Beitrag O: Michael Klafft, Agnieszka Dudzińska-Jarmolińska, Ivana Harari, Ricardo Gacitua Bustos, Solhanlle Bonilla Duarte, Teresa Morrobel

A Citizen Science Approach Using Information Systems to Provide Qualitative Information on Historic Natural Disasters to Risk Communicators and the General Public

Michael Klafft[1], Agnieszka Dudzińska-Jarmolińska[2], Ivana Harari[3], Ricardo Gacitua Bustos[4], Solhanlle Bonilla Duarte[5], Teresa Morrobel[6]

[1]*Jade Hochschule Wilhelmshaven and Fraunhofer FOKUS, michael.klafft@jade-hs.de*
[2]*Uniwersytet Warszawski, a.dudzinska-ja@uw.edu.pl*
[3]*Universidad Nacional de La Plata, iharari@mail.info.unlp.edu.ar*
[4]*Universidad de La Frontera, ricardo.gacitua@ufrontera.cl*
[5]*Instituto Tecnológico de Santo Domingo, solhanlle.bonilla@intec.edu.do*
[6]*Instituto Dominicano de Desarrollo Integral, tmorrobel@iddi.org*

Abstract

This paper presents the concept of an ICT tool for collecting existing knowledge in the population on historic natural disasters, and an organizational concept for making this knowledge and experience usable for risk and crisis communication, and discussions with relevant decision makers including politicians. A key focus of the proposed solution is the systematic collection of qualitative information on past natural disasters using a citizen science approach: what did previous disasters actually mean for the everyday lives of the citizens, what was the concrete damage caused by the disaster and what did this damage look like, how did the disasters impact people's safety, their wellbeing, and their economic activities, what type of help was needed (and missing) when the disaster struck, where was it needed, how could people have better prepared themselves, how did the affected population cope with the disaster, what were successful (or unsuccessful) coping strategies. In order to achieve these goals, the proposed software will be able to enrich existing quantitative information on disasters with qualitative experiences in the form of live cases narrated by survivors, and historic (multi) media documentations such as texts, photographs and films on disasters. In order to make this information usable, relevant meta data will be acquired and provided for each contribution, and the information will be archived in an easy to use data base, that allows for an intuitive (visual) presentation of its inputs. In order to assure that a critical amount of input is generated

(and used), an organizational concept involving educational institutions like schools, and universities, as well as volunteer organizations is proposed. The expected advantage of the proposed approach is that it will become clearer to all stake holders what a disaster actually means for the everyday lives of the population. Instead of just relying on disaster statistics, the impact of a potential disaster becomes audible and visible. Multimedia materials from the system can be used to create exhibitions on the local relevance of disasters, which can be used to communicate existing risks to (younger) citizens, as well as politicians and other decision makers.

Zusammenfassung

Dieser Beitrag präsentiert das Konzept einer Software, mit deren Hilfe in der Bevölkerung vorhandenes Wissen über in der Vergangenheit eingetretene Naturkatastrophen systematisch erfasst werden kann. Zudem wird ein organisatorisches Konzept vorgestellt, mit dessen Hilfe sich die vorgeschlagene Software in der Praxis effizient einsetzen lässt. Dabei wird ein „Citizen-Science“-Ansatz verfolgt, der darauf abzielt, insbesondere qualitative Informationen zu vergangenen Naturkatastrophen systematisch zu erheben: wie wirkten sich die Naturkatastrophen auf das alltägliche Leben aus, wie sahen die angerichteten Schäden aus, wie beeinflusste die Katastrophe die Sicherheit, das Wohlbefinden und die wirtschaftlichen Aktivitäten, welche Hilfe wurde wann wo benötigt (und war ggf. nicht verfügbar), was waren erfolgreiche (oder auch weniger erfolgreiche) Krisenbewältigungsstrategien, was hätte man tun können, um sich besser auf die Katastrophe vorzubereiten. Um diese Ziele zu erreichen, reichert die vorgeschlagene Software vorhandene quantitative Informationen zu Naturkatastrophen mit subjektiven Erfahrungen Überlebender in Form von (Audio-)Berichten an und archiviert vorhandene historische multimediale Materialien wie Fotos, Film- und Textbeiträge über die vergangenen Katastrophen. Um diese Informationen nutzbar zu machen, müssen bei der Dateneingabe für jeden Beitrag relevante Metadaten erfasst werden. Zudem sollen die in einer Datenbank erfassten Inhalte über ein Front-End wie z. B. eine Webseite zugänglich sein, wobei besonderer Wert auf eine intuitive visuelle Repräsentation der Inhalte gelegt wird. Um sicher zu stellen, dass für die jeweilige Anwendungsregion auch eine ausreichende Menge an Beiträgen generiert wird, schlagen die Autoren ergänzend ein organisatorisches Konzept vor, das auf einer Zusammenarbeit mit Schulen, Hochschulen und Freiwilligenorganisationen aufbaut. Vorteil des hier präsentierten Ansatzes ist es, dass allen Stakeholdern, aber auch den Bürgern deutlicher wird, was die lokal relevanten Naturkatastrophen für die Bevölkerung konkret bedeuten, da die Auswirkungen hörbar und sichtbar werden. Die vorhandenen multimedialen Materialien aus der Datenbank können dann vor Ort dazu genutzt werden, die

