Affective Geographies: Toward Richer Cartographic Semantics for the Geospatial Web

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ABSTRACT
Due to the increasing sophistication in web technologies, maps can easily be created, modified, and shared. This possibility has popularized and democratized the power of maps by enabling people to add and share cartographic content, giving rise to the geospatial web. People are increasingly using web maps to connect with each other and with the urban and natural environment in ways that no one had predicted. As a result, web maps are growing into a venue in which knowledge and meanings can be traced and visualized. However, the cartographic semantics of current web mapping services are not designed to elicit and visualize what we call *affective meaning*. Today's web maps show you the "where" and "when" of information, but cannot visually associate that information with the personal meaning one ascribes to a specific topological or social setting. Contributing a new perspective for the geospatial web, the authors argue for *affective geographies* capable of allowing richer and multiple readings of the same territory. This paper illustrates the cartographic semantics developed by the authors to elicit and visualize affective meaning in collaborative web maps, and discusses the semantics used through a case study in natural heritage interpretation and preservation.

Categories and Subject Descriptors
H.5.m [**Information interfaces and presentation (e.g., HCI)**]: *Miscellaneous*

General Terms
Design, experimentation, human factors

Keywords
Collaborative web mapping, information visualization, map-based interaction, web cartography

1. INTRODUCTION
The possibility to "read-and-write" online maps has given rise to the geospatial web. Web services such as Google Maps have popularized and democratized the power of maps by enabling people to add and share cartographic content. People are now irreversibly cutting their bonds to the desktop and using computing to connect with each other and with their urban and natural environment in ways no one had predicted [23].

Maps are increasingly the venue where knowledge and meanings can be traced and visualized. Current web mapping services provide features for users to contribute location-based content. However, their cartographic semantics are not designed to elicit and visualize what we call "affective meaning." By affective meaning we refer to the perceptions, interpretations, and expectations one ascribes to a specific physical and social setting ("affective" in the sense of showing how we are "affected" by environmental settings, and in turn "affecting" the way in which we experience and interpret the mapped environmental settings). The cartographic semantics of current web mapping services show the where and when of information, but they do not visually relate that information to one's perceptions, interpretations, and expectations—they are not designed to show the personal meaning that one ascribes to specific locations. In a society where "computing means connecting" [23], being able to capture and visualize affective meaning is vital to enhance our perception of space, deepen our connections with the urban and natural environment, and stimulate reflection and discussion about the places in which we live and that we share.

We believe that the future of the geospatial web requires richer cartographic semantics, and we propose the idea of "affective geographies." By "affective geographies," we mean the digital representation of space and place that is enabled by cartographic semantics capable to elicit and visualize affective meaning in collaborative web maps. Affective geographies can be powerful tools to link experience, interpretation, and management of the places in which we live and that we share by allowing us to visualize what really matters personally.

Opening up new perspectives for the geospatial web, the paper aims to frame the idea of affective geographies and illustrates the cartographic semantics the authors have developed to elicit and visualize affective meaning in collaborative web maps. The paper discusses the usage and impact of the cartographic semantics used

through a case study in natural heritage interpretation and preservation.

2. RELATED WORK

The term "geospatial web" or "geoweb" has been coined to denote a new infrastructural paradigm to access and explore data on the web—one that permits users "to navigate, access, and visualize georeferenced data as they would in a physical world" [19]. With computers bifurcating database and visualization [1], the geospatial web is offering directly to users the possibility to easily create, modify, and share online maps. Google Maps [15] and Google Earth [14], for example, enable users to create personalized 2D and 3D maps and share them with relatives and friends. With Google Maps, users can create their own maps by using place markers, shapes, and lines to define a location, an entire area, or a path. Cartographic content can then be annotated with text, photographs, and videos. Furthermore, through Google Maps API, several mashups have been created to provide map-based representations using the same Google Maps' cartographic semantics of place markers, shapes, and lines. One example is Chicago Crime [7], which visualizes information about crime concentrations in the Chicago area. Another example is Hurricane Digital Memory Bank [17], which allows users to contribute and share their stories on the aftermath of the hurricanes Katrina and Rita, and visualize the location of such contributions on the map.

