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Seeing, Believing, and Feeling: The Relationship between Sense of Place and Geovisualization Research

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Abstract: Advancements in GIS and media technologies have created opportunities for developing realistic and geographically-accurate representations of the environment that can be recognized and related to as "real places." In turn, these "geovisualizations" can connect with the meanings, values, beliefs, and/or feelings people associate with places, i.e., their "sense of place," which positions them as powerful place-based tools for inclusive and collaborative environmental management efforts. However, despite their place-based applications, geovisualization studies rarely explicitly incorporate place theories and concepts. This lack of integration is reflected in the current state of knowledge, as much of geovisualization research has advanced knowledge on technological capacity for processing and rendering images from spatial data, whereas knowledge on how people interact with and use these tools in collaborative management strategies has lagged behind. This research effort serves as a move toward addressing this knowledge gap by explicitly illustrating the relationship between sense of place and applications of geovisualizations in collaborative management. The paper employs ideas from research on human-media interactions and conceptual models from research on sense of presence to synthesize a coherent theory on how geovisualizations can function as place-based tools. The paper then reviews landscape visualization studies to provide evidence that geovisualizations can operate as place-based tools. Such evidence includes observations on geovisualizations' ability to communicate "meaningful information" on places, elicit responses reflective of particular place-based values, and evoke emotional responses associated with places.

Keywords: Geovisualizations, Collaborative Management, Sense of Place

Introduction

The relationships people form with their surroundings give rise to "places," that is, subjective representations of geography that are shaped by meanings, beliefs, symbols and values associated with certain localities and/or environments (Botts et al. 2003, 110). These relationships reflect how people understand and perceive their environment, which in turn influences aspirations for and behaviours toward said environment (Vaske and Kobrin 2001). Accordingly, people-place relationships have been recognized as integral elements in designing and conducting effective inclusive and collaborative environmental management, as it is through understanding and acknowledging these relationships that different beliefs, interests, activities, and needs associated with an area targeted for management can be incorporated and/or addressed in plans and strategies (Cheng et al. 2003; Stocker et al. 2012; Williams and Stewart 1998; Yung et al. 2003). However, the practicalities of incorporating place-based considerations into management strategies can present challenges. Places can have indistinct boundaries that can not always be defined and managed spatially (Collins and Kearns 2010, 437-442), and it can be difficult to account for place-based values in management efforts when it is not entirely clear to where certain meanings and values are ascribed (McLain et al. 2013, 659-661). In addition, values for places can be expressed in vague terms, which can create uncertainty around how people's aspirations might concretely manifest into environmental management outcomes and potentially result in conflict when enacting a management plan or strategy (e.g., Rockloff and Lockie 2004, 89). Thus, there is an evident need for tools that can capture and convey "place" in a clear manner, as it is through such tools that people's values and interests surrounding a particular place can be effectively understood, and socio-culturally sensitive, collaborative environmental management strategies can be successfully designed and employed in said place.

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Advancements in GIS and media technologies have created new opportunities for developing place-based tools by providing the means for constructing (increasingly more) realistic and sophisticated geographically-accurate representations of real-world places. Through the use of these technologies, geographical data/information can be integrated with state-of-art three-dimensional visual simulation techniques, giving rise to what is referred to in this paper as "geovisualizations"[1] (Canessa 2008, 24). Because they are georeferenced and simulated as a three-dimensional environments, geovisualizations can be constructed with both high spatial accuracy and low abstraction, allowing them to be easily recognized as the built and non-built environment in real-world places; examples of these being realistic landscape visualizations (e.g., Schroth et al. 2011; Smith et al. 2012) or three-dimensional digital models of communities and/or parks (e.g., Salter et al. 2009; Grêt-Regamey et al. 2013). This approach to geovisualization can be used to communicate outcomes of potential environmental management strategies in a "relatable" fashion, meaning that they provide people with vivid understandings of how they would feel about certain management outcomes or impacts if transpired in real places (e.g., Lewis and Sheppard 2006). Sheppard (2001, 183) evoked the metaphor of "crystal ball gazing" to illustrate this communicative capacity, describing how visualizations essentially provide people with glimpses of potential futures for familiar places by displaying these places as they would appear if certain courses of action were taken. Accordingly, geovisualizations have been observed as having the ability to elicit strong emotional reactions from users in circumstances when dramatic (and in some cases, undesirable) modifications to personally known and valued environments were depicted (Salter et al. 2009; Schroth et al. 2009; Schroth et al. 2011; Sheppard et al. 2011). These observations indicate that visual information conveyed by geovisualizations can be internalized by users as actual possible fates for places of personal value and meaning, and in this manner, geovisualizations can connect with the meanings, values, beliefs and/or feelings people associate with places, collectively referred to as a person's "sense of place" (Williams and Stewart 1998, 19).

