Designing Public Geovisualizations to Improve Tsunami Education in Ucluelet, British Columbia

Matt J. Kurowski[1], Nick R. Hedley[2]

Geography, Simon Fraser University
Spatial Interface Research Lab
1 mjk5@sfu.ca,
2 Director - Spatial Interface Research Lab, hedley@sfu.ca

Abstract

The aim of this research is to develop and evaluate less conventional forms of geovisualizations which communicate spatial risk of a local tsunami scenario. The term geovisualization (geographic visualization) refers to the visual representation of geographic space. This includes conventional, two dimensional maps, as well as two dimensional animations, three dimensional maps, and interactive virtual spaces (Slocum 2005). New technologies need to be investigated to determine their potential to produce increased spatial cognition (Shelton and Hedley, 2002).

Background and Relevance

Residents on the West Coast of Vancouver Island are vulnerable to both telegenic and local tsunamis (Anderson & Gow 2004). If a strong earthquake occurs in the Cascadia Subduction Zone, located approximately 100km west of Vancouver Island, mathematical models indicate that due to bathymetry and probable ocean displacement, a locally generated tsunami will hit Ucluelet, British Columbia. It is estimated that approximately thirty minutes after the earthquake a maximum run-up of 20 meters will occur. Due to the short arrival time of the local tsunami and the severe damage the earthquake will cause on local infrastructure, citizens need to rely on their own knowledge and situational awareness to make prompt, safe and educated decisions for tsunami evacuation of inundation areas.

Current research indicates that in Canada, along with several other identified countries, tsunami education programs that attempt to prepare the public for tsunamis are ineffective (Anderson & Gow 2004, Haque 2006). These education programs are successful in providing awareness, but fail to promote preparedness (Johnson et al. 2002, Paton 2003). There is a need to provide better tsunami education in communities, especially for the case of a local tsunami (Dengler 2005). To fill this gap, this research explores how to improve tsunami education in Ucluelet, British Columbia using hazard mapping.

The aim of this research is to develop and evaluate less conventional forms of geovisualizations which communicate spatial risk of a local tsunami scenario. The term geovisualization (geographic visualization) refers to the visual representation of geographic space. This includes conventional, two dimensional maps, as well as two dimensional animations, three dimensional maps, and

interactive virtual spaces (Slocum 2005). New technologies need to be investigated to determine their potential to produce increased spatial cognition (Shelton and Hedley, 2002).

This applied research is part of a larger Geomatics for Informed Decisions (GEOIDE) funded collaboration between the District of Ucluelet, the British Columbia Provincial Emergency Program, the University of British Columbia Civil Engineering and Simon Fraser University Geography. Facilitated by the British Columbia Provincial Emergency Program, the community of Ucluelet arranged for UBC Civil Engineering to model a worst-case local tsunami scenario and recommend safe havens. Our research in the Spatial Interface Research Lab at Simon Fraser University focuses on how to best visually communicate this new risk information to the population of Ucluelet.

Method and Reasoning in Developing New Tsunami Geovisualizations

The first stage of developing new communication tools involved reviewing current applications of community tsunami risk maps in the USA, New Zealand and Australia. Geovisualizations seem to be entirely limited to static two dimensional inundation maps of communities which, if viewed online, may reference two dimensional and three dimensional animations. However, these animations never refer to the local geographic area in question. This, together with two dimensional static inundation maps may lead users to distorted spatial and temporal presumptions of a tsunami event in their community.

Given these limitations of current tsunami educational products, we are developing public Geovisualizations which directly utilize more spatial information created in the previous modeling stages of tsunami risk assessment. This includes technical two dimensional animations of an inundation scenario in Ucluelet, along with digital elevation models.

Our first prototype geovisualization used ArcGIS to render a set of three dimensional flights around Ucluelet. With Adobe Flash, we designed an interface that allows users to choose and fly to different views of Ucluelet and watch an inundation scenario from each view, thus creating a non-linear geomovie. However, due to limitations within ArcScene, inundation animations needed to be simplified to a linear and continuous sea-level rise rather than visualizing a non-linear rise as predicted by the mathematical model.

In order to have finer control over how temporal and elevation information is visualized and animated, it was necessary to move from ArcGIS to a program environment designed primarily for visualization. Currently we are developing renderings in AutoDesk 3Ds MAX to bypass visualization limitations of ArcGIS. Combining developed 3Ds MAX renderings with Flash will provide users intuitive and interactive access to the temporal and spatial nature of a tsunami in a three dimensional geovisualization specific to the geography of Ucluelet.

Any educational tool which disseminates spatial information needs to be carefully considered. The influences different geovisualizations have on user cognition are still poorly understood (Slocum 2005). Design decisions in the process of developing geovisualization products can vary in many characteristics. These characteristics include: i) the content: spatial, spatio-temporal ii) the representation: two dimensional, three dimensional iii) the degree of interaction between the tool and the user. Geovisualization design could potentially impact how users perceive and understand the nature of the tsunami; therefore it is important to explore how new forms of geovisualization may affect users' spatial knowledge. This presentation shows recently developed geovisualizations and discusses how design decisions were made using guidelines and suggestions from tsunami science literature.

Future User Testing

The primary goal of this research is to compare newly developed geovisualizations to current geovisualizations of Ucluelet which consist of small scale animations and static inundation maps. The two approaches may produce significantly different understanding of the spatial and temporal nature of a tsunami in Ucluelet. Working with the municipal government and schools of Ucluelet, residents will be part of tests that empirically measure effects of the two educational tools. User testing is planned for Spring 2009

Conclusions

Creating new information is no longer the biggest challenge facing areas of high environmental hazard - using already existing information within society poses a larger challenge (Tierney 2005). This research explores how designing intuitive geovisualizations, which utilize more information from the tsunami modeling process, may influence tsunami education.

The geovisualizations resulting from this research aim to provide an educational product for Ucluelet, which can provide individuals with improved spatial decision making and understanding of the nature of a tsunami. Providing citizens with better access to spatial and temporal information may improve not just tsunami awareness but also preparedness within the community.

References

Anderson P. & Gow G. A. (2004). Tsunamis and Coastal Communities in British Columbia: An Assessment of the B.C. Tsunami Warning System and Related Risk Reduction Practices. *Ottawa, Public Safety and Emergency Preparedness Canada*.

Dengler L. (2005). The Role of Education in the National Tsunami Hazard Mitigation Program. *Natural Hazards 35:* 141-153.

Haque C. E., Dominey-Howes D., Karanci N., Papadopoulos G. & Yalciner A. (2006). The need for an integrative scientific and societal approach to natural hazards. *Natural Hazards 39*: 155-157.

Johnson D, Paton D, Houghton B, Becker J & Crumbie G (2002). Results of the August September 2001 Washington State Tsunami Survey. Science Report #2002/17. Wellington, New Zealand, Institute of Geological & Nuclear Sciences.

Paton D (2003) Disaster preparedness: a social-cognitive perspective. *Disaster Prevention and Management 12:* 210-216.

Sheldon B E, Hedley (2002) Using Augmented Reality for Teaching Earth-Sun Relationships to Undergraduate Geography Students, *The First IEEE International Augmented Reality Toolkit Workshop,* Darmstadt, Germany.

Slocum T. A. (2005). Thematic Cartography and Geographic Visualization. *Pearson/Prentice Hall*.

Tierney K (2005) Effective Strategies for Hazard Assessment and Loss Reduction: The Importance of Multidisciplinary Approaches.