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INTERACTIVE FUNCTIONALITY OF CARTOGRAPHIC INFORMATION SYSTEMS FOR NATURAL HAZARDS DATA

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ABSTRACT

Natural hazards assessment results are often presented in form of cartographic visualizations. Due to the advantages of interactive systems hazard representations are increasingly integrated in web-based information systems. Advantages for general users include the easy access of available data as well as thematic and spatial navigation. Natural hazards experts, however, require more detailed data as well as advanced functionality to carry out their tasks. In this paper we give an overview on functionality and included data of freely accessible Swiss Geoportals, compare them to an expert system, and finally present how this expert system can facilitate natural hazards management tasks.

BACKGROUND AND OBJECTIVES

Cartographic visualizations have proved effective tools for the presentation and assessment of spatial data (Merz et al., 2007). The implementation of such visualizations in digital cartographic information systems adds value through the potential of interactive functionality. Strengths include thematic and spatial navigation, customization of visualizations and querying of spatial data. In case web-based technologies are applied, many users can be reached and provided with information. These advantages led to a quick spreading of such systems and consequently to uncountable versions of graphical user interfaces (GUIs) with varying levels of interactivity.

Interactive systems, however, are only effective when they are adapted to the needs of the users (Cooper and Reinmann, 2003). Hence, a thorough identification of user needs stands at the beginning of every development of an interactive information system. A key point that has to be considered in such assessments of user needs is the amount of offered interactive functionality. Technically, interactive systems can be provided with dozens of functionalities that could be of some use for some users. In practice, however, such a wealth of functionality can become overwhelming for users and decrease the usability of the system. GUI design and the selection of offered functionality are therefore essential tasks during the development of interactive systems. Cron (2006) investigated existing functionality in interactive atlases and presents a structured grouping of these interactive functions as well as suggestions about their implementation in a GUI.

In this paper we focus on interactive systems for the visualization and communication of natural hazards data. Many natural hazard management tasks are based on assessments of potential natural processes (Kienholz, 2005). As these results have a spatial relation, the above mentioned advantages of interactive systems can facilitate the interpretation of hazard related data and are therefore often used in the field of natural hazards management (Kunz et al., 2010). In order to illustrate the variety and the different functionality of existing systems the next section gives an overview and presents a ranking of the offered functionality as well as the included data of selected Swiss systems. After a subsequent discussion of strengths and weaknesses an interactive cartographic information system that has been developed for natural hazards experts is presented and compared to the existing systems.

OVERVIEW OF TEN SWISS GEOPORTALS

The federal structure of Switzerland with its 26 cantons that are responsible for the acquisition and management of official survey data of their territory led to the development of many different solutions of so called Geoportals. Geoportals are web-based interactive systems for the visualization of spatial data, often serving as basis for the purchase of official data. Apart from official survey data these portals often encompass data about other topics such as nature and water conservation, forests, spatial planning, noise protection, natural hazards, and many more.

In order to illustrate the variety of interactive systems for the visualization and exploration of natural hazards data we selected ten Swiss Geoportals from the cantons of Aargau (AG), Bern (BE), Fribourg (FR), Lucerne (LU), Obwalden (OW), St. Gallen (SG), Solothurn (SO), Schwyz (SZ), Zug (ZG), and Zurich (ZH).

In Table 1 available functionalities of the selected Geoportals are summarized and ranked according to the frequency of implementation.

Table 1: Interactive functionality of ten Swiss Geoportals (ranked according to frequency of implementation)

Functionality	AG	BE	FR	LU	OW	SG	SO	SZ	ZG	ZH
Zooming	x	x	x	x	x	x	x	x	x	x
Panning	x	x	x	x	x	x	x	x	x	x
Choice of base map	x	x	x	x	x	x	x	x	x	x
Search	x	x	x	x	x	x	x	x	x	x
Print option	x	x	x	x	x	x	x	x	x	x
Export maps as images	x	x	x	x	x	x	x	x	x	x
Help	x	x	x	x	x	x	x	x	x	x
Measurement tool	x	x	x	x	x	x		x	x	x
Display of detailed information	x			x	x	x	x	x	x	x
Back to last view	x	x	x		x	x	x	x	x	
Back to total view	x	x	x		x		x	x	x	
Redlining		x	x		x	x				
Superimposition of layers					x					

In general, all systems offer a high level of interactivity including interactive zooming, panning, choice of different base maps, a search function, print and export options, a help menu, as well as a layer structure for individual data selection. Some systems even encompass the option of redlining or the superimposition of several map layers.