Risikokommunikation zu unterstützen (zum Beispiel durch den Download als Unterrichtsmaterial, aber auch durch die Nutzung der Materialien in Ausstellungen zu den örtlich bedeutsamen Naturkatastrophen).

1 Motivation

Existing technical solutions that ask citizens to provide information on disasters focus on the present and the future. Mee and Duncan [Mee & Duncan 2015], for example, developed a concept based upon the Dewetra tool to monitor ongoing volcanic activity in Saint Vincent and the Grenadines with the help of local citizens. Web-based tools like Ushaidi have been used to gather information on ongoing disasters with the purpose to coordinate relief efforts by volunteers [Gao et al. 2011]. However, these solutions do not focus on gathering and using experiences from historic disasters for risk communication purposes. Data bases on historic disasters, such as EM-DAT [Center for Research on the Epidemiology of Disasters 2018], focus on the quantitative aspects such as lives lost and damage caused, but provide little insights on the qualitative impact on societies and everyday lives. Communication research, however, points towards the persuasive power of narratives in risk communication. [Ricketts et al. 2010] found that narratives are 19% more effective in promoting safety behavior, compared to non-narrative communication approaches, and narratives achieved this goal without inducing fear in the audience. [Janssen et al. 2013] point out that narratives are suitable to increase risk awareness in a health risk context, and [Dahlstrom 2014] showed that narratives “offer increased comprehension, interest, and engagement” when communicating about scientific topics. Given the fact that all natural disasters are caused by scientific phenomena, this provides an argument for including narratives in risk communication on natural disaster risks. Existing data bases, however, are not providing suitable materials for this communication approach. With the proposed solution, we intend to close this gap.

2 Approach

In order to address existing information gaps on historic disasters, we propose an easy-to-use technical solution (for information collection, retrieval, and presentation), and an organizational concept how the tool can be embedded in existing risk-communication and urban planning strategies.

2.1 Organizational strategy

The goal of the organizational concept is to motivate citizens to participate in the data collection effort by providing eyewitness accounts and historic media material on high-impact, low-frequency disasters. The organizational concept will be based on the following approaches:

- Data collection activities will be included in courses at universities and higher educational institutions. This can be achieved as part of courses on risk and crisis communication, urban planning, or disaster management. Media projects conducted as part of journalism and media science programs can also collect and use information on historic disasters to create exhibitions or multimedia features on disaster types of regional relevance. The feasibility of this approach has been shown – among others – by [Mucha 2017] who designed and produced a radio feature on the snow catastrophe in Eastern Frisia in 1979, based upon archival materials as well as interviews with stakeholders affected by this disaster (citizens, and disaster managers).
- Acquired multimedia contributions on historic disasters will be provided to geography and history teachers for download, who can then use the material in their classes at school. The materials will also be of interest for extra-curricular learning places who often provide teaching modules on natural hazards and disasters - for example on flooding of rivers [Restrepo 2016] or on the history of coastal protection and climate change [Lernort Technik und Natur 2017].
- A prerequisite to maximize the impact of the proposed data base will be to cooperate with stakeholders such as disaster management organizations, volunteer organizations, urban planners, and policy makers to match content from the data base with current disaster prevention and coping strategies, and urban planning activities.