As aforementioned, understanding and acknowledging place-based relationships enables inclusive and collaborative approaches to management as it allows for different place-based beliefs, interests, activities and needs to be addressed in plans and strategies. Similarly, by connecting with people's sense of place, geovisualizations can be used as tools for facilitating inclusive and collaborative management as they can be used to simulate different stakeholders' thoughts and concerns associated with the place-based relationships they have formed with areas targeted for management. Because geovisualizations can represent an environment and convey potential impacts/alterations to these environments in a salient and relatable fashion, they can be employed in stakeholder discussions and co-planning sessions to illuminate a variety of place-based insights, such as what different people perceive as significant components of a place, how people feel a place should appear and/or be managed, and what types of development and activities are desirable or undesirable within a place (e.g., Natori and Chenoweth 2008; Schroth et al. 2011; Tress and Tress 2003). Subsequently, this understanding can be used to guide environmental management strategies and plans in a manner that ensures that these strategies/plans address and include the local social realities, concerns and needs associated with the management area.

In concert with this line of thinking, previous research has posited that geovisualizations can be potentially powerful tools for collaborative planning and management strategies (e.g., Lewis and Sheppard 2006; Salter et al. 2009; Schroth et al. 2009; Schroth et al. 2011); however, despite the clear place-based implications in this area of inquiry, geovisualization research rarely explicitly incorporates place theories and concepts. The lack of research integration is likely due to epistemological differences, as the two areas of research, i.e., geovisualizations and sense of place, have developed through distinctly different areas of scholarship. Geovisualizations essentially serve to make sense of abstract spatial data (Jude et al. 2007, 526), and thus advancements in geovisualization research has been heavily driven by work in spatial sciences

and data visualization (Nöllenburg 2007). In contrast, place research has academic roots in humanistic geography, which is a discipline that seeks to understand how humans relate to the world through phenomenological approaches that treat humans as thinking and feeling beings (Tuan 1976, 266). The humanistic perspective emerged to overcome what was perceived as limitations in using predominantly spatial approaches for understanding geographical relationships and phenomena, and thus spatial sciences and place theory have traditionally rested within different academic camps (Agnew 2011; Gold and Goodey 1983; Kaltenborn and Williams 2002). As a result, research on geovisualizations and thinking on sense of place also have evolved on separate sides of this disciplinary division with little integration.

The consequences of the lack of research integration are reflected through an observation made by Lewis et al. (2012, 86), who noted that visualization research has made significant advancements in terms of technological capacity for processing and rendering images from spatial data, whereas research on how visualizations operate as effective tools for collaborative management and how users interact with these tools has lagged behind. This observation indicates that geovisualization research is advancing primarily through a spatial focus and a knowledge gap exists concerning the "human component," meaning research is lacking on how geovisualizations operate within the social and cultural dimensions germane to environmental management plans and processes. The following paper serves as a motion toward an integrated research agenda that would bridge this gap, as it lays a foundation for this form of research by explicitly illustrating the relationship between sense of place and the role geovisualizations play in collaborative environmental management.

Because this paper discusses the concept of sense of place and examines its relevance to geovisualizations, there are several important considerations to note in order to clearly understand the specific purpose of this work. Firstly, the relationships people form with places are complex and integrative phenomena that are influenced by a variety of social, economic, cultural and environmental factors (Devine-Wright and Howes 2010; Gosling and Williams 2010; Scannell and Gifford 2010; Vorkinn and Riese 2001); accordingly, the study of sense of place has been explored through a variety disciplinary lenses, such as environmental psychology, human geography, sociology, architecture, anthropology and tourism studies (Lewicka 2011, 207). This work does not undertake an exhaustive review of sense of place as it is characterized through the comprehensive suite of disciplinary perspectives; instead, it draws upon perspectives developed through geography and environmental psychology in order to specifically examine the relevance of the concept to the application of geographically-accurate representations of real-world environments in collaborative approaches to environmental management and planning. Secondly, similar to sense of place research, studies on the development and application of three-dimensional virtual environments have been conducted in a range of disciplines for a variety of different purposes; for example, research has been done on visualizations of Building Information Models (BIM) within the fields of architecture and engineering (e.g., Johansson et al. 2015) and research has been done on virtual learning environments within the field of education (e.g., Lau and Lee 2015). The current research effort specifically examines the growing field of literature around modeling outdoor environments (referred to in some studies as landscape visualizations) for the purposes of determining how such virtual representations can be used for collaborative management and planning efforts (e.g., Lewis and Sheppard 2006; Salter et al. 2009; Schroth et al. 2009; Sheppard et al. 2011). With these considerations in mind, this paper draw the connections between theoretical (and empirical) work done around people-place relationships and the applied work done around geovisualizations (i.e., landscape visualizations), specifically in environmental management and planning context. The objective of drawing these connections is to create a precedent for geovisualization research that can benefit from both theoretical and applied areas of scholarship, allowing for comprehensive investigations that examine what is needed to create these tools, how they can be applied to collaborative

management and planning scenarios, and why various stakeholders interact with and react to the tools in different ways.