Apart from interactive functionality the amount and type of available data is relevant for the effectiveness of a system: while some cantons offer detailed intensities and frequencies for hazardous processes, others classify them into hazard levels (hazard map), and some only provide information about the general hazard situation (in form of hazard index maps).

Table 2 lists the data included in the selected Geoportals.

Table 2: Available data

Data	AG	BE	FR	LU	OW	SG	SO	SZ	ZG	ZH
Hazard map (hazard levels)	x	x	x	x	x	x		x	x	x
Hazard index map	x		x	x			x	x	x	
Frequencies	x	x		x		x			x	x
Intensities (classified areas)	x			x		x			x	x

The two presented lists (Table 1 and Table 2) do not allow for any kind of usability or quality statement, as these strongly depend on end users and their tasks. As different hazard management tasks require different levels of interactivity as well as different levels of information, each Geoportal might be optimal for a specific task. Our intention was to provide an overview on openly available Geoportals.

Interactive cartographic information system for natural hazards experts

The above presented Geoportals are freely accessible for the general public (URLs are provided in the reference list). Some natural hazards management tasks, however, require functionality and features that are adapted to the needs of experts. Kunz et al. (2010) suggested functionalities needed by expert users for natural hazard management tasks. Apart from offered functionalities also other map elements contribute to the usefulness and quality of an interactive system; Kunz and Hurni (2011) analyzed hazard representations in general and identified crucial map elements that have to be of high quality in order to provide comprehensible and visually appealing maps.

The suggestions provided in Kunz et al. (2010) and Kunz and Hurni (2011) have been implemented in an interactive cartographic information system for natural hazards experts. The GUI (see Figure 1) is kept lean and contains as few buttons and menus as possible in order to allow for an efficient use without time-consuming training.