The possibilities offered by the geospatial web in conjunction with mobile computing are also inspiring new metaphors for collaborative mapping and the description of experiences in geographic spaces. For example, mobility data [21] and sensor data [4] are increasingly used to obtain different kinds of "geovisualizations." Artists and researchers are using these data to visualize information flows and to display, for example, the real-time dynamics of pollution phenomena, or users' galvanic skin response in conjunction with specific geographical locations [3], or users' personal routes within the city [2]. In particular, participatory approaches [4][13] emphasize the role of users as knowledge authors and stress the importance of easily enabling them to intentionally gather, analyze, and share location-based knowledge. According to Girardin and colleagues [13], uploading, tagging, and disclosing location-based information can be interpreted as an act of communication rather than a purely implicit history of physical presence. Their goal is to use explicitly disclosed location information to enrich the quantitative understanding of the city that is provided by the spatio-temporal patterns of mobility data (i.e., latitude, longitude, and timestamp). In general, the assumption is that "geovisualizations" based on mobility data or sensor data support social navigation, in that people's past interactions with the environment can be read as "recommendations," and may impact others' behaviors within the same space. However, even when users disclose location-based information explicitly, the communicative function of such information has to be extrapolated from the map exclusively through the visualization of its spatio-temporal patterns.

Other projects, such as Social Tapestries [24][18], promote a stronger participatory approach to data collection, exploring the potential benefits and costs of collaborative web maps generated by means of public authoring systems. Framed within map-based community practices revolving around ideas of place and identity, these systems enable community members to participate and contribute their experiences. In Social Tapestries, knowledge mapping and sharing is pursued through various themes, community interventions, and contributed cartographic content. However, once again, even participatory approaches appear to be lacking an investigation of how web mapping and visualization may support qualitative readings and foster reflection and discussion. The Snout map of London [Figure 1], for example, is a collaborative web map created as part of the Social Tapestries project. It visualizes air pollution data collected by the community through different kinds of environmental wearable sensors. The map combines markers, colors, and text to represent different types of air pollution. For each data point collected, the map provides only location and taxonomy (i.e., carbon dioxide versus organic solvent vapor), using balloons that are difficult to read and interpret.

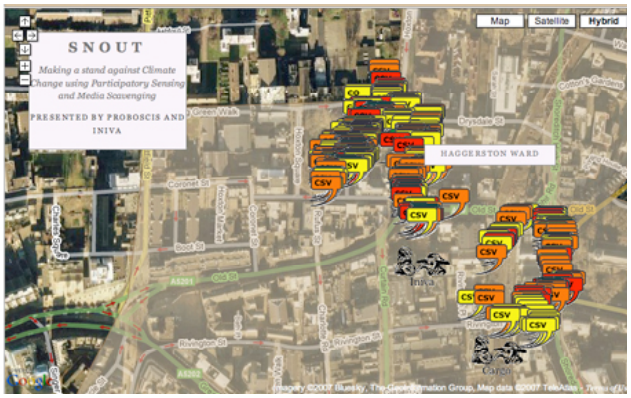

Figure 1 The Snout map (http://socialtapestries.net/snout/).

Independent of the methodology used to collect and contribute cartographic content (whether "sensed" or "user-generated"), we argue that the main limit of current approaches to web mapping and visualization is in the cartographic semantics. It displays only where a specific information is located and, even when enriched by users' comments, photographs, or other multimedia content, it does not visually conveys individual meanings or "social moods" [6] at first glance.

3. AFFECTIVE GEOGRAPHIES OF SPACE AND PLACE

Affective geographies, then, are maps that elicit and visualize "affective meaning"—the perceptions, interpretations, and expectations one ascribes to a specific topological and social setting. We call these "affective" because they reveal how we are "affected" by environmental settings, and in turn "affect" the way in which we experience and interpret the environmental settings mapped. They are maps that display cartographic content contributed by users as well as their personal readings of such content.

3.1 Mapping Space

The widespread tendency in the last centuries of European history has been to think of space and place in terms that reduce space to topological construct and place to mere location or position within an extended space [5]. In this way of thinking, space turns out to be a given entity, and place a somewhat arbitrary or constructed notion. Place is often considered to be identical with either the position of a body in space or with an area of the kind that can be identified by using physical markers in a space (e.g., in the geospatial web, pushpin-like place markers). An alternative tendency has been to think of place as a "significant locale," that is, as a space to which human meaning is attached.