Finally, these activities shall be extended by workshops or townhall meetings to initiate a dialogue between local government and citizens, in order to discuss disaster prevention measures, as well as measures for adaptation to climate change. This so-called social participation approach mobilizes the society to participate in the changes to be made in a given area. The approach is also required by the Aarhus Convention, which imposes a duty to inform the society about decisions connected with the natural environment and having an effect on the functioning of social groups [Sobiesiak-

Penszko 2013]. As a result, (trustful) relations are established between the public administration and the citizens, and decision makers gain additional knowledge and experience which they do not possess yet [Siemiński 2007]. This also allows for mitigating complications and conflicts during the implementation of planned solutions (such as inconveniences caused by construction works during the transformation period).

As proposed in [Cremer et al. 2013], interviews or workshops with a wide circle of specialists (risk and crisis communicators, urbanists, architects, landscape architects, hydrologists, metrology specialists, etc.) should be conducted, in order to make the proposed citizen science approach in data collection more effective. Specialists will specify what contributions they need most to create a specific strategy for risk and crisis communication, or for adaptation of a given area to climate changes. To stay focused, risk communicators and urban planners need to delimit the areas requiring data collection activities. In case of floods, stakeholders can build upon the “Copenhagen Cloudburst Formula” as described by the [American Society of Landscape Architects 2016], and empiric data obtained from local communities (including the elderly, who have unique knowledge and experience connected with historic disaster incidents). In order to make citizen participation as seamless as possible, contributors from society should be given the freedom to choose time and place for the handover of information, which increases the outreach to various social groups [Jezierska 2015]. The result should be the creation of the so-called social coverage and its interpretation during the common discussion, during with the social history of disasters will be reconstructed and the experiences connected with it will be shared [Jarosz & Gierczyk 2016]. Subsequently, the obtained information must be interpreted and design solutions must be adapted to specific areas, along with an additional analysis of socioeconomic benefits and costs in accordance with the Copenhagen Cloudburst Formula [American Society of Landscape Architects 2016]. Once possible solutions have been designed, another important step will be to engage in a dialogue with the society and to present (in a clear manner adapted to a given social group) the created solutions, using proper tools, such as: discussion or activities of "Planning for real" type, i.e. explanation of proposed solutions through their visualisation on large models of city parts or through visual presentations [Cremer et al. 2013]. It is important that the dialogue goes both ways. The last step is the process

of implementation of the solutions and their monitoring. Participation of citizens in adaptation of urban areas to negative effects of climate changes is to be planned on a long-term basis.

2.2 Technological implementation

In order to support the organizational approach, an information system to collect and provide qualitative information on historic natural disasters has to be developed. This technical solution should comprise

- an easy-to-use smartphone app and website that allows volunteers (or elderly people themselves) to collect, categorize, and visualize information on and experiences with past disasters, such as historic photos, eyewitness reports on disaster impact or on historic observations from nature, drawings, sketches, etc.
- a back-end for information storage, including a tool used by moderators to validate and approve new users, as well as entries into the data base,
- a website for information retrieval (both using map-based multimedia presentations as well as a functionality for the download of specific content).

2.2.1 Architectural considerations

In order to implement the proposed solution, the authors propose a layered-architecture as illustrated in Figure-1.