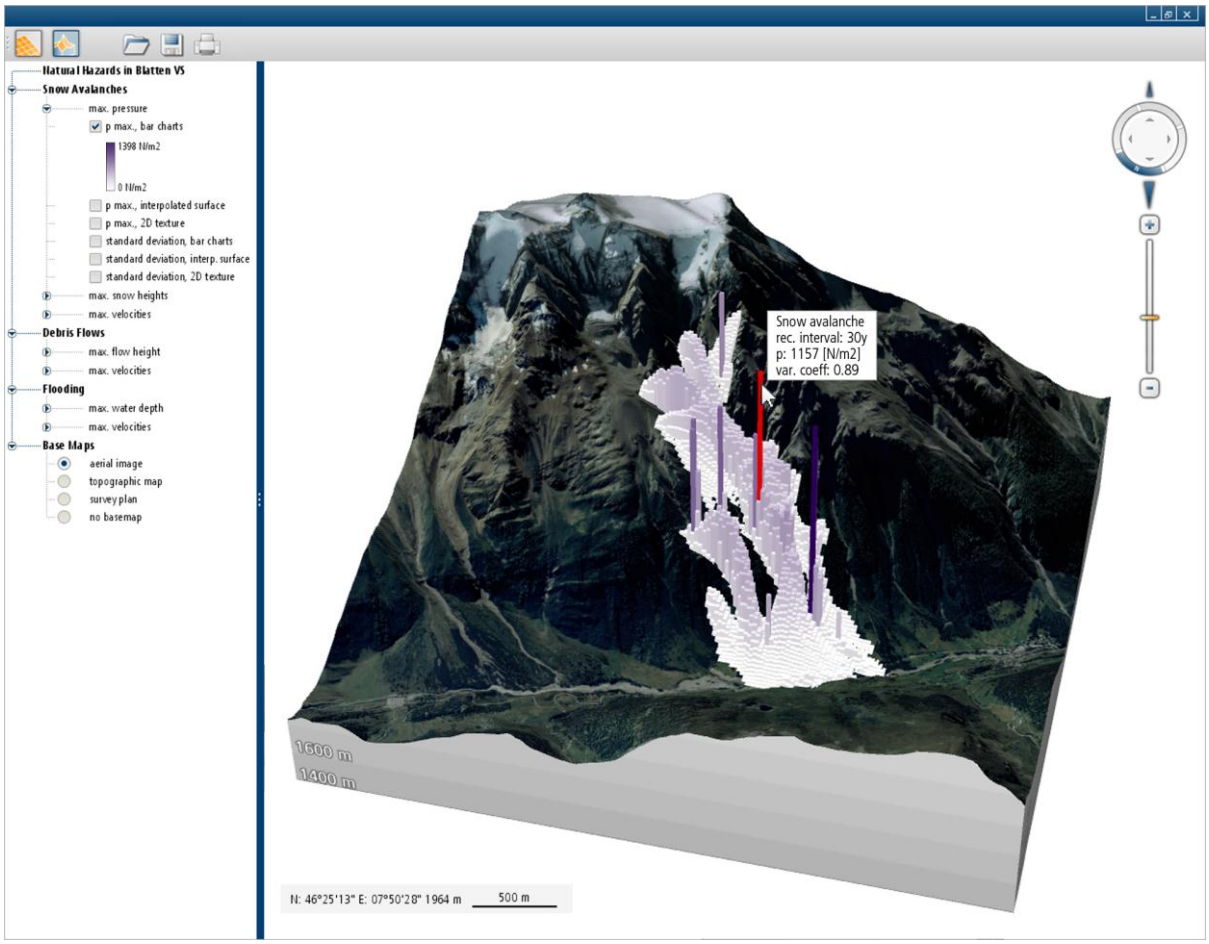

Figure 1: Graphical user interface of our cartographic information system for natural hazards experts

In order to keep the GUI as lean as possible, only the most important standard functionality such as spatial navigation (possible with the help of the navigation tool or mouse and keyboard interactions), thematic navigation (by a layer structure), print and export options and a help menu were implemented.

The main differences between the openly available Geoportals and our expert system can be found in the visualization, the query functionality as well as the option to retrieve information about uncertainties associated with assessment results.

In addition to commonly available 2D maps our system features 2.5D visualizations in form of block diagrams that are supplemented with 3D symbolization such as bar charts (see Figure 1) or interpolated surfaces. These views help to get an overview on the affected area, the terrain as well as the intensities of the processes. If 3D symbolizations cause occlusions that hinder detailed analyses of the data users can switch to 2D mode with only one mouse click. Unlike in most Geoportals, the superimposition of multiple layers is possible. In addition, different visualization methods are available in order to satisfy different user needs. This customization is extended by the provision of different color schemes that can be applied to the visualizations.

Another important feature for expert users is the option to interactively query the data: as original assessment data is integrated in the system, detailed information can be provided. This information is available in form of tooltip windows that appear next to the cursor whenever it is moved over symbolization.

Despite the necessity to communicate uncertainty associated to natural hazards assessment results (e.g. Bezzola and Hegg, 2008), hardly any hazard representation encompasses information about uncertainty. The option to include uncertainty visualizations is therefore another feature that cannot be found in any of the above mentioned Geoportals. Figure 2 shows an example of available uncertainty visualization.

