Visual Analytics for Prevention of the Catastrophes from Natural Disasters

Alejandro Bautista Ramos*, Fisnik Turjaka and Ilona Heldal

School of Informatics, University of Skövde, Skövde, Sweden

ABSTRACT

Visual Analytics (VA), a set of combined techniques from the fields of Data Mining and Information Visualization, can lead towards new insights of threat zones prediction and increased awareness of catastrophes to human population. This work illustrates some benefits of the tools based on VA and a short description of these tools is provided as well. Since these modern tools have not yet been implemented in the majority of countries, this work concludes by giving some mention of the learned lessons that should be considered before creating or implementing these tools.

Keywords: Visual analytics, data mining, information visualization, disaster management, context-awareness.

1 1. BACKGROUND

New computational tools promise a better understanding of large amounts of data related to climate changes. However, trying to find significant information from heterogeneous sources that can be used to detect potential threat zones caused by disasters is a complex task. The volume of generated data often exceeds human's capacity to filter and interpret all necessary information. In this context, there are existing tools such as Visual Analytics (VA) that can provide a better overview via visual representations of the data on geographical maps and via allowing direct interaction with the data.

VA combines techniques from the fields of information visualization and data mining that can be applied into some of the climate variation data such as records of temperature, humidity, wind, precipitation and so on; new interpretations from these tools can alert population from a disaster or detect the potential threat zones that can be originated from it [1].

2 MOTIVATIONS

The benefits of interactive visualization for informing public on changes in geographical places are demonstrated previously [e.g. 2]. Understanding the potential of VA to produce new knowledge is top priority in a research and development agenda for information visualization since a decade. Using VA to inform public and support human understanding of hypotheses and their consequences regarding issues of general matter, such as climate changes or disasters needs to be explored further [3].

If potential disaster zones that may pose a threat to population can be detected before some humanitarian disasters occur then people should be informed in advance, moreover, if VA contributes to detecting e.g. starvation or riots before these actually occur then VA should be also used more broadly.

*Corresponding author.
Email addresses: b14aleba@his.se (A. Bautista Ramos), a10fistu@his.se (F. Turjaka) and ilona.heldal@his.se (I. Heldal).

3. OBJECTIVES

The purpose of this work is to illustrate the capabilities of VA for preventing catastrophes or natural disasters. The first aims are to provide evidences about the usefulness of the tools when the decision makers (governments) in real situations use them.

4. METHODOLOGY

In order to find evidences from the literature and practice on how VA tools can be used to inform about climate changes, a brief literature review was performed. Based on the lessons of using VA in general, and identifying the usefulness of VA tools applied for natural disasters in particular, a few tools were selected. In a future study, we plan a more proper investigation also for other potential tools from the area.

5. EXAMINED TOOLS

Three visual analytical tools that are applied in prevention of catastrophes from natural disasters are proposed: A) Canada's Multi-agency Situational Awareness System (MASAS) project, B) the Context Discovery Application (CDA) tool from the Virtual Globes project, and lastly, C) the Coastal Infrastructure Management tool in North Carolina, USA. These tools were selected due to the fact that they already demonstrated benefits in situations of preventing further tragedies during natural disasters.

5.1 Canada's Multi-Agency Situational Awareness System (MASAS) project

The MASAS project is intended to become Canada's National system for exchanging emergency information through the different levels of the emergency management response department [4], that is, the exchange of information may range from local authorities of small communities to Federal Government Operations Centre.

In 2011, the MASAS project was deployed during the flood season on the provinces of Manitoba and Yukon [3]; MASAS proved to be successful at delivering information about the roads that were not accessible due to the floods, moreover, the tool demonstrated to be an easy-to use tool because officials from the two provinces did not require long training hours and they were able to act at the moment.

5.2 Virtual Globes Tool: The Context Discovery Application (CDA)

Virtual Globes (VGs) is a coined term that refers to the global awareness of the disaster situations derived from natural phenomena or humanitarian crises [5]. VGs try to identify dangerous regions before phenomena occur or trace affected populations once the disaster has occurred.

The CDA assists the situational awareness zones of disasters; implicit information is processed from "geographic and thematic references of RSS feeds" of a specified country, which are

converted as reference points and traced out around other areas, thus, a defined map about the beneficial and prejudicial impacts that some areas affect that country is defined. As it was claimed by the United Nations digital service for the coordination of Humanitarian Affairs, ReliefWeb, the evaluation of the CDA proved to be an eminent and powerful tool for the benefit of humanitarian disasters [5].

