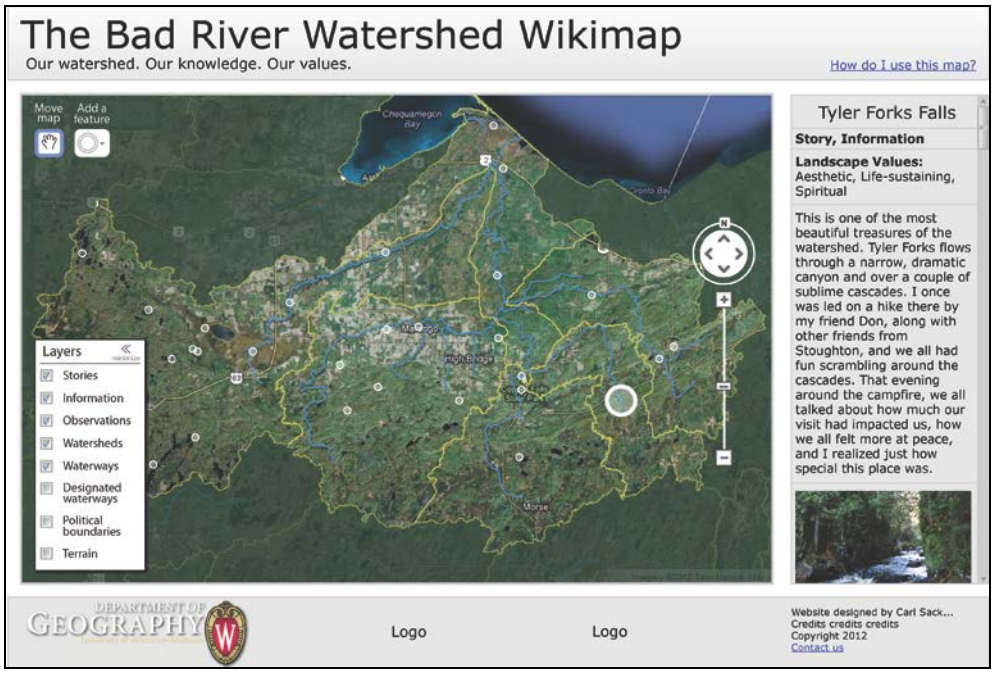

Figure 3. An initial static mock-up of the wikimap interface.

Application development took approximately six months. Over that time period, two partially-working prototypes were developed and sent to participants for feedback. Less feedback was received on the prototypes than on the conceptual design, and the responses that were received lacked detail. Thus, the prototyping stage turned out to be more developer-directed than other stages of the project. The final working application is shown in *Figure 4*.

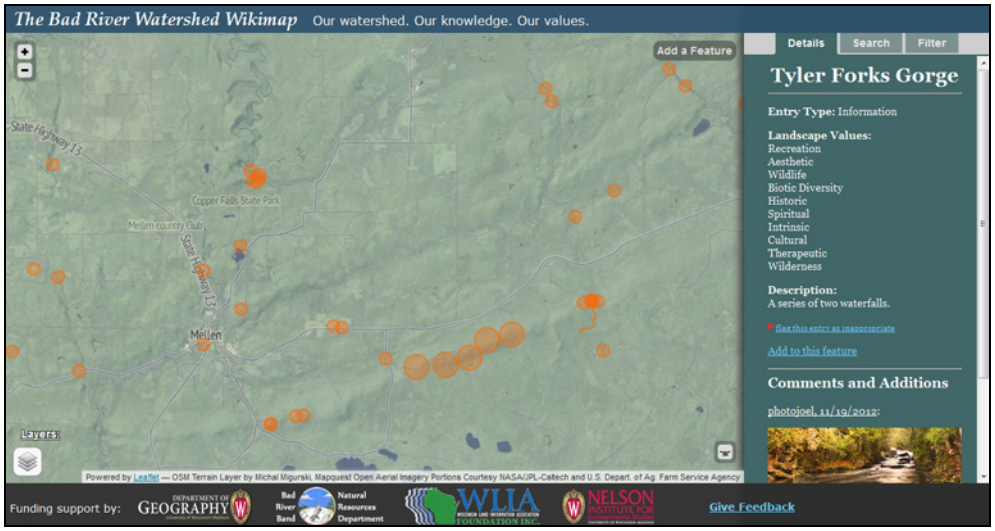

Figure 4. A screenshot of the final wikimap application.