Harrison and Dourish [16] initially distinguished two aspects of spatially organized environments: "space" is concerned with those material and geometrical properties (such as relational orientation, proximity, partitioning) that enable certain forms of movement and interaction; "place" has to do with the ways in which human activity and social practices can occur within a space. Ten years later, Dourish revised this view by arguing that space should be seen as "a social product just as much as place" [8]. Grounding his position in anthropology and human geography, he argues that geography is the product of a particular kind of social practice that gives us an account of space.

In line with this later approach, affective geographies allow users to visually define space by enabling them to choose what to map according to their own knowledge and practices. Through contributed cartographic content, the resulting geography provides a living account of space as a social product of individual embedded knowledge, daily practices, and concerns.

3.2 Giving Meaning to Place

However, "there is no there there" [25], as Gertrude Stein would say, to be visualized. In other words, contributed cartographic content alone does not allow visualizing the personal meaning associated to the mapped territory. Such a map would not refer us to any particular site or locale that has a special significance. As a result, the space is mapped, but no meaningful context is visually provided for that mapping. A "sense of place" is missing from the map in that there is neither a sense of the character or identity that belongs to certain places or locales, nor a sense of our own identity as shaped in relation to those places [20]. We might say that although the space represented is the account of individual knowledge, practices, and concerns, no sense of place is represented because no account is *visually* provided for such knowledge, practices, and concerns. What would be visible on the map is only the "where," or at best the "when," of information.

The cartographic semantics of affective geographies provide a visual account of how space and place relate to each other. Visual mechanisms are provided so that users' actions (e.g., their own particular decisions about collecting and annotating cartographic content) not only stimulate reflection on personal experience, but also encourage reflection about others' experiences that may in turn inform subsequent action.

Mobile devices and "technologies of spatiality," such as global positioning system (GPS) tools and maps, can create new opportunities for social interaction and help people remember and "re-encounter" everyday space [8]. By weaving affective meaning in geospatial mapping and visualization, affective geographies provide a new way of thinking and exploring the social relationship between space and place. Their role can then be understood as one of assisting in the remembering, reconstructing, and representing our geography of space and sense of place.

In summary, affective geographies enable users to define space by choosing what to map, and at the same time to give meaning to the place by providing a personal reading of the mapped territory. Mapping and visualization in affective geographies reveal individual emotions, concerns, and values. But in order to foster reflection and discussion, it is fundamental for affective geographies to visually correlate these unique perceptions with places to which people collectively ascribe a similar meaning and spaces that people map and recognize as belonging to the same territory but without strong feelings or expectations about them. Affective geographies must reveal individual as well as collective patterns of perception and interpretation in relation to the same territory. Only in this way can they display aspects of the environment that lie beyond our usual perception and allow multiple readings of the same territory.

Making the geospatial web a richer tool means revealing and eliciting the affective meaning that is associated to a mapped territory. This requires affective geographies that evolve according to the social perception and interpretation of the individual meanings and values that one ascribes to specific topological and social settings. It requires maps that can be easily created and modified by users, so users not only contribute information but also are able to annotate and qualify this information by expressing their feelings and concerns in relation to it. Affective geographies enable users to easily visualize and read on the map the compound of cartographic content and affective meaning that defines one's geography of space and sense of place.

4. WEAVING AFFECTIVE MEANING IN GEOSPATIAL MAPPING AND VISUALIZATION

Affective geographies are enabled by cartographic semantics that elicit and visualize affective meaning. To this end, we have developed a cartographic semantics based on the principles of the Abaque de Régnier method.

4.1 The Abaque de Régnier Method

The Abaque de Régnier [22] is a method used today in areas as diverse as human resources, regional planning, and sustainable development to help people express themselves and build shared understanding. The method uses a color-coded scale by which to provide answers to specific questions. The colors are suggestive of the traffic light, whose codification is the same in most countries (even though the same color may have different names). The colors are green, yellow, and red and, in addition, light green and light red. This scale moves from the most favorable position (green) to the most unfavorable (red). Additionally, white and black are also used to indicate that the respondent does not have any opinion (white) or refuses to answer (black). According to the method's terminology, colors are called "transparencies" and white and black are called "opacities." By combining logical and statistical representation, the method converts colors into numerical values and produces visual matrices where raw data are permutated.

