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The immersive visualization theater: A new tool for ecosystem assessment and landscape planning

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ABSTRACT

In this study focusing on human–environment interactions, we analyze the use of an immersive visualization theater (IVT) for exploring how humans use and value cultural ecosystem services provided by natural landscapes in Israel's Carmel Forest. Our goal in this inductive, exploratory study is to assess the impact of the IVT on the quality and content of stakeholder discussions held in the theater.

We facilitated 10 focus group discussions in the IVT, where a series of high-resolution photographs were projected. Participants were asked (in writing and orally) to choose from among the scenes where they would prefer to spend time, and then asked to explain their answers. Next, they were asked to describe activities in selected scenes in which they were likely to participate. We suggest that the immersion theater, due to screen size, photo resolution, social interaction, and group isolation within the theater, elicited attention to detail and triggered memories and sensory responses to various landscapes. The qualitative data derived from focus group discussions add to our understanding of the diverse meanings and importance that different people attribute to the landscape, contribute to understanding the social processes and conditions through which participants attribute value to cultural ecosystem services, and allow us to generate testable hypotheses for continuing research.

1. Introduction

In this research, we assess the utility of a relatively new research venue – the immersive visualization theater (IVT) – for experimental inquiries into public preferences regarding natural landscapes and the cultural ecosystem services derived from these landscapes. Three interconnected fields of scholarly inquiry converge around our experimental venue, including 1) ecosystem services (ES) assessment (cultural ES in particular), 2) human perceptions of landscapes, and 3) the potential role of stakeholders in land use planning and policy. The first is a relatively new science, while the latter two are well-established research foci that have traditionally utilized visualization (Steinitz, 1990, Oh, 1994, Daniel & Meitner, 2001, Lange, 2001, Lange & Bishop, 2005, Sheppard, 2005, Lewis & Sheppard, 2006).

Utilizing high-definition photographs of landscapes from Israel's Carmel Mountain in an IVT has enabled us to form insights regarding the potential utility of the IVT as a research tool. Further, using the IVT (rather than other visualization tools) has challenged us to reconcile the benefits and shortcomings of this technology. Here we ask: What are the possible advantages and added value of using the IVT for research on landscape preferences and perceptions? By addressing this question, we add to the emerging literature that assesses the contribution of advanced-technology visualization tools to the study of landscape perception and planning (Sheppard, 2001, Paar, 2006).

We begin with a short overview of related work concerning cultural ES assessment, human perceptions of landscapes, and visualization theory and research applications. We then describe the experimental venue, the IVT, and the experimental methodology, focus group discussions. Next, using the predominant themes that arose during focus group discussions, we outline the suggested contribution of our IVT – called the VIZ-Lab – in eliciting responses from participants to our research questions. We conclude with a discussion regarding the proposed strengths and weaknesses of the experimental venue compared to those of other potential media and venues as described in the research literature.

2. Background

Cultural ES are defined as processes and characteristics of an ecosystem that provide benefits to humans in the form of spiritual, educational, social and recreational value (Reid et al., 2005, Church, Burgess, & Ravenscroft, 2011). The ES conceptual framework (which also includes provisioning, supporting and regulating services — all crucial to human survival and wellbeing) has proliferated across the research, planning and policy-making communities (Braat & de Groot, 2012, Maes et al., 2012). While the framework has gained popularity, understanding of cultural ES has remained rather generic, partially due to the dearth of social scientists participating in ES assessment and research (Duraiappah &

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Rogers, 2011). With the recent influx of social scientists into this realm, definitions of cultural ES and the methodologies for assessing them are becoming increasingly nuanced and structured (Chan et al., 2012, Daniel et al., 2012, Tengberg et al., 2012, Gould et al., 2015).

The study of cultural ES demands a focus on the non-material values derived from ecosystems, including spiritual and aesthetic values, cultural identity, social cohesion and heritage value, among others (Church et al., 2011, Chan et al., 2012, Gould et al., 2015). Since cultural ES provide non-material benefits (e.g., experiences, activities) as an outcome of socio-ecological interactions, there is a crucial need for understanding peoples' ways of life, and especially the meanings and interpretations that people relate to the benefits they experience from their interactions with natural environments)Tilley, 1994, Chan et al., 2012, Tengberg et al., 2012). As such, cultural ES research builds upon existing bodies of knowledge provided by environmental psychology, human geography, anthropology and landscape architecture. Further, cultural ES research borrows from the research methodologies of these disciplines, including observations, ethnographies, surveys and interviews, and guided group discussion.

With the recent increase in social research on cultural ES, ES research has begun to focus on the landscape itself, rather than on its particular biotic components (e.g. Fagerholm, Käyhkö, Ndumbaro, & Khamis, 2012, Tengberg et al., 2012). Several studies investigating ES through a social lens revealed that aesthetic and cultural landscapes were the most highly-valued components of the ecosystem (Gee & Burkhard, 2010, Tengberg et al., 2012, Sagie, Morris, Rofè, Orenstein, & Groner, 2013, Orenstein & Groner, 2014). This discovery poses a particular challenge for land use and natural resource management and for ES scholars, who have tended to focus on ecosystem services that could be measured in ecological terms or valued in economic terms, and who were criticized for these reasons (Spangenberg & Settele, 2010, Luck et al., 2012). New questions have been raised, including: What ES should be managed within the landscape? What biotic components of the landscape provide cultural ES? Does a particular species composition or level of biological diversity create more favorable landscapes? Do people appreciate landscapes regardless of their biological composition (Orenstein & Groner, 2015)? These questions bring cultural ES research closer to the disciplines that have traditionally studied landscape perceptions including, in particular, landscape architecture, natural resource planning and management, and environmental psychology (and have led some researchers to adopt the term "landscape services", e.g. Termorshuizen & Opdam, 2009, Brown, Montag, & Lyon, 2011). Likewise, these disciplines have been engaged in the theoretical and applied development of visualization methodologies.

