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The ethics of Google Earth: Crossing thresholds from spatial data to landscape visualisation

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ABSTRACT

'Virtual globe' software systems such as Google Earth are growing rapidly in popularity as a way to visualise and share 3D environmental data. Scientists and environmental professionals, many of whom are new to 3D modeling and visual communications, are beginning routinely to use such techniques in their work. While the appeal of these techniques is evident, with unprecedented opportunities for public access to data and collaborative engagement over the web, are there nonetheless risks in their widespread usage when applied in areas of the public interest such as planning and policy-making?
This paper argues that the Google Earth phenomenon, which features realistic imagery of places, cannot be dealt with only as a question of spatial data and geographic information science. The virtual globe type of visualisation crosses several key thresholds in communicating scientific and environmental information, taking it well beyond the realm of conventional spatial data and geographic information science, and engaging more complex dimensions of human perception and aesthetic preference. The realism, perspective views, and social meanings of the landscape visualisations embedded in virtual globes invoke not only cognition but also emotional and intuitive responses, with associated issues of uncertainty, credibility, and bias in interpreting the imagery. This paper considers the types of risks as well as benefits that may exist with participatory uses of virtual globes by experts and lay-people. It is illustrated with early examples from practice and relevant themes from the literature in landscape visualisation and related disciplines such as environmental psychology and landscape planning. Existing frameworks and principles for the appropriate use of environmental visualisation methods are applied to the special case of widely accessible, realistic 3D and 4D visualisation systems such as Google Earth, in the context of public awareness-building and agency decision-making on environmental issues. Relevant principles are suggested which lend themselves to much-needed evaluation of risks and benefits of virtual globe systems. Possible approaches for balancing these benefits and risks include codes of ethics, software design, and metadata templates.

1. Introduction

'Virtual globe' software is growing rapidly in popularity as a way to visualise and share 3D environmental data. Google Earth "A 3D Interface to the Planet" was publicly released in June 2005 and has attracted widespread public use and attention due to its ability to view landscapes in fairly realistic three dimensions, using a combination of digital elevation models, satellite imagery, and 3D building envelopes (in some selected cities). Google Earth grew to over 100 million users on the Internet within one year of its release (Google Corporation, n.d.). In the United Kingdom, it is reported that "Google Earth" became the eighth most popular search term during the month of January 2006 (Hopkins, 2006). Other programmes are becoming available with some similar capabilities, including World Wind (NASA, 2006) and ESRI's ArcGIS Explorer (Environmental Systems Research Institute, 2006).

Breakthroughs in tiling, data transfer, and caching technology have allowed seamless viewing and real-time exploration of spatial data, including medium to high resolution satellite imagery anywhere in the word. The appeal of these techniques is evident, not only for private users but also for scientists, practitioners, policy-makers, and stakeholders on environmental and planning issues (Butler, 2006). The speed of uptake by the scientific community, for example, can be gauged by the fact that the American Geophysical Union's Conference advertised 38 technical presentations on the use of virtual globes in the earth sciences (AGU, 2006). There would seem to be unprecedented opportunities for greatly increased

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access to, engagement in, and collaborative use of spatial information. Are there, however, risks in this widespread and possibly indiscriminate usage when applied to awareness building and decision-making contexts central to the public interest? If so, how might these risks be balanced with the advantages provided by virtual globe systems?

In considering possible problems stemming from virtual global systems and possible solutions, this paper reviews theoretical frameworks and principles applying particularly to the use of 3D environmental visualisation methods, drawn from relevant disciplines and fields of professional practice. The paper explores how these principles apply to the new subcategory of visualisation known as virtual globes, primarily in the context of social learning and decision-making by government and local communities on issues such as environmental awareness-building, public policy debates, and land use planning. Accordingly, the focus will be primarily on questions of validity (including notions of correctness or appropriateness of the information), not the more obvious aspects of utility in information transfer, usability, and engagement, which are already becoming self-evident. We will argue that it is vital to consider more than the cognitive role of virtual globes, by virtue of their realistic depiction of real places with diverse social meanings to users. Ultimately, it is hoped that a structured identification of observed and potential issues and corresponding principles will encourage much-needed and systematic evaluation of virtual globe use, so we can justify confidence in their use.