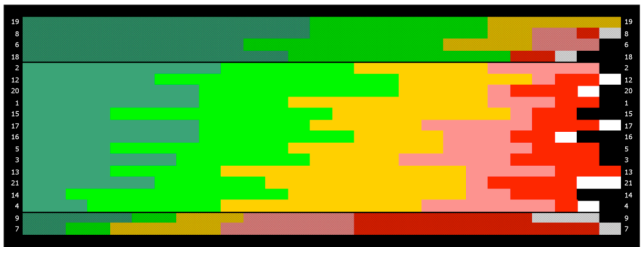

Figure 2 Abaque de Régnier: Visualization of favorable agreement (highlighted, top) and unfavorable agreement (highlighted, bottom).

Tendencies toward "favorable agreement" are located at the top of the matrix (majority of greens), and tendencies toward "unfavorable agreement" are located at the bottom (majority of reds). Problems are located in the middle where there is a

significant diversity of colors ("disagreement"). "Areas of uncertainty" are revealed by the cross section of yellows, and weighted according to its width [Figure 2]. "Anomalous positions" (e.g., isolated red dots or isolated green dots) are revealed by further permutation [Figure 3].

Figure 3 Abaque de Régnier: Visualization of anomalous positions (highlighted).

Representation of values by colors is immediately recognized, and the color-coded scale enables an exploration of subjective perception at three different levels: local, regional, and global. The individual (local) level is represented by the cell at the intersection of a column and a row. It shows the opinion an individual holds about an item. Columns or rows represent the regional level and show the overall positions of all participants on a single item or of a single individual on all the items. The global level is represented by all the colored positions on all the items, and is expressed by the whole matrix. Evaluations and varied adoptions of the method over the past 30 years have demonstrated that this visualization successfully elicits reflection and discussion. In particular, recursive cycles of data collection, visualization, and discussion have proven successful in providing mutual understanding within groups sharing the same problems.

4.2 Toward a Cartographic Semantics for Affective Geographies

The strength of the Régnier method is its ability to map subjective perceptions by means of colors, visualize patterns of judgment at different levels, and visually foster reflection and discussion.

We have translated Abaque de Régnier principles to collaborative web mapping and adapted them to provide a cartographic display of individual meanings and social relations that might provoke reflection and discussion about the places where we live and those that we share. We have created a visual notation for location-based information based on the Régnier colors: dark green, light green, yellow, light red, and dark red. White is used exclusively to indicate content not yet annotated and therefore not public. On our map, colored dots serve the function of both locating information and representing the affective meaning one has ascribed to that information. The dots visually compose an affective geography that defines both the mapped space and its subjective quality as place. Color dots assume different sizes according to the zoom level: the higher the zoom level, the smaller the size of the dot (from a cloud of small dots to the view of a clickable single dot). At a bird's-eye view, clouds of dots identify color patterns and visualize areas of positive and negative agreement, dissension, uncertainty, and anomalous positions [Figure 4]. These patterns can be correlated with the characteristics of a specific location, and show which places elicit strong feelings (prevalence of red or green dots) or no particular expectations (prevalence of yellow dots). Patterns can be explored at different levels, from the local level of the individual user (single dot) to the global level of the community (clusters of dots).

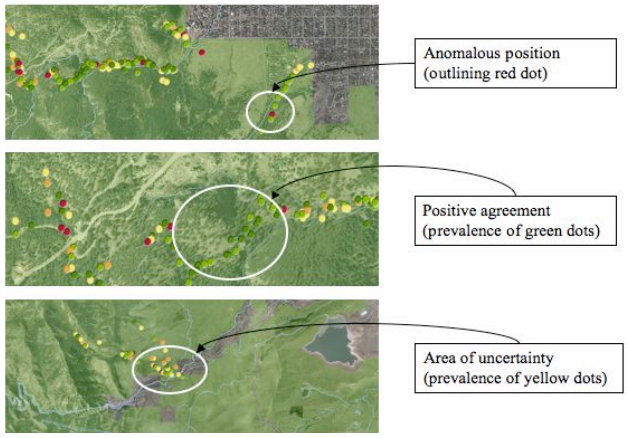

Figure 4 Color patterns in the cartographic semantics.

Our cartographic semantics combine this visual notation with the capability to preview cartographic content (such as an image or a sound) by mousing over the dot, and to access additional verbal descriptors (such as associated tags and a personal journal) by clicking on the dot.