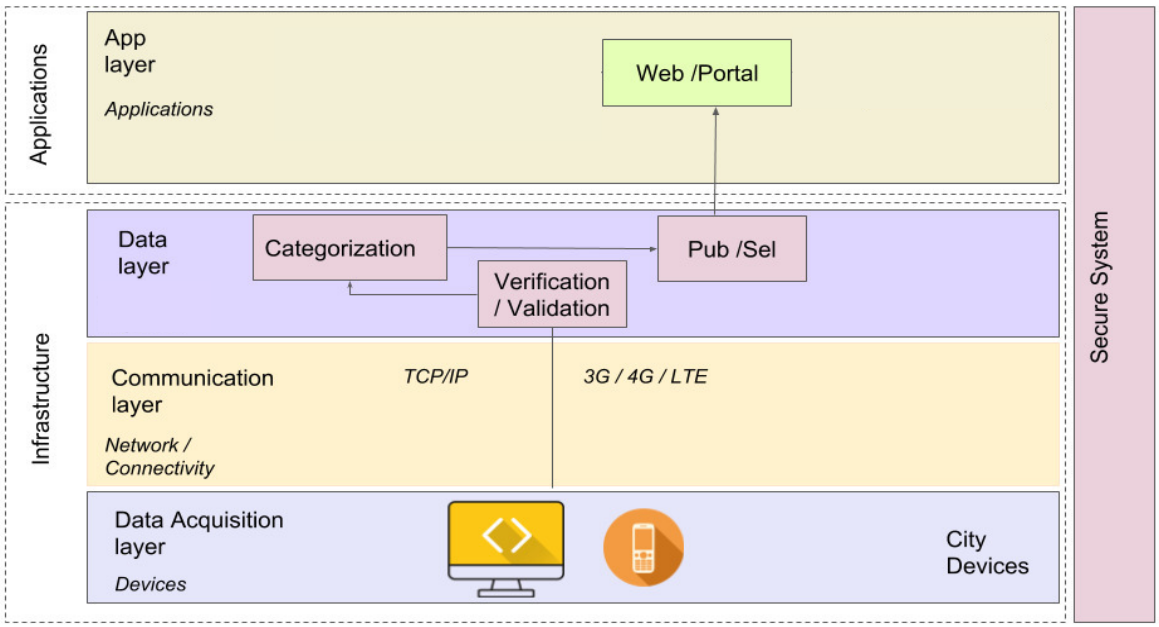

Figure 1: Architecture of the system

The architecture comprises four main layers, which are described as follows:

- *a. Data acquisition layer*.

  The bottom layer of the architecture is the data acquisition layer. Devices to acquire data will mainly be smartphones or desktop computers, which will be used to upload photographs, text, audio files, etc. Smartphones are well suited for data acquisition by volunteers who visit disaster survivors, and they usually provide functionalities for content collection such as microphones for audio recording and a camera. However, some initial discussions with seniors who experienced disasters indicate that this target group may prefer stationary computers to provide their multimedia contributions to the system, so that both a mobile and a desktop version of the data collection tool are needed. Please note that some basic meta data on the multimedia materials is also collected in this layer.
- b. *Communication layer*.

  The communication layer supports the connectivity of data acquisition devices with the data base, using protocols such as TCP/IP (and HTTP/HTTPS and RESTful approaches on those).
- c. *Data layer*.

  This layer stores the data provided by the input devices and provides the ability to process and act upon these data. This layer comprises three main components:
  - a *verification / validation module*, which performs some (automated) procedures for checking that the input data is related to disaster events and complies with minimum input requirements.
  - a categorization *module*, which uses, among others, taxonomies of disasters and timelines to further classify input materials into different contexts and situations (context-based grouping of related contributions based upon contribution properties and their metadata). This will be needed because many end-users of the systems may be laypeople (e.g. history teachers) who will not be able (or do not want to) perform sophisticated queries on the database and may want to be easily provided with material on certain situations.
  - a *publication / selection module*, which provides contextualized multimedia materials to the end-users' front end(s).

- *d. Application layer.*
  This layer contains the application that present the database's content to end-users like citizens, teachers, or urban planners. Initially, this shall contain a visualization component with different filters (e.g., based upon disaster types or situations), as well as a download functionality to provide multimedia materials to end-users for their further use. Future extensions to third party applications shall be possible. Please note that the application may also be used to access hardware resources in the data acquisition layer (if run on the data acquisition device).

2.2.2 User interfaces

Technology acceptance models [Davis 1985] indicate that ease of use is a key factor influencing the adoption of an IT system. It is therefore essential to make it very easy for the system's users to contribute input on disasters, and to access information on disasters. Figure-2 provides an initial interaction design idea for the desktop version of the site for collecting input on disasters from citizens. Besides information on the contributor, it provides the opportunity to upload audio and video files, photos, and to post written disaster reports. Meta data are collected by selecting the relevant incident type(s), as well as location information and information on the date to which the new contribution refers. Some help functionalities are also provided so that users may contact a moderator if they experience problems with the website. One possible approach to implement quality assurance would be to introduce peer-to-peer reviewing, where other users who experienced the same situation / context are asked to review new contributions. This may be implemented in addition to a reviewing tool for moderators / administrators, who should also be able to assess contributions (and eventually reclassify or delete them).