To achieve the described objective the paper begins with a discussion on "sense of place," describing how the concept has been explored through disciplinary lenses developed through branches of geography and environmental psychology and the relevance each of these perspectives has to geovisualization research. The paper then describes the capacity geovisualizations have for connecting with sense of place by discussing the cognitive processes involved in forming this connection and providing observations from previous environmental management research that indicate this connection can occur. The paper concludes by providing examples on how integrating sense of place research and theory into geovisualization studies can result in research efforts that more comprehensively examine the role geovisualizations can have as tools for collaborative approaches to environmental management and planning.

Sense of Place

As noted above, sense of place has been explored extensively through multiple, different disciplinary lenses (Lewicka 2011, 207); however, this paper describes the concept through three perspectives, selected specifically due to their relevance to the application of geovisualizations in environmental management. These perspectives are defined through the disciplines of perceptual and behavioural geography, humanistic geography and environmental psychology.

Perceptual and Behavioural Geography

Earlier research on people's subjective interpretations of their environment includes Lynch's (1960) seminal work of *The Image and the City*, which examined people's perceptions of urban environments for the purposes of understanding what components of these environments contribute to their "legibility" (i.e., ease in which a city can be imagined and/or understood). Lynch did not employ or develop specific terminology around "place," per se; however, he did develop ideas that bear semblance to current understandings of the sense of place phenomenon, namely through the concept of the "environmental image" (Ibid., 4-13). Environmental images are mental representations of localities that are composed of both spatial aspects and emotional and functional meanings, and Lynch claimed that a coherent environmental image can lead to the sense of comfort and emotional security that comes with knowing one's surroundings. Therefore, even though this discussion did not explicitly refer to sense of place, it clearly parallels the concept as it refers to the meanings and emotional associations that people form with places through developing familiarity with and understanding of these places.

Gould and White (1974) further explored the perceptual line of inquiry, and also added a behavioural component, through their work on "mental maps." Mental maps are cartographic representations of people's perceptions of places, and Gould and White (Ibid., 15-18) posited that such representations can reflect preferences for certain areas and locations, which in turn, could be used to gain insight on migratory behaviour. Downs and Stea (1977) built on Gould's and White's mental maps by developing the concept of "cognitive maps," and it is through this work that the relationship between imagined cartography and sense of place can clearly be seen. Similar to mental mapping, cognitive mapping refers to mental representations people form of their environments, which subsequently, can guide spatial behaviour; however, Downs and Stea (Ibid., 6-27) also described these maps as "coat hangers" for memories and understandings of places, noting that they are distorted through experiences and interactions with these places. In this way, cognitive maps are reflections of people's senses of place because they react and are shaped by the meanings, values and significances people associate with places.

By convention, perceptual and behavioural research typically involves two-dimensional visual tools, such as mental maps (e.g., Gueben-Venière 2011; McKenna et al. 2008); however, the principles and findings from this field of inquiry have clear applications to three-dimensional

(and four-dimensional) geovisualizations. In particular, this disciplinary approach operates under the notion that people hold subjective imagery of their environment, meaning their mental conceptualizations include, exclude and/or distort certain aspects and elements depending on their perception of a place (i.e., Downs and Stea 1977; Gould and White 1974; Lynch 1960). This is pertinent to geovisualization research because it indicates that the way people respond to inclusion/exclusion of certain elements in a visualization can provide insight on what people believe to be significant or meaningful components of a place. For example, Bishop and Rohrmann (2003, 272-277) found that the realism of vegetation models in a virtual environment significantly contributed to whether people felt the virtual depiction accurately represented a "real place," whereas the inclusion (or exclusion) of humans and animals did not. Although they did not specifically refer to sense of place in their study, these findings illustrate how particular elements of the virtual environment can coincide with certain people's mental conceptualizations of place, and such insight could be further interrogated to understand what people find significant (and "of value") to a place.

Humanistic Geography

Although perceptual and behavioural geographers developed ideas and understanding on how people subjectively relate to their environment, they did not formally conceptualize theories of place. This was done through the works of humanistic geographers, who rejected the notion that human beings could be characterized as rational objects located within space and argued that the relationships people form with the world are better understood through their interactions and experiences with their surroundings (Cresswell 2009, 3; Kaltenborn and Williams 2002, 190). Through the humanistic perspective, place is fundamentally a function of lived experiences and "existing" within an environment (Cresswell Ibid., 3). Humanistic geographer, Yi-Fu Tuan (1977, 6), succinctly captured this perspective through his widely cited comment on place, noting that "undifferentiated space becomes place when we endow it with value." This comment essentially describes place as a transformation of the physical environment into geographies that are defined more by human meanings than spatial boundaries. Therefore, through the humanistic perspective, the way people "sense" places can be viewed as a function of the experiences that catalyze space-to-place transformations and characterized through the meanings and feelings that define place-based geographies.