The web application we have created [Figure 5] enables users to choose and collect cartographic content through mobile devices. GPS data locate this content in space and time on an interactive map created through an open source Geographic Information System (GIS). Once cartographic content is uploaded, users can access, manage, and interpret it by visually associating Régnier colors and annotating it with tags and narratives. In this way, cartographic content as well as users' personal interpretations become publicly available at the immediate level of the visual notation and then incrementally through map-based interaction.

More specifically, the web application provides an Edit mode and an Explore mode. In the Edit mode, registered users can privately visualize on the map their collected content and distinguish between content they have already annotated (colored dots) and content they have not yet annotated (white dots). Mousing over the dot enables users to preview the content, whereas clicking on the dot selects the content and automatically opens the window, enabling color rating and textual annotation. The Explore mode allow both registered and unregistered users to navigate the map and filter the cartographic output according to several criteria such as color, and tags of interest.

Through the web application, users create and share cartographic content that visualizes their daily practices and personal perspectives. The resulting affective geography provides multiple readings of the same territory at different levels: from the local level of the individual (single content and single color), to the regional level of social patterns (local clusters of content and colors), to the global level of the community (overall trends of content and colors). These readings, in turn, can be conducted at the local level of a specific site, the regional level of a specific topological area, or the global level of a community's self-defined geography. Additionally, the different filtering capabilities provided by the web application allow the user to define and operate "permutations" of the cartographic content and multiply such readings according to the user's specific interests.

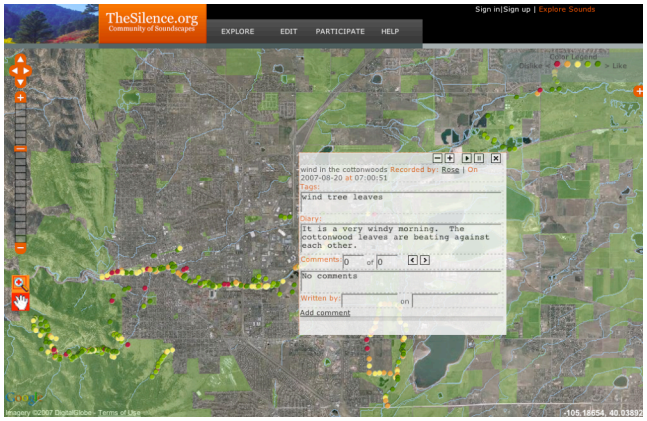

Figure 5 The collaborative web mapping application (http://thesilence.f-dat.org/).

In summary, we have developed a cartographic semantics for collaborative web mapping by which visual notation provides an immediate visualization of both individual and collective affective meanings, while the content to which meanings are associated is provided incrementally through map-based interaction. Mousing over the dot enables the user to preview the cartographic content, and clicking on the dot provides more detailed information about both content and meaning. In this way, the cartographic semantics proposed smoothly overlays location, meaning, and content, starting from an immediate and intuitive visualization.

5. CASE STUDY: COMMUNITY OF SOUNDSCAPES—TOWARD AN AFFECTIVE GEOGRAPHY OF SILENCE

Community of Soundscapes is part of a long-term project called "The Silence of the Lands," a socio-technical environment using sounds to raise environmental awareness and promote the active and constructive role of local communities in the interpretation and management of their urban and natural environment [9][10][11]. The project was initiated by Giaccardi at the University of Colorado, Boulder, in 2005, and currently involves an international collaboration among the CU-Boulder's Center for LifeLong Learning & Design (USA), the University of Brescia (IT), and the University of Plymouth's Institute of Digital Art and Technology (UK). Based on the belief that sounds are an important and personal element of the natural environment, the project's goal is to encourage a focused and engaged way of "listening to the land." In doing so, the project sustains a narrative mode of social production of natural heritage aimed at fostering environmental awareness and eventually supporting new forms of sustainable development.