5.3. North Carolina, USA: Coastal Infrastructure Management (CIM)

The CIM is a suite of different displays of the same data set where users are able to switch between different displays in order to change perception of visualization [6]. CIM's function is to analyse existing coastal infrastructures based on rich coastal data; decision makers can determine potential risk zones of hurricanes.

Data acquisition, data cleaning and analytics, and interactive data visualization are sent through 3D stereoscopic graphics. According to the evaluations made by coastal guards experts [6], this tool offers the capability to monitor with great depth the coastal infrastructure changes and it provides a better understanding of the "oceanic development from multiple aspects".

6. LESSONS LEARNED

As it was mentioned in the first session, the vast amount of data generated by computers simply exceeds human's capacity of interpretation and the VA tools proved to be the solution that can cope with this difficulty, therefore, the countries who have not started to make initial steps on their own VA tools could face difficult situations when trying to accurately predict the potential disaster zones, hence, humanitarian catastrophes can be avoided.

A first lesson from these three examples of situational awareness tools was the importance of considering interoperability, not only when using different technologies, but also for examining research and design of these applications. While interoperability of technologies is important, shown via the MASAS project, it is not necessarily considered in the research environments, according to the CIM study, or to the diversity of possible social applications, according to the CDA project. To communicate with the public includes diverse groups. The diversity with a large amount of different expertise and people with different experiences may cause misunderstanding [2], and therefore set additional requirements on design, requires iterative evaluation and technology insertion in practical usage areas [6].

A second immediate lesson enhances the importance of considering security and privacy issues, already from the beginning, according to the SIM study. An overall description about the lessons from using the three examined tools can be seen in table 1.

Nevertheless, it is important to mention that some of these tools are only on the stage of test and early development; it is too early to start using them in a broader context, e.g. for mass evacuation or for collaboration with other countries. More proper evaluations, and also feedback on experiences from other VA tools, and test cases need to be developed in order to achieve stronger reliability for further used in practice.

TABLE I. TOOLS AND THEIR USEFULLNESS

Tools	Applied	Technology support	Usefulness for governments
MASAS	Establishing a better emergency collaboration in flood seasons.	Open source collaboration tools.	Common ground for understanding alerts, common locations in incidents.
CDA	Uncover what, where and when disaster occurs on the globe.	Google Earth and Web mapping systems.	Understanding numerous locations that affect a particular place.
CIM	Discovering risk zones in coast infrastructures during hurricanes.	Pantograph multitouch techniques.	Trace out coastal regions that could pose a threat in hurricane season.

7. CONCLUDING REMARKS

The VA tools presented in this work provided strong solutions mainly to government agencies and, according to the authorities and experts of disaster management. They can provide new intuitively understandable information and they also can deliver a better insight of information by filtering relevant data. Furthermore, some of the tools proved to have an impact in the resolutions made by decisions makers, that is, a better flow of information was better addressed to local authorities and population about the disasters. Because the tools proved to be effective to curb some catastrophes from natural disasters, we recommend that other governments start developing or adopting this type of tools.

8. ACKNOWLEDGMENT

The main author acknowledges the support of the Erasmus Mundus Lamenitec Programme for the awarded scholarship.

9. REFERENCES

[1] Fekete, J., Wijk, J.V., Stasko, J., & North, C. (2008). The Value of Information Visualization. doi:10.1007/978-3-540-70956-5_1

[2] Heldal, I., (2007) Supporting participation for planning new roads by using virtual reality systems, Virtual Reality, Special Issue for E-society, 11(2), 145-159.

[3] Thomas, J., Cook, K.(2005): *Illuminating the Path: Research and Development Agenda for Visual Analytics.* IEEE-Press.

[4] Pagotto, J., & O'Donell, D. (2012). Canada's Multi-Agency Situational Awareness System – Keeping it Simple. Proceedings of the 9th International ISCRAM Conference – Vancouver, Canada, April 2012.

[5] Tomaszewski, B. (2011). Situation awareness and virtual globes: Applications for disaster management. Computers & Geosciences 37, 86-92.

[6] Wang, X., Butkiewicz, T., Cho, I. & Wartell, Z. (2012). Towards Utilizing Heterogeneous Analytics Interfaces in Coastal Infrastructure Management. Technical Report CVC-UNCC-12-15.