The humanistic perspective is useful for geovisualization research because, unlike perceptual research that regard subjective interpretations of the world as projections of or onto one's environment, humanistic geographers focus on the person and regards place as formed through personal experiences and interpretations (Tuan 1975, 151-153). In this light, sense of place is an egocentric phenomenon and place itself is essentially a manifestation of how a person "makes sense" of and relates to the world around him or her. To provide an example, humanistic geographer, Edward Relph (1976, 49-55), described sense of place in fundamentally egocentric terms by employing a metaphor of immersion, in where sense of place exists on a scale that ranges from "existential insideness," i.e., deep understanding and feelings of belonging to a place, to "existential outsideness," i.e., meaninglessness and feelings of alienation from a place. The reason why such a person-centered, egocentric characterization of sense of place is pertinent to geovisualization research is because sense of place can then be understood as feelings of what it is like to "be there," or present within a particular place (Cresswell 2004, 7-8), and since geovisualizations are not physical locations, their effectiveness as place-based tools hinges on people's ability to connect with these feelings in the absence of the place's physical environment. Supporting this discussion is a study by Turner and Turner (2004) that employed Relph's scale of "insideness" to compare placed-based experiences between real and virtual viewpoints of Prague. Albeit the study did not specifically examine environmental management applications of geovisualizations, Turner and Turner (Ibid., 345-346) found that this methodological approach to

be useful for gaining insight on the ability virtual representations have for stimulating the same feelings and thoughts one would experience if presented with a real-world place.

Environmental Psychology

Environmental psychology literature refers to sense of place as the collection of meanings, values, symbols and feelings people associate with their environment (Williams and Stewart 1998, 19). Because sense of place is referred to as inclusive of personal meanings and feelings, the environmental psychology perspective bears similarities to that of humanistic geography. Where the disciplines differ is in methodologies and approaches employed in studying people-place relationships and (as a result) the conceptualizations and theoretical models used in their respective literatures. While humanistic geographers employ qualitative phenomenological research approaches, environmental psychologists typically use quantitative methodologies that involve psychometric measures for assessing strengths and types of people-place relationships (Lewicka 2011, 209-226). Through psychometric approaches, environmental psychology studies often deconstruct people-place relationships into different aspects or dimensions such as "place identity" and "place dependence" (e.g., Kyle et al. 2004; Lee 2011; Lai and Kreuter 2012). Place identity refers to symbolic meanings people hold for places and can involve the emotional and/or spiritual significance associated with these places (Williams and Vaske 2003, 831). Place dependence refers to functional associations with place and reflects the potential a particular place has for satisfying a person's interests and meeting their objectives (Ibid., 831).

The environmental psychology perspective becomes relevant to studies on geovisualizations when this research is specifically designed to investigate how geovisualizations can be used as tools for facilitating environmental management efforts. Unlike perceptual and humanistic approaches, environmental psychology seeks to understand distinctions in the different types of relationships people form with places (i.e., functional or emotional) for the purposes of understanding the reasons behind people's preferences for how places are treated or managed (e.g., Kyle et al. 2004). Accordingly, this understanding of sense of place can be used in geovisualization research to gain deeper insights on why different stakeholders react positively or negatively to a depiction of a particular type of management scenario, as their reactions can be linked to certain values, interests and aspirations held for an environment.

Geovisualizations and Sense of Place

Although research on geovisualizations and sense of place is a relatively unexplored area of inquiry (especially in the environmental management context), other types of visual media have been investigated in terms of their ability for influencing place-based understandings and meanings for different landscapes and environments. For example, visual art has been noted for its power to stimulate imagination, and through this capacity, it has been argued that art can alter current perspectives on familiar environments and/or add layers of meaning and feeling to unfamiliar landscapes (Stocker and Kennedy 2013, 3-4). Other examples of visual media studied in the context of place include imagery used in tourism advertisements, such as in a case detailed by Carter et al. (2007) involving a marketing campaign designed to attract people to the rural areas of Sunshine Coast in Australia through crafting a place narrative that specifically catered to interests and aspirations typically held by middle-class urban dwellers for seasonal residence and rural tourism (e.g., fun, pleasure, relaxation, etc.). Both effective art and advertising have exhibited the ability that visual media has for interacting with people's sense of place; however, the approach these types of media take in this interaction is not applicable to research on environmental management applications of geovisualizations, and thus different thinking is needed to examine geovisualizations' potential as place-based tools. Art and marketing use what Lewis et al. (2012, 91-92) refer to as "push" techniques, which is the use of visual tools for conveying particular messages and convincing people of specific "truths" regarding a place. In

contrast, geovisualizations must be designed as "pull" or user-driven tools that encourage people to express their "personal truths" on places (i.e., the meanings, values and understandings they ascribe to their environment) (Ibid., 101). It is through the pull approach that insights can be gained on how different stakeholders value and relate to a place and that geovisualizations can be employed as place-based tools for inclusive and collaborative management strategies.