This goal is accomplished by allowing people to capture and map their sonic experiences and then annotate and share the soundscape of the environmental settings where the sounds were recorded. Users record sounds by using a mobile device outfitted with GPS mapping hardware and software, called Sound Camera. Recorded sounds are then uploaded on the web through the collaborative mapping application, where they are associated with their owner and placed on the map [11]. Geographic position, time, and date are entered automatically. Then, through the web application, users are able to add and share descriptions of the sounds they heard, indicate by means of colors whether they liked or disliked those sounds, and comment on other people's sounds. The result is an "affective geography of silence," as we call it, where understandings and encounters with space and place evolve according to how users' experiences and interpretations of the sonic environment are mapped, visualized, and in this case audio-streamed in the form of an interactive soundscape.

5.1 Pilot Study

In collaboration with the City of Boulder Open Space and Mountain Parks Department and Water Quality Department, we engaged the local community of Boulder, Colorado, in capturing and sharing sonic experiences for a period of six weeks. Contextualized within the City of Boulder nature programs and public hikes, *Community of Soundscapes* enrolled a group of community members representative of different age populations and professional backgrounds [Figure 6]. From July 2007 to September 2007, participants engaged in sound walks and workshops, mapping and sharing more than 1300 sounds [12].

Figure 6 Participants from the Boulder community using the Sound Camera.

The goal of the pilot was to evaluate the use, impact, and real-world application of our sound mapping technology in the context of natural heritage interpretation and preservation. Because sounds hold a strong affective meaning in relation to our experience of space and place, we were interested in investigating how sound mapping can encourage people to reflect on their perception and interpretation of the environment, facilitate looking at each other's experiences and connecting with each other's perceptions, and finally help unfold new understanding of the environmental settings in which people live and that they share. The findings presented in this paper offer data relevant to evaluate aspects of the cartographic semantics proposed and discuss implications of the evaluation to the visualization strategy.

5.2 Methodology

A sample of 20 volunteers (4 males and 16 females) participated in the pilot study. Their ages ranged from 20 to 62 years. They all held a higher education degree and represented varied professional backgrounds. They included writers, engineers, scientists, managers, designers, educators, therapists, musicians, and college students.

Participants were asked to capture their sonic experiences by using the Sound Camera and to upload sounds on the web application, where they could annotate them and share them with other participants. They were asked to take at least three sound walks: one on Flagstaff Mountain, one along the Boulder Creek Path, and a third one of their choosing. A total of 1338 sounds were recorded by using the Sound Camera, and 567 sounds were selected and made available on the web application.

We triangulated qualitative data collected through: (a) three focus groups at the beginning of each organized workshop, (b) two questionnaires (a pre-questionnaire and post-questionnaire), (c) unstructured interviews and direct observations conducted during participants' activities, and (d) participant's narratives associated with sounds. Quantitative data derived from database queries and web analytics have not yet been integrated in the evaluation.

5.3 Findings

5.3.1 Expressing Affective Meaning

The first theme that emerges from the data concerns whether people felt able to express affective meaning by means of the cartographic semantics designed for the web application. One question in the post-questionnaire explicitly asked: "Did you feel able to express and share your perceptions and values through the technology provided? Can you give an example?"

Answers to this question, corroborated in the focus groups and by our observations as well, indicated that participants felt able to express and share their perceptions and values through the technology provided, in particular by being able to "rate" a sound (as they often referred to the use of Régnier colors). One participant answered:

"I never liked the sound of small aircraft that seem so prevalent in Boulder, and especially when I go on a walk or hike. When I recorded these sounds and was able to rate them, I was able to convey my strong dislike of these sounds."

More clearly, another participant explained:

"Yes [I felt able to express and share my perceptions and values, authors' contextualization*]. First of all through the choices of what to record and keep in the web application. Second through descriptions of sounds and comments on sounds of others."*

Another participant wrote:

*"Rating sounds make me think about *good* sounds vs. noise + how it differs for me depending on my mood."*

These and other similar answers give us material to sustain that being able to annotate sounds and particularly "rate" them through Régnier colors seemed to enable and encourage participants to reflect on their own experiences and to express their impressions and interpretations of the space encountered during designated hikes (i.e., Flagstaff Mountain and Boulder Creek Path) or their daily practices (for locations of their own choosing).

This is confirmed by some of the narratives provided to annotate sounds. One participant, for example, "rated" the sound of small aircraft as a pleasant sound:

"There are always airplane sounds at Sawhill Ponds. Right now there are two overhead. One is a cute little red bi-plane."