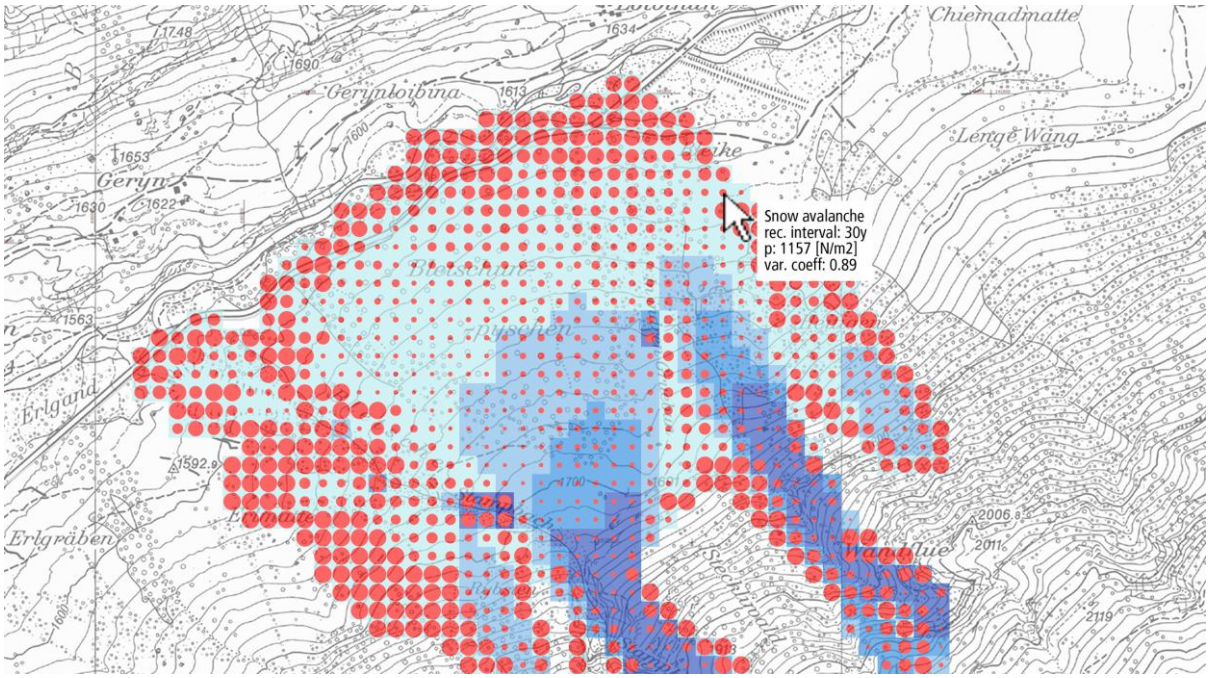

Figure 2: Combined visualizations of snow avalanche impact pressures (depicted in a blue color scheme) and uncertainty information (variation coefficients; illustrated by proportional point symbols)

CONCLUSIONS AND FUTURE PLANS

The overview of freely available Geoportals presented in this paper gives an overview on existing functionality for interactive systems in the field of natural hazards management. While the provided interactivity of the selected Geoportals is generally high, the information level of available data differs widely. In order to make such interactive system suitable for expert users more detailed data as well as further functionality is necessary. We presented an example of such an expert system. Its main features are cartographic visualizations in high quality (available in 2D and block diagram mode), the possibility to interactively query the data and retrieve detailed information, as well as the visualization of uncertainty inherent to natural hazards assessment results. If the inclusion of additional functionality will be required to optimally support natural hazard specialists will be determined by detailed user tests.

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LINKS TO MENTIONED GEOPORTALS

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BE: Geoportal des Kantons Bern, http://www.geoportal.sites.be.ch/site/geo/geo (accessed February 9, 2011)

FR: FR.ch – Geoportal des Kantons Freiburg, http://geo.fr.ch/ (accessed February 9, 2011)

LU: Geoportal Kanton Luzern, http://www.geo.lu.ch/ (accessed February 9, 2011)

OW: Geografisches Informations-System Obwalden, http://www.gis-ow.ch/moz/index.html (accessed February 9, 2011)

SG: geoportal.ch, http://www.geoportal.ch/ (accessed February 9, 2011)

SO: SO!GIS® - Geographisches Informationssystem Kanton Solothurn, http://www.so.ch/departemente/bau-und-justiz/sogis.html (accessed February 9, 2011)

SZ: WebMap SZ, http://webmap.sz.ch (accessed February 9, 2011)

ZG: Geoportal des Kantons Zug, http://www.zugmap.ch (accessed February 9, 2011)

ZH: GIS-Browser Kanton Zürich, http://www.gis.zh.ch (accessed February 9, 2011)

All cantons: http://www.bafu.admin.ch/gis/02915/07203/index.html?lang=de (accessed February 10, 2011)