When the application was nearing completion, a formative usability assessment was planned. One of the interview participants took a leading role in aiding with the design and logistics of public workshops for this purpose. Four workshops were held in different locations in and near the Bad River Watershed in November, 2012. The goals of the workshops were to test the wikimap for user satisfaction and technical glitches and to gain buy-in by promoting the wikimap to the public. The workshop plan called for participants to identify important locations within the watershed on a paper map, then transfer those locations to the wikimap under the guidance of the facilitator. Issues with the system encountered by participants were recorded in a notebook by the facilitator.

Most issues identified during the workshops were rectified, and some participant suggestions implemented, over the course of a two-week debugging period. The wikimap was then released for public use, with additional debugging performed on an ongoing basis. The wikimap was publicized at two large events: a public hearing directly related to the controversial mining proposal, attended by 265 watershed-area residents, and a winter sporting event attended by 3,500, many of whom were from outside the watershed area. It was also promoted through posters in local establishments and online forums frequented by watershed-area residents.

After its release, the application recorded user-map interactions and placed records from each use session in a database. Users were informed of this recording through a statement displayed as part of the application for a user

account. As a summative evaluation, the session logs were analyzed to determine how users engaged with the system.

3. Results

3.1. Needs Assessment

Participants in the initial needs assessment interviews were questioned about key themes regarding online participatory mapping. The interview questions were grouped into seven sections. Five sections each asked fundamental questions about how the project should proceed, while the sixth section was a guided activity to test a landscape values typology for the watershed, and the seventh section consisted of open-ended questions to prompt any further discussion (*Table 1*).

Section	Theme
“Who”	Key stakeholder groups
“Who”	Digital divides
“Who”	Public participation and buy-in
“Who”	Wikimap maintenance and moderation
“What”	Base map information sources
“What”	Types of user-contributed information
“What”	Limits on contributions
“Why”	Advantages of a wikimap
“Why”	Disadvantages of a wikimap
“Why”	Past participatory mapping projects
“When”	Types of map media
“When”	Appropriate map media for Bad River Watershed
“How”	Wikimap functionality
“How”	Evaluate examples of similar applications
“Landscape Values”	Identify a place in the watershed for each of 14 values and “other” value
“Conclusion”	Other aspects of project
“Conclusion”	Other ethical issues
“Conclusion”	Continuing role of participant in the project

Table 1. Key themes explored during the needs assessment interviews.

The first set of questions attempted to characterize potential wikimap stakeholders and users. Several participants cited lack of internet access as a

potential barrier to wikimap use, although one participant referenced a survey showing a large majority of watershed residents had access. Some participants indicated that much of the watershed's population is elderly and rural, therefore less likely to use the internet, while others discussed an inflow of young and more technology-savvy people into the area. The participants identified some public places within the watershed that people could go to use the internet, particularly libraries and coffee shops. They made a number of suggestions for recruiting wikimap users, including press alerts and outreach to key community leaders. Almost everyone felt that a reputable and stable organization based in the local community should control and maintain the wikimap.

When asked to compare the idea of a wikimap with other forms of participatory mapping, several saw the guided creation of paper maps as more familiar and potentially gaining more buy-in from the community. Online technology was seen as exciting for its potential to be more "organic," i.e. without the need for direct facilitation by an expert, and as having "an opportunity to live on, as opposed to being a short-term project," in the words of participants.

These discussions largely shaped the formative assessment project phase. Public accessibility was taken into account when selecting locations and times for workshops to introduce the wikimap. As suggested, outreach to township boards, churches, community organizations, and the press was conducted in the lead-up to the workshops. The workshops themselves were designed to be a synthesis of paper-based and online participatory mapping (see *Section 3.2*).

The interview participants envisioned a broad range of information types and sources for the wikimap to contain. Waterways, aerial imagery, and county-level spatial data were the most requested layers. When asked about types of volunteered information, some participants emphasized the ability to add scientific data and descriptive information to the map, while others were most interested in personal stories and historical knowledge related to places in the watershed.

The "Landscape Values" section of the needs assessment asked participants to identify a location in the Bad River Watershed that holds a certain landscape value for each of 15 different values. The goal of this exercise was to test whether each value in the typology, modified from the typology presented in Brown (2004), was applicable to the Bad River Watershed. At least two places were identified for each value, indicating that all values of the typology could be useful to wikimap users. Two additional values were each mentioned by one participant, leading to the creation of an "other" category of values in the final typology.