Contrary to the reaction of the participant who generally dislikes the sound of small aircraft, this participant expresses and reveals a different set of experiences in relation to the expected identity of a familiar location. Interestingly, unfavorable patterns of judgment (red dots) toward the sound of aircraft appear in locations expected to be pristine (e.g., Flagstaff Mountain), whereas anomalous positions, such as the one recorded at Sawhill Ponds, appear in locations whose identity is more strongly tied to an individual's personal experiences. Anomalous positions visualize occasional events and users' idiosyncrasies (including moods) with respect to one's unique experience of a specific place. This information is visualized and easily singled out at the global level, and has proven to be a particularly useful strategy to stir curiosity and foster reflection in map-based interaction (see Sections 5.3.2 and 5.3.3).

5.3.2 Exploring Other People's Experiences

Another theme that emerges from the data concerns whether people felt able to explore and understand other people's experiences through the cartographic semantics.

Answers provided to the post-questionnaire's direct question: "Did you find it interesting to listen to other people's sounds? Can you give an example?" are particularly useful. Generally speaking, participants appreciated the possibility of enjoying sounds collected by other participants. A couple of them, for example, commented:

"I loved the sounds from the Boulder Farmer's Market. I could listen to the sound and visualize the setting without being there."

"Yes, I liked hearing the more random sounds from crowds in downtown Boulder."

Other participants emphasized the differences in perceptions and interpretations that emerged within the community and stressed the enrichment they gained from these differences. For instance, some interesting answers to the same question include:

"I learned from their trials. For example, there are not many animal sounds in the heat of the day, I noticed, so I planned to 'walk' later in the day."

"I was curious about what others chose to record. Many were like my choices; some were totally different (a trash can lid)"

Once again, the adopted visualization strategy appeared useful to participants. Through colors, participants were able to notice differences, and in general find their own way through map exploration and interpretation. Participants demonstrated an awareness of the dependency between an individual, that individual's color "rating," and the context of the recording. Because of that they were curious about other people's sounds when looking at colors on the map; in particular, when looking at the extreme ones (dark reds and dark greens), typical answers to the question: "Did colors trigger specific behaviors in your exploration of the map? Can you give an example?" included:

"Dark green and red (both ends of spectrum) were ones I checked out first."

"I liked going through the red ones, to see what people classified as negative sounds."

Participants' differences stirred quite a lot of reflection and discussion also in the focus groups, keeping participation high, and motivating participants to more recordings.

5.3.3 Reading and Understanding the Map

With regard to the general visualization strategy, another relevant theme that emerged from the data concerns what aspects the cartographic semantics allowed participants to judge. The following answers provide a comprehensive account of how participants tended to use and read the map, and to what they paid more attention:

"Extremes (extreme likes/dislikes). I could also see places that I might like to visit (lots of dark green dots)."

"What areas were louder, more contaminated with traffic, and which were quieter."

"I noticed areas that I was supposed to visit, e.g., the east end of the Boulder Creek Path, that had sounds other people liked."

Overall, the colors painted a general impression of an area, guiding participants in their map-based interactions and explorations. As the pilot study suggests, colors also influenced participants' reflective processes, learning, and behaviors. What emerges from the data collected is that the adopted visualization strategy—based on the principles of the Régnier color schema—plays an important role in people's reading and understanding of the map, and also in supporting subsequent actions in the real world as a result of these readings. In the next section, we discuss such impacts.

6. DISCUSSION

The results of the pilot seem to suggest that the cartographic semantics proposed provide an effective mode of reflection and discussion about the individual and collective perceptions, interpretations, and expectations that relate to a specific location and its environmental setting. The resulting affective geography of *Community of Soundscapes* seems to produce a new mode of interaction with the environment and with other members of the community that is responsible for several perceived benefits. Based on participants' feedback, these benefits can be categorized as an enhanced perception of the environment, deepened social and environmental connections, increased environmental awareness and reflexivity, and behavioral change. We are aware that further studies are needed to reveal the co-dependency between the use of the cartographic semantics and sounds, and to help isolate the specific benefits and limits of the cartographic semantics. We discuss here our initial set of results.

6.1 Enhancing Perception

Enhanced perception of the environment seems to be the first and more immediate benefit perceived by participants:

"Nature sounds have always been a favorite background while I'm working, but now I'm also more curious of the outdoors and I want to trace sounds."