Two groups of users are the focus of this paper; in both cases, these have not previously been typical users of or practitioners in visualisation systems. One group comprises scientists and experts from various disciplines, seeking to use these new tools to inform, present and contextualize their work. The other group comprises interested members of the lay-public (here defined as people without particular expertise in science or environmental professions), who can freely access these tools over the Internet and potentially interact in new ways with public processes; this group would include both viewers who primarily browse and navigate through the available information, and more active users who manipulate, add to, and re-post the information, essentially serving as data providers. While it is beyond the scope of this paper to review systematically patterns of current usage of virtual globe systems, we will highlight potential issues by reference to some early examples of Google Earth use. Accordingly, considerable reliance on information from web-sites is unavoidable in this paper, given the recent availability of the virtual globe software.

After reviewing relevant frameworks and principles for evaluating virtual globe systems in the context just described, the paper describe benefits (briefly) and possible risks (in more depth) of using virtual globes. It concludes with suggestions for balancing those benefits and risks on issues of public interest, and for prioritizing further research.

2. Possible frameworks and principles for evaluating virtual globes

The field of computer-based visualisation is still only a couple of decades old and theories, frameworks and principles to guide appropriate usage are still emerging. Two disciplines that have begun to develop frameworks for understanding and evaluating visualisations in ways that are relevant to the focus in this paper comprise cartography/GIS, with particular reference to collaborative GIS and web-GIS applications, and landscape visualisation.

The main discipline in which visual media are used to convey environmental and scientific information has been cartography and allied or derivative forms of geo-visualisation, showing the world in GIS maps, diagrams, or conceptual simulations of 3D forms (Appleyard, 1977; Monmonier, 1996). These media are typically semiotic as they communicate using primarily abstract symbols. MacEachren (2004, p. 355) uses the term "visualisation" in the context of "cartographic visualisation" or "scientific visualisation", which refers to the use of "advanced computer technology to make visible scientific data and concepts". He has proposed one schema for analyzing uses and types of visual media (including maps) that could be applicable to 3D virtual globes, in the form of a conceptual cube (Fig. 1).

MacEachren (2004, p. 257) summarizes the visualisation cube variables as follows:

> The dimensions of the interaction space are defined by three continua: from map use that is private (tailored to an individual) to public (designed for a wide audience); map use that is directed towards revealing unknowns (exploration) versus presenting knowns (presentation); and map use that has high interaction versus low interaction. There are no clear boundaries in this human–map interaction space. All visualisation with maps involves some communication and all communication with maps involves some visualisation. The distinction made is in emphasis. Geographic visualisation is exemplified by map use in the private, exploratory, and high interaction corner. Cartographic communication is exemplified by the opposite corner.

This framework distinguishes between use of visual media for "visualisation" (emphasis on analysis or exploration) and "communication" (emphasis on presentation), with the suggestion that an important role of visualisation is to discover information not previously known from other data sources. The public/private dimension can be related to general use by lay-people (more public) versus scientists or individual experts (more private). Under this framework, virtual globes would seem generically to occupy a space in the cube with high public content and presenting mostly 'knowns', in the sense that the information is not new to science, although presenting perhaps much previously unknown information to the public. This would lean toward an emphasis on communication as represented in the cube, but with quite high levels of interaction in some limited ways, e.g. visual

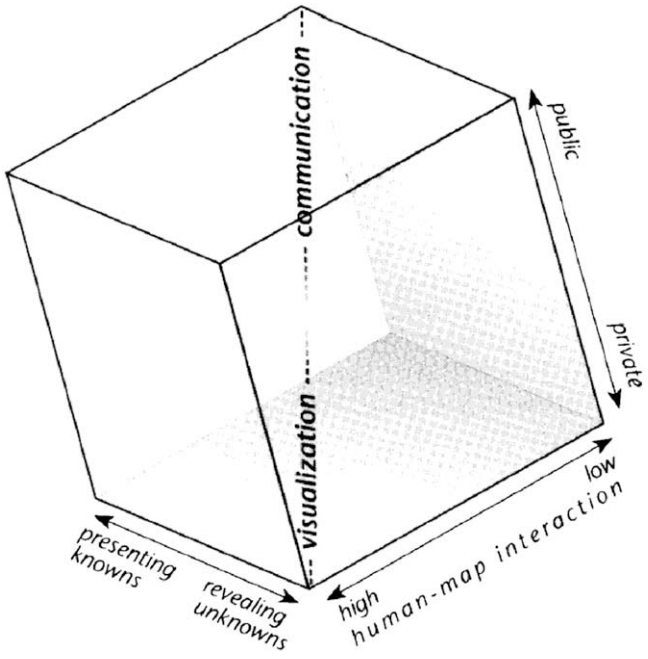

Fig. 1. MacEachren's cube diagram representing key dimensions related to visualisation and communication. Source: MacEachren (2004, p. 358) with permission from The Guilford Press, New York, NY.