The use of visualization for research of natural and constructed landscapes has a long and rich history (Ribe, 1989, Daniel, 2001, Lange & Bishop, 2005, Lange, 2011), and interest in its use continues to rise alongside growing interest in public participation in natural resource management and environmental planning (Bell, 2001, Sheppard, 2001). The reasons provided for employing visualization in landscape research, planning and design fall within a spectrum ranging from theoretical research for understanding aesthetic preferences and perceptions to applied research aimed at procuring stakeholder opinions regarding specific planning, design and management issues. But overall, there is a strong bias towards applied research for planning and management. The oeuvre of Zube et al. is noted for its focus on the development of a theory of human perceptions of landscapes (Zube & Pitt, 1981, Zube, Sell, & Taylor, 1982, Zube, 1984), but even they emphasize applied value as their motivation; "Inquiry centered on the landscape itself is most strongly motivated by the pragmatic concerns of environmental management, planning or design" (Zube et al., 1982; p. 6).

Visualization, regardless of the medium, uses visual imagery to engender a response from the viewer. Bell (2001) asserts forthright that "people tend to judge things on the basis of what they see as much as or more than on what they know". If this is true, then simply showing someone a given landscape could be the first step in obtaining their opinion of the site, and should elicit a more germane response than asking them about a scene in the absence of a visual image, actual or reproduced.

There are diverse tools for employing visualization, the most common of which are the use of photographs, which are generally small enough to be held in one's hand or to have several spread across a table in front of the viewer (e.g., Arriaza, Cañas-Ortega, Cañas-Madueño, & Ruiz-Aviles, 2004, Natori & Chenoweth, 2008, Shipley & Feick, 2009, and others). As early as 1967, Sonnenfeld (cited in Zube & Pitt, 1981) used photo-slides for comparing native and non-native residents' landscape preferences for residential settlement in Arctic and non-Arctic environments. Apart from actual site visits, photographs were the first medium to be used in experiments assessing the aesthetic preferences of individuals for landscapes, which sometimes attempted to establish mathematical relationships between landscape characteristics and aesthetic preferences (Shafer & Brush, 1977, Ribe, 1989). In other early work, photographs were shown to park users as a basic strategy in developing a visual preference model, which then was used to produce concrete recommendations for landscape planning (Steinitz, 1990).

Landscape visualization techniques underwent a substantial shift with the development of computer graphics and 3D capabilities (Lewis & Sheppard, 2006, Paar, 2006). This shift included the growing utilization of computer-generated images or photographs – 'photo-realistic landscape visualizations' (Lewis & Sheppard, 2006) – displayed on a computer screen or projected in either 2D or 3D. The rise of 3D landscape simulations and other technologies greatly improved the quality of virtual reality (VR) environments (Bowman & McMahan, 2007) and their potential utility for stakeholder-integrated landscape planning.

Some research of the past two decades has focused on the relative strengths and weaknesses of various visualization tools for planning purposes. For example, Bailey, Brumm, and Grossardt (2001) compared the efficacy of three visualization modes for computer-generated images, including 2D, 3D and VR, each projected on a computer screen, for use in collaborative highway planning. They found that users preferred 3D images, citing realism and functionality among their primary advantages (in particular, the ability to observe a scene from multiple angles). Lewis and Sheppard (2006) compared the use of photo-realistic images to GIS maps in planning and found that use of images led to a more in-depth, lively and meaningful discussion regarding interviewees' landscape preferences.

The comparative response of individuals exposed to different visualization tools is an ongoing topic of dispute and research (Daniel & Meitner, 2001, Sheppard, 2001, Lewis & Sheppard, 2006, Paar, 2006). Zube and Pitt (1981) provided evidence that landscape evaluations using wide angle photographs yielded results that were highly correlated with evaluations made in situ. Daniel and Meitner (2001) provided an inventory of additional research that supported this finding. However, noting exceptions to this claim, they conducted their own study of landscape perceptions using various levels of photorealism. They concluded that more abstract representations of landscapes do not provide correlating results with those produced using photographs. In contrast, Paar (2006), who surveyed planners regarding the efficacy of 3D landscape simulations, found that photorealism ranked relatively low in importance, while ease of learning and interoperability were ranked the most important characteristics of 3D visualization software.

The immersive visualization theater (IVT) provides a unique venue for visualization. While the technical profile of each theater is unique, we refer to a theater-like environment that includes a large surround or semi-surround projection screen and high-definition projectors. The immersive aspect of these theaters can, as stated eloquently by Fraser et al. (2012), have "the ability to dominate the viewer's senses, focus the viewer's attention on the stimuli, provoke the senses, and cause the viewer to become absorbed by the story and characters" (Fraser et al., 2012, p. 4-4). IVT can include a range of features and capabilities, such as 3D projection, tracking cameras for allowing participants to interact with the projected images, internet and conferencing

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