The process for developing pull-type visual media holds a different set of considerations than that of push-type media. Rather than deliberately attempting to manipulate a viewer's emotional state through provocative imagery (i.e., as in push-type media), pull-type visuals encourage people to mentally connect with a real-world place and experience the emotions and feelings they would if in that actual place. This requires them to feel what is referred to as a "sense of presence," i.e., the sense or feeling of being within a particular environment without being physically situated in said environment (Carassa et al. 2004, 7). It is through these feelings of "being present" (or understanding what it is like to "be present") that people can imagine a place and subsequently summon the meanings and feelings associated with that place. In this way, sense of presence enables the cognitive processes that allow geovisualizations to connect people's sense of place.

A logical assumption concerning sense of presence is that presence would increase the more a virtual environment coincides with the sensory experiences associated with the real-world environment; indeed, this was an assumption that dominated earlier research on presence (Biocca 2003, 2-3). However, the assumption is flawed due to the fact that certain types of media can evoke presence without reproducing these experiences of the evocated environment. Such a flaw is characterized through what is referred to as the "book problem," which describes the ability for novels to elicit a sense of being within a story's setting even though the interface for the setting (i.e., paper and text) holds little to none of the sensory qualities of the actual environment that is imagined (Gysbers et al. 2004, 13). To resolve this problem, Biocca (Ibid., 5) suggested that presence operates through a three pole-model, consisting of virtual space, physical space and mental imagery space (referred henceforth as "imagined space"). When applying this model to geovisualizations, the virtual space is the digital representation of an environment (i.e., the geovisualization), the physical space consists of the structure and setting of the location in where a person interacts with the representation (i.e., the room where a geovisualization is used), and imagined space is comprised of a person's mental images, memories and imaginings of environments and places. According to this model, a person's sense of presence can oscillate between the three domains, and spatial and place-based cues from one domain can influence, merge with or distort experiences in other domains (Ibid., 5-6).

Through the three-pole model of presence, geovisualizations can be regarded as a method for connecting with sense of place and maintaining particular place-associated thoughts and feelings. In interacting with a geovisualization, the "virtual place" (i.e., virtual environment) produces place-based cues that influence and merge with "imagined place," shaping it around thoughts and memories of the real-world place that is depicted through the visual representation. Imagined place will then contain particular place meanings associated with the real-world place, which reflexively can serve as place-based cues that influence and merge with presence in the virtual place and (psychologically) layer the virtual environment with a specific place-based context (see Figure 1a). In accordance with Biocca's (2003) three-pole model, a user of the geovisualization will likely oscillate presence between the virtual and imagined place; however, in this case, both the virtual and imagined are aligned and complementary. Through this "coupling" of the virtual and imagined, the user is able to consistently engage with thoughts and feelings associated with the place represented through geovisualization.

When shifting presence from the virtual place to interact with people in "physical place" (i.e., as would occur in stakeholder discussions or co-planning sessions), a person is no longer present in the virtual place; however, since their imagined place has aligned with virtual place, oscillation between the physical and imagined can allow for discussions that can be guided by

thoughts and feelings associated with the place represented by the geovisualization without actually interacting with the geovisualization. Ultimately, due to a lack of place-based cues from the virtual environment, presence in imagined place likely will diminish eventually (see Figure 1b), or at least change in nature (i.e., what is "imagined"); however, this presence can be regained by shifting attention back to the virtual place and once again aligning the virtual with the imagined. In this way, geovisualizations can allow people to maintain a certain level of presence in a place in where they are not physically situated. Previous research supports this supposition, namely a study conducted by Baños et al. (2005) on the use of virtual environments in sustaining sense of presence. They found that an imagined presence could be induced without the use of visual aids (i.e., using mental exercises that encourage people to vividly imagine a setting); however, this sense of presence could only be maintained when people were exposed to virtual representations of the imagined setting.

