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Applying design thinking methods to ecosystem management tools: Creating the Great Lakes Aquatic Habitat Explorer

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ABSTRACT

Ecosystem management (EM) requires new tools to facilitate stakeholder access to information and analysis, however these tools are often not perceived by stakeholders to be usable, useful, and salient to their concerns. This paper provides a case study which applies new participatory design methods, known as design thinking, to create an EM tool called the Great Lakes Aquatic Habitat Explorer. Both participating and non-participating stakeholders rated the usability of the resulting tool positively, and stakeholders who attended design workshops rated the perceived usefulness and salience of the resulting tool more highly than those who had not. Design workshop survey data found that the methods produced an environment of collaborative learning among participants, including diverse participants, authentic dialog, and creativity. Design thinking methods hold promise for the development of new tools which better respond to the needs of EM stakeholders.

1. Introduction

Planning and management efforts in marine and aquatic environments have increasingly adopted the concept of ecosystem management (EM), which argues all environmental decisions should be made through a holistic consideration of ecological, economic, and social dimensions [1–3].[1] To implement EM, professionals increasingly rely on digital tools to access scientific information, evaluate alternative management decisions, and facilitate interdisciplinary communication among stakeholders. New information technologies, especially web-based geographic information systems (GIS) and decision support systems, hold great potential for EM tools since they can be used for expanded visualization and analysis of management options, and help overcome obstacles like providing stakeholders access to information at appropriate spatial scales [4].

Despite widespread recognition that digital tools can enhance EM efforts, and a growing collection of EM tools which exist, use of these tools in practice has been hindered by technical and design problems which limit available their usability and usefulness. Users of existing EM tools complain that they are difficult to use, lack documentation, contain bugs, and are poorly supported [5]. Studies of existing tools in specific regions have identified more serious critiques: an examination of five coastal spatial decision support systems in the Netherlands found they did not provide users appropriate functionality and were overly complex [6], and a review of web-based geospatial tools for Great Lakes management found many were focused on narrow policy domains, lacked spatially detailed data, and featured confusing interfaces [7]. Changing EM software design practices and improved communication with users have been suggested to address these problems [8,9]. However, for digital tools to be most useful, developers must also address problems caused by differences among users' perspectives and needs.

Successful EM requires bridging the diverse intellectual worlds of resource managers and stakeholders through a process which results in a new shared understanding [10]. Thus, to be effective, EM tools should reflect agreements among users on issues like how information should be processed and presented, and what functionality is needed. Therefore designing EM tools – like EM itself – requires a collaborative process where users are considered as stakeholders, and are provided opportunities to engage in dialog, shared learning, and meaningfully shape tool designs.

However, creators of EM tools seeking to foster such a collaborative process need not start from scratch. In recent years, there

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[1] Term "ecosystem management" is used here as a synonym for the more common "ecosystem-based management" since the former is more widely used in the literature on the Great Lakes.

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has been a dramatic growth in methods for designing new technologies for groups of diverse users. In particular, a set of methods known as "design thinking" has emerged from extensive practical and scholarly development [11–16]. Unlike expert-led design approaches which often result in difficult-to-use technologies that focus on expert-identified needs, design thinking methods urge technology creators to follow a five-step process centered on the needs and perspectives of users.

This paper reports on a project which used design thinking methods to create a new EM tool for the Laurentian Great Lakes basin. In addition to describing the process and resulting tool, the effectiveness of the methods are tested by examining participants' dialog quality and learning during the tool design process, as well as by comparing the perceived usability and usefulness of the tool by the participants of design workshops and with a control group that was not involved in the process. Although design thinking methods generally require somewhat greater investment than expert-led methods, they result in tools that can be adapted to a variety of situations and help minimize the creation of flawed tools. This study suggests that not only did design thinking methods foster a desirable collaborative process, they also resulted in a tool that was perceived as usable and useful by Great Lakes environmental managers.

2. Methods

2.1. Conceptual background

Although ecologically distinct from oceans, the Great Lakes share institutional and human use characteristics with marine environments. They are governed by a set of binational treaties and cooperation, and include waters administered by multiple U.S. states and the Canadian province of Ontario [17] and binational organizations like the Great Lakes Fishery Commission and the International Joint Commission. Like in marine systems, the lakes support multiple human uses such as industrial shipping, commercial and recreational fisheries, and tourism. EM has expanded in marine systems, often via marine spatial planning (MSP) projects [18–20], and has a long history in the Great Lakes region through adaptive fisheries management [21] and other binational efforts reflected in the 2012 Great Lakes Water Quality Agreement and other regional initiatives [3,22,23].