"I find myself saying 'that would be a cool sound to capture' such as a bird call, coyote howl. I'm also much more interested in the man-made sounds, such as the ding of the bus."

"[I am] more perceptive, or at least more open to listening for sounds—went on a night hike and sat and listened to intense duet between insects and the hum of the city—wished I had brought the Sound Camera."

6.2 Deepening Connections

Participants also reported a deepened connection to the environment and an increased sense of place. One participant, for example, explained:

"[I have] more appreciation for how rare it is to be away from human sounds. Also, it really made me feel bad for wild animals that have to deal with human sounds, must mess with their instincts."

A few participants asserted that sharing sonic experiences and listening to other people's sounds have somehow changed their sense of belonging to the community. One participant wrote:

"I do admire some of the sounds the other volunteers found. It is an interesting way to connect with others."

6.3 Fostering Reflection and Awareness

From participants' feedback emerged the feeling that the possibility of color rating and annotating sounds was an effective mechanism to provoke reflection and stimulate environmental awareness. Some participants perceived this benefit at the personal level. Some, for example, wrote:

"I have a greater awareness and appreciation for the ability of some sounds to have a negative affect on my mood."

"Increased awareness of sound. Enhanced experience of life."

For other participants, this awareness assumed a different scale. For example, one participant said:

"Awareness of other 'life' that we share space with—disappointment of not being able to escape man-made sound (i.e., cars). Even when you get far enough away, city noises and airplanes disrupt the natural sounds every few minutes."

6.4 Supporting Behavioral Change

Enhanced perception, deepened social and environmental connections, and increased environmental awareness and reflexivity seemed to encourage participants to spend more time in the outdoors and learn more about their environment and the community in which they live. Some participants, for example, wrote:

"I learned to pay attention and be aware of the sound environment. The main benefits were the immediate ones, going out and spending time in nature, and the longer-term awareness of the sounds around me."

"I'm more interested in learning to recognize specific bird calls. Also, I am more attentive to sounds, whereas before I mostly got lost in my mind while walking."

In general, participants perceived these benefits as so meaningful to them that the only limitations they reported concerned the usability and robustness of the system: they liked what they were doing and wanted to be able to do it faster and more reliably. Participants also suggested new features to be added to the application, such as the possibility of switching directly from the explore mode to the edit mode when accessing information related to their own recorded sounds. Despite technical limitations, though, the kind of experience and interaction provided by *Community of Soundscapes* motivated half of the participants to request continuation of the project over the entire year. To this end, the web application is being improved to both overcome the current technical limitations and provide participants with new interaction possibilities. New visualization strategies are also being discussed to allow users to manage multiple readings of the same location through the filtering mechanisms.

7. CONCLUSIONS

The research activities we have described here are motivated by the desire to address the need for affective geographies as a central issue for the geospatial web. We have defined affective geographies as web maps that reveal how we are "affected" by environmental settings, and that in turn "affect" the way in which we experience and interpret the environmental setting mapped.

Other researchers have attempted to create geovisualizations of subjective content. Their maps, however, even when enriched with users' comments, photographs, or other multimedia content, appear difficult to read and hardly convey some kind of individual and/or social meaning at first glance.

Attention is shifting to these new concerns, due not in the least to increasing sophistication in web mapping technologies and mobile computing, and to the increasing role that web maps play as venues where knowledge and meanings can be traced and visualized. The goals, of course, are challenging. What this attention to web mapping and visualization as well as map-based interaction needs is additional design thinking about some of the core concerns presented here, including how to elicit and visualize the social system of experiences, interpretations, and expectations that contribute to one's geography of space and sense of place.

We have argued that, by weaving affective meaning in geospatial mapping and visualization, affective geographies provide a new way of thinking and exploring the social relationship between space and place: they enable users to define space by choosing what to map, and at the same time to give meaning to place by providing a personal reading of the mapped territory.

We have proposed a cartographic semantics for affective geographies capable of providing immediate and spontaneous readings of the same territory at multiple levels (local, regional, and global), and we have illustrated its viability through a case study. Initial positive results suggest that the proposed cartographic semantics foster reflection, discussion, and behavioral change: users' actions (e.g., their own particular decisions about collecting and annotating cartographic content by means of the semantics provided) not only stimulate reflection on personal experience, but also encourage reflection about others' experiences that may in turn inform subsequent action.

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