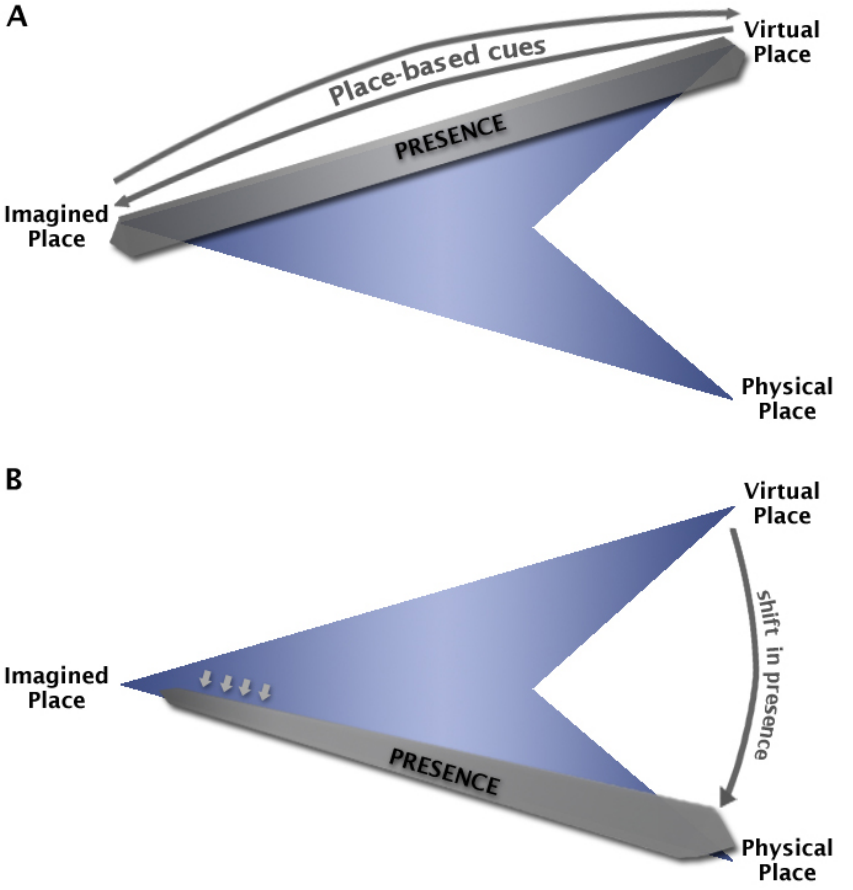

Figure 1: Interactions with geovisualizations and presence within virtual, physical and imagined place. Models have been adapted from Biocca's (2003) three-pole model of presence. The model depicted in (A) represents a user interacting with the geovisualizations. The model depicted in (B) represents user shifting attention from the geovisualization and engaging in discussion with others in the room.
Source: Newell and Canessa (prepared for this publication)

If geovisualizations operate as suggested above (i.e., virtual and imagined places reflexively exchanging place-based cues), this would suggest they have a greater ability to evoke presence and connect with sense of place if the user is familiar with the represented environment. In cases of high familiarity with places, users presumably would have more salient memories and

understanding of these places, which would allow them to draw from more coherent place-based cues when interacting with a virtual representation. Supporting this notion is a study by Bishop and Rohrmann (2003, 275), which found that people rated a virtual environment's ability to emulate a real-world place more positively after visiting, experiencing and becoming familiar with the actual place. In the context of environmental management, this role place familiarity has in increasing geovisualizations' capacity to represent places and connect with sense of place has positive implications. Effective collaborative management consists of inclusive, participatory approaches that involve stakeholders that are affected by management decisions (Poe et al. 2014, 170; Trimble and Berkes 2013), and said stakeholders are typically people that have relationships (and thus familiarity) with places targeted for management strategies (Poe et al. Ibid., 167-169). Therefore, geovisualizations can be considered as particularly effective for connecting with sense of place in collaborative management process, which supports the position that they operate (or at least have the potential to operate) as place-based tools when employed in environmental management efforts.

Evidence for Geovisualizations as Place-based Tools

Although place concepts and theories are rarely incorporated into geovisualization research, previous research has provided evidence that geovisualizations can act as place-based tools without making explicit reference to said concepts and theories. This evidence includes observations on the ability visualizations have for communicating "meaningful information" on places. To elaborate, previous research has shown that visualizations have capacity for communicating potential environmental changes (i.e., outcomes from landscape management, development, environmental issues, etc.) in a relatable fashion that allows people to vividly envision and imagine impacts on real-world, familiar places. Exemplifying this capacity is Lewis's and Sheppard's (2006) study on comparing realistic landscape visualizations with conventional maps, in terms of the abilities these tools have for communicating potential riparian and forest management outcomes to local community members of Cheam First Nation (Fraser Valley, BC, Canada). Lewis and Sheppard (Ibid., 304) observed that the community members favoured (for the most part) the visualizations, noting them to be much more "real" than maps. This reference to "real" indicates that the visualizations were prompting people's thoughts on actual environments and places, stimulating meanings and feelings associated with their respective senses of place. In fact, one of the study participants made a direct reference to these feelings, noting that the visualizations provided "a way better understanding [that is] almost a feeling" (Ibid., 308). In another example, Sheppard et al.'s (2011) made similar observations with residents of south Delta (BC, Canada) in an investigation on the use of realistic visualizations for communicating localized effects of climate change. In this study, Delta residents expressed how the visualizations "hit home" (Ibid., 408), meaning that these visual tools contextualized climate change issues in a manner that allowed for vivid and personal understandings and feelings of the implications of climate change on familiar and meaningful places.