All participants saw the ability to volunteer information and values, as well as access the information added by others, as important interactions for the application to include. Several participants desired the capability to zoom to different map scales and toggle data layers. Some stated that a simple, user-friendly interface would be important for gaining buy-in from community members with a low level of technological expertise.

The most difficult question for many participants was whether and how to adequately moderate the information placed on the map, with specific worries about the ensuring the accuracy of volunteered information, maintaining respectful dialog, and controlling sensitive information, such as locations of fragile ecosystems and Native American sacred sites. The question of how to balance open access with information control was a recurring theme during the interviews, and no participant claimed to have a definitive answer. One participant expressed that appropriate limits to information contribution should be set through community dialog, because such limits "require a level of consensus amongst communities or identity groups."

In response to these concerns, the conceptual design envisioned a system of membership-based posting privileges with moderation of posts by community leaders. This system was implemented with few changes.

To view or post to the wikimap, users must sign up for an account, which requires an agreement to abide by a set of terms and conditions that define responsible posting. Each volunteered post is visible to one or more moderators through a separate application that only the moderators have privileges to access. New posts are placed online immediately, but the moderator can approve, edit, or remove them at will. Users have the ability to 'flag' a feature or comment, which highlights it in red on the moderator application. To further protect sensitive sites, users may exercise an option to 'generalize' a point feature when it is created, which places a circle on the map that has a ground diameter of at least 850 meters and a center offset from the feature's true location. To encourage conscientious posting, users are reminded before submitting a post that it will be publicly visible and should not be posted if indicating a sensitive feature.

Other such needs discussed during the interviews were written into the conceptual design. The full document described nine components of the wikimap: the objectives of the application, non-map website components, map interface components, a layer control and legend, information panel content, an 'add information' form, an 'add comments' form, a 'flag post' form, and the Geoweb technologies to be used. Most of the conceptual design was ultimately applied during prototyping, with the exception of the

technologies component. Many of the Geoweb technologies initially selected were proprietary, and were later replaced with open-source technologies. This step was taken to avoid financial costs associated with initial setup and ongoing maintenance, and to increase the flexibility and extensibility of the final application.

3.2. Formative Usability Assessment

To test the initial version of the wikimap, four public workshops were held in November, 2012 at different locations in and near the Bad River Watershed. The workshop plan included a two-part procedure, wherein participants would first identify important places on a large poster map of the watershed, then add those locations to the wikimap under facilitator guidance. The workshop facilitator was expected to take notes on any problems or difficulties experienced by participants.

Despite a promotion strategy guided by the needs assessment, the workshops did not garner robust participation. Eight people total participated. The original workshop plan was only carried out at one of the workshops. Other sessions had very light attendance, and those who attended chose to use the wikimap without first completing the poster map exercise. Nonetheless, the usability assessment produced two important outcomes. First, participants identified several technical issues, including a major cross-browser compatibility problem, and contributed ideas of tools to add to the application. Second, participants seeded the wikimap with over 100 volunteered features, providing a robust information set for future wikimap users to explore.

3.2. Summative Evaluation

In order to draw insight into the ways in which the wikimap was used, the application was programmed to record user interactions with the map. This system logging allowed for non-intrusive data collection during organic user sessions (Sweeney et al. 1993). Over the four months following the wikimap's public release, the number of users climbed to more than 50. The system recorded 156 session records, 53 of which included ten or more user interactions, as of when this analysis was conducted. A technical glitch prevented some sessions from being recorded, on a random basis that did not bias the data.

The interaction logs were analyzed in two ways: by the frequency of back-to-back pairs of interactions conducted by users, and by sets of ten sequential interactions performed during individual use sessions. Each approach was visualized using a Sankey flow diagram. Each interaction type was used as a node, with the height of each node proportional to the number of that

interaction type performed at that point in the sequence. The links between interaction nodes were made proportional in height to the number of that sequence of interactions performed by users.

Figure 4 visualizes the volume of each interaction and each unique pair of interactions performed in sequence. By far the most common interactions were zooming the map to different scales, panning the map, and retrieving the name of a volunteered feature using a tooltip. The most common sequence pattern, accounting for 39% of all pairs, was to repeat one of these three interactions. Less frequent but still common patterns were to follow zooming with panning (8%), follow panning with zooming (7%), or retrieve more information about a feature after seeing its tooltip (6%). Other map interactions were infrequently used, but there was a broad diversity of usage patterns between them.