This project is the outreach and implementation component of the Great Lakes Aquatic Habitat Framework (GLAHF) project, a spatial and classification framework that integrates key habitat data across the basin [24].[2] GLAHF has three primary products: (1) a novel spatial framework, (2) a database of spatial data, and (3) an aquatic habitat classification system. The spatial framework consists of geo-referenced grid cells that cover the entire Great Lakes basin, including coastal and nearshore systems. These grid cells have been referenced to a suite of physical, chemical, biological, political, and human activity data that can be aggregated into larger functional units depending on user needs. This hierarchical structure provides the framework for developing a Great Lakes aquatic habitat classification system that can be used at the spatial scale appropriate for the development of regulatory policies, prioritizing management activities, and identifying jurisdictional responsibilities. Building on the framework and database, GLAHF is developing an ecological classification tailored to the Great Lakes. The broad aim of the GLAHF Explorer project was to draw on the rich information contained within GLAHF to develop a novel EM tool to assist Great Lakes environmental managers address questions they face in deciding about management actions.

2.2. Need for design thinking approaches in ecosystem management

Despite the large number of EM tools that currently exist, there has been relatively little attention paid to the interrelated issues of how they are created and used.[3] Research on the challenges which face EM illustrate the need for new tool development methods. These methods should not only aim to produce high-quality software, but also seek the input from diverse stakeholders in a way which focuses on specific goals, minimizes domination by particular groups, and cultivates shared perspectives about the tool.

Two relevant studies suggest that many existing tools are not useful for users, and that alternative development methodologies are needed. First, an empirical study of five European spatial decision support systems (SDSS) for coastal management and planning concluded that the systems were not used because they did not provide the functionality desired by users. The authors concluded, "in all of the systems, contact with the decision process seems to be lost during the development of the SDSS […] the need for a closer link between developers and users during development is probably the most important lesson from this paper" [6]. Similarly, scholars associated with the Ecosystem-Based Management Tools Network investigated complaints that the tools compiled by this network were "often difficult to use, lacked documentation, contained numerous bugs, and were poorly supported and maintained" [5]. Based on the results of interviews with tool users, these authors argued for changes to how such tools were developed and funded, and proposed EM tool developers adopt commercial software development methods such as the agile methodology or the waterfall model. Although these methodologies may be helpful, the EM literature described below suggests problems with the tool utility transcends these primarily technical considerations. For instance, improved software development methods may result in a bug-free tool that still does not address stakeholder needs.

Research in diverse contexts has concluded that successful EM requires overcoming important intellectual gaps among stakeholders. Van Wyk et al. [10] found information providers and decision makers came from different "intellectual worlds," and argued the solution was a process to cultivate shared understanding. The diverse intellectual disciplines involved in EM result not only in different intellectual approaches, but also power imbalances among participants. For example, one study found that unequal access to GIS data and technical skills contributed to unequal power within a project [25]. Tools for EM must overcome additional challenges related to obtaining, processing, and presenting useful information. By its nature, EM requires integrating diverse and often complex information sources [1,21]. EM projects find "information-related transaction costs" are "substantial", and information at appropriate spatial and temporal scales may be lacking [4]. Advances in technical methods are ameliorating some of these concerns. For example, recent work in MSP highlights the use of analysis techniques to transform sampling data or other inputs into continuous maps of predicted abundance or suitability

[2] GLAHF has been developed through an interdisciplinary collaboration among participants from the University of Michigan, the NOAA-Great Lakes Environmental Research Laboratory, the International Joint Commission, Michigan Department of Natural Resources, the USGS Great Lakes Science Center, The Nature Conservancy, Michigan State University, University of Minnesota-Duluth, U.S. Fish and Wildlife Service, and with participation with Ontario Ministry of Natural Resources and Forestry and Environment Canada, and others. The project was funded by the Great Lakes Fishery Trust.

[3] A directory of tools compiled by the Ecosystem-Based Management Tools Network can be accessed online at https://ebmtoolsdatabase.org.