In addition to exhibiting capacity for communicating meaningful place information, previous research has also found that visualizations can elicit responses reflective of particular place-based values, thereby implying that they are capable of connecting to sense of place. This research includes studies that investigate people's preferences around landscape management and industry development by presenting them with visual media that depicts different management and/or development scenarios and then examining their reactions to these scenarios. Because sense of place encompasses the meanings and values held for a place, it also is strongly related to how a person believes a place should be managed or developed (Yung et al. 2003, 855).Therefore, it follows that particular reactions to certain visual depictions of management and/or development scenarios applied to a representation of a place are driven by people's beliefs and values for the

actual place, which implies that the visual tool is connecting with these people's sense of place. For example, Natori and Chenoweth (2008) presented a series of landscape images depicting different approaches to rice paddy management to group of study participants in Niigata Prefecture (Japan), and they found preferences for the imagery differed depending on whether a participant was identified as a farmer or naturalist. Farmers exhibited a stronger preference for landscape imagery that depicted more productive and easier to manage rice paddies, whereas naturalists preferred landscape imagery that displayed higher levels of biodiversity (Ibid., 255-263). These observations clearly indicate that the visual preferences for landscape imagery were strongly driven by (and thus reflective of) values, interests and meanings encompassed within the different people's respective senses of place. In another example, Tress and Tress (2003) investigated the preferences local and nearby residents of a rural place in Denmark had for local development by presenting them with altered images of the place, depicting different potential development directions (i.e., farming, recreation, conservation or residence). They observed that people residing locally were strongly in favour of the farming scenario, whereas people residing nearby strongly favoured the tourism scenario (Ibid., 171). Such observations demonstrate that people's place-based values, particularly their place dependence or functional values, played a central role in their responses to the visualizations, which in turn exhibits the potential geovisualizations have for connecting with sense of place.

Perhaps the most salient evidence for the notion that geovisualizations can connect with sense of place is observed through research that has found visualizations capable of evoking emotional responses. Sense of place includes the feelings and emotional significances people hold for place (Cresswell 2009, 1); therefore, a tool or device that stimulates or activates place-related emotions must be connecting with sense of place in order to achieve this activation/stimulation. For example, Salter et al. (2009, 90) presented residents of Bowen Island (BC, Canada) with a visualization depicting potential outcomes of increased local housing density, and they found that the visualization created a sense of "unease" with one participant noting that "[s]eeing the visible impact makes me uneasy". This denotes that the visual representation produced a negative emotional reaction associated with disruption of the character or nature of a familiar and valued place, and thus is interacting with place-based values and meanings. Another example includes a community planning process conducted in Kimberley (BC, Canada) and led by Schroth et al. (2009), which used geovisualizations to convey potential impacts of local wildfires. Schroth et al. (Ibid., 25) reported that the local Kimberley residents participating in the planning processes exhibited strong emotional reactions when viewing the spread of wildfire through the visualization, indicating that these visuals stimulated imaginings of the actual places (i.e., Kimberley neigbourhoods) being consumed by fire. In both the Bowen Island and Kimberley examples, emotional responses resulted from the visual representations of alterations and impacts to places that hold personal meaning and significance, indicating that through interacting with the visual tools, people could imagine the actual possibilities of disruptions to said meanings and significance. This is a clear indication that geovisualizations hold capacity for connecting with sense of place and act as place-based tools when employed in collaborative management.

An Integrated Research Agenda

This paper has explicitly illustrated the relationship between research on sense of place and studies on applications of geovisualizations in collaborative management, and it has done this for the purposes of moving toward an integrated research agenda. In this fashion, the paper provides precedent for future research that can integrate methodology, theories and knowledge from diverse disciplines, such as spatial sciences, perceptual research, human geography and environmental studies. Such research has the potential to lead to a comprehensive understanding of how to build a geovisualization, what situation (and with whom) a particular geovisualization

would be best applied, and how to interpret the results of user interactions with a geovisualization. As an example, a potential area where this type of integrated research approach could be applied is in investigations on how to facilitate collaborative planning around controversial offshore windfarm proposals. Previous research related to collaborative wind energy planning has included studies such as examining methods for developing interactive wind turbine visualizations (e.g., Bishop and Stock 2010), exploring the role that visualizations have for facilitating collaboration amongst proponents of and opponents to proposed offshore windfarms (e.g., Phadke 2010), and investigating how place relationships can influence the ways different communities and socio-economic groups perceive (and accept) proposals for local offshore wind energy developments (e.g., Devine-Wright and Howes 2010). By integrating thinking and/or research approaches from these different types of studies, a research effort could comprehensively examine offshore windfarm visualizations, producing valuable insight on how to develop said visualizations in a manner that they can be applied in contentious stakeholder planning sessions and nuanced interpretations of the reactions to various windfarm scenarios as they differ among communities and socio-economic (and cultural) groups.