Figure 5 displays longer sequences of interactions performed during different sessions of wikimap use. From examining each sequence, a variety of map use patterns emerged. Three dominant patterns were: exploration of the map itself, shown by zooming, panning, and toggling base map layers; exploration of the volunteered information, shown by retrieving feature labels and clicking a feature for more information; and volunteering of new information, shown by drawing features and submitting posts. Most sessions exhibited one of these themes, although some combined map-reading with information-seeking. A small minority of sessions demonstrated information-volunteering.

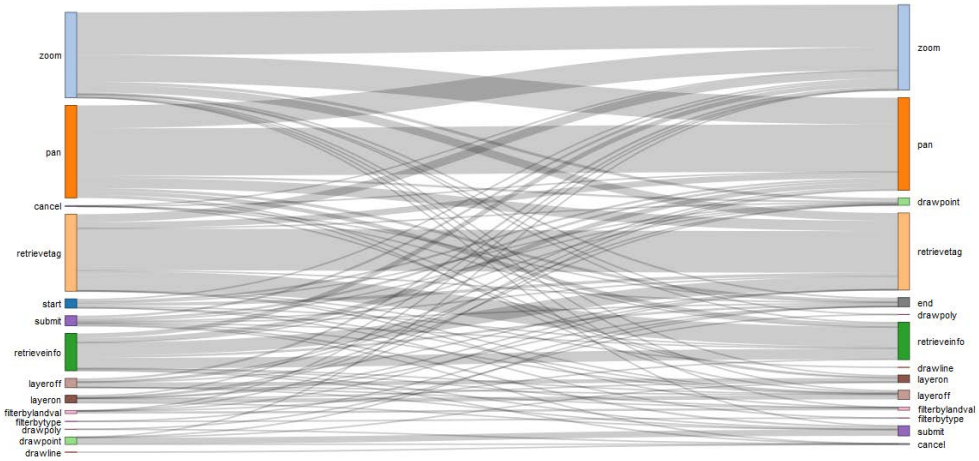

Figure 4. Sankey diagram showing frequency of interaction pairs.

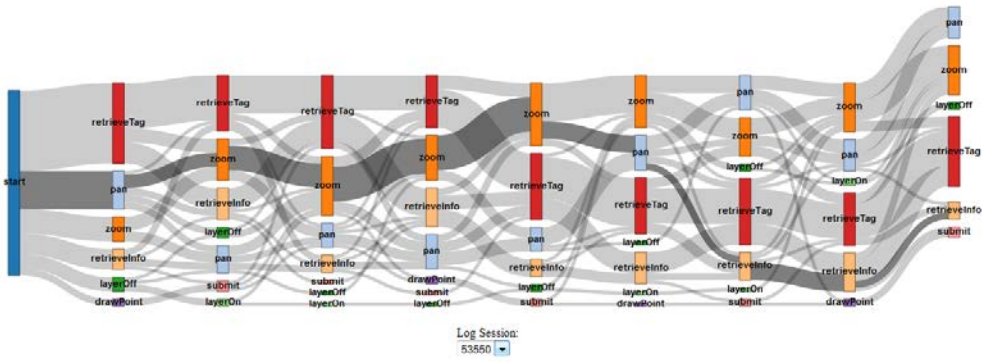

Figure 5. Sankey diagram showing wikimap use sessions. The highlighted session demonstrates map-reading followed by information-seeking.

4. Conclusion

Crowdsourced information on the Geoweb may empower local communities to promote their own values and assert sovereignty over resources if implemented transparently and ethically with strong community input and oversight. The Bad River Watershed Wikimap was developed as an attempt to meet these goals through user-centered design praxis.

With over 50 users, the wikimap application could be considered a modest success. Its development was assisted by the presence of a contentious natural resource issue and the help of a small number of enthusiastic volunteers in the community. The summative assessment demonstrated that the website was useful to a number of users in a variety of ways, although most users limited their sessions to map exploration and information retrieval, and only a small minority volunteered new information. Further analysis could reveal these use patterns in more detail and suggest possible user motivations. Additionally, the moderation system could be further evaluated to conclude whether it adequately protects the accuracy and propriety of information placed on the map.

The wikimap's effectiveness for demonstrating what landscape values are present in the Bad River Watershed remains untested. The small number of information contributors makes the reliability of the identified landscape values difficult to assess, since the value of a place may differ between individuals. In the future, users will be surveyed as to what difference, if any, using the wikimap made to their perceptions of places in the watershed.

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