Another way in which an integrated research agenda would benefit geovisualization research is by using knowledge on how people value and form relationships with places to inform what elements to include within a visualization. Real-world environments are highly complex, and as Appleton et al. (2002, 147) succinctly states, "reality will always exceed our ability to simulate it". Builders of geovisualizations cannot feasibly capture all the elements and features found within a real-world environment; therefore, these builders need to be selective in what they include. In terms of building geovisualizations for collaborative management, such a selection process could be informed through sense of place and place attachment investigations, as such research has the ability to shed light on what aspects of a place are considered by different stakeholders as particularly important. For example, in a place attachment study involving Appalachian Trail hikers, Kyle et al. (2004, 219-223) found that hikers with a higher place identity type attachment held different expectations for the social and environmental conditions of the trail than people with higher place dependence, and part of these expectations involved a different tolerance for "crowding" from other hikers. This suggests that potential increases in human traffic could be an important aspect of how different people and/or communities respond to a proposed management plan for local parks and trails. Accordingly, simulated increases/decreases in presence of people could be a key feature to include in geovisualizations when researching their application in the collaborative management of public parks and trail systems.

In addition to being able to provide deeper understanding on how users interact with geovisualizations, an integrated research agenda could also provide insight on influences and personal "biases" experienced by builders of a geovisualization when developing these tools. Geovisualizations are not "objectively" built, meaning the process of translating data into realistic environmental representations is subject to the geographical understanding and interpretations of the builders (Lewis et al. 2012, 101); therefore, comprehensively examining how geovisualizations can be built and used in collaborative management also requires an understanding of the "human" factors on the builder-side that can influence their development. These factors can be elucidated through methods used by environmental psychologists and human geographers to investigate people's sense of place, as such methods can provide data on how builders interpret and understand a place's environment prior to developing a virtual model of said environment. For example, sense of place can be examined through semi-structured interviews (e.g., Gunderson and Watson 2007), and a geovisualization research effort could include a component where those building and contributing to the development of a geovisualization can be interviewed in such a manner. In turn, this interview data can be analyzed to better understand the decisions (conscious and subconscious) involved in developing the geovisualization that extend beyond purely data and technological considerations, such as

why certain elements are included and others excluded in a geovisualization (i.e., when data availability is not an issue) or why certain aspects seem to be prepared with more attention to detail than others (i.e., when technological limitations are not issues).

Conclusion

The lack of incorporation of place theories and concepts into geovisualization research appears surprising when examining the clear convergence in these research areas (i.e., as it exists in the environmental management context); however, as aforementioned, this deficiency is likely more associated with epistemological differences. It is possible that if humanistic geography emerged and produced its seminal theories on place in more recent decades (when technology has allowed for the development realistic, immersive visualizations), geovisualizations and sense of place would be investigated frequently in the same studies. Referring back to Tuan's (1977, 6) comment that "undifferentiated space becomes place when we endow it with value," this is similar to how geovisualization researchers describe visual tools as having the capacity to transform abstract data into salient and meaningful information concerning familiar real-world places (e.g., Jude et al. 2007; Lewis et al. 2012; Sheppard et al. 2011). In other words, the building of recognizable textures and objects in a geovisualization can be seen as a method for creating the conditions for people to "endow" visual imagery with place-based values. Such a perspective positions geovisualization research as a type of "humanistic geomatics," which due to disciplinary divisions, many geographers might regard this term as an academic oxymoron. However, in actuality, the term characterizes a complementary and suitable fit between applied research (i.e., geovisualization studies) and theoretical framing (i.e., place theory), which is a fit that has been alluded to previously but not sufficiently explored.

By illustrating the relationship between sense of place and applications of geovisualizations in collaborative management, this paper lays a foundation for future research that can bridge spatial sciences, perceptual research, human geography, and environmental studies. Potential examples of such research have been detailed in this paper; however, these examples simply represent initial thinking and further exploration in this line of research will open opportunities for a variety of geovisualization studies that will benefit from diverse areas of scholarship and disciplinary perspectives.[2] Ultimately, it is through such interdisciplinary approaches that we can effectively address the complex real-world problems that threaten sustainability (Dale and Newman 2005), allowing us to better understand how to sustainably manage and live within the planet's valuable and vulnerable places.

Endnotes

1. This paper employs the term, "geovisualization," to refer specifically to digital representations of real-world places that are geographically-accurate and built with high degrees of realism; however, it is important to note that the term can hold a broader meaning in other literature, where it can be used to more generally refer to visual depictions of geospatial data (e.g., Nöllenburg, 2007).

2. The authors of the paper are currently exploring this line of research, and plan to publish papers on studies that use this integrated research approach within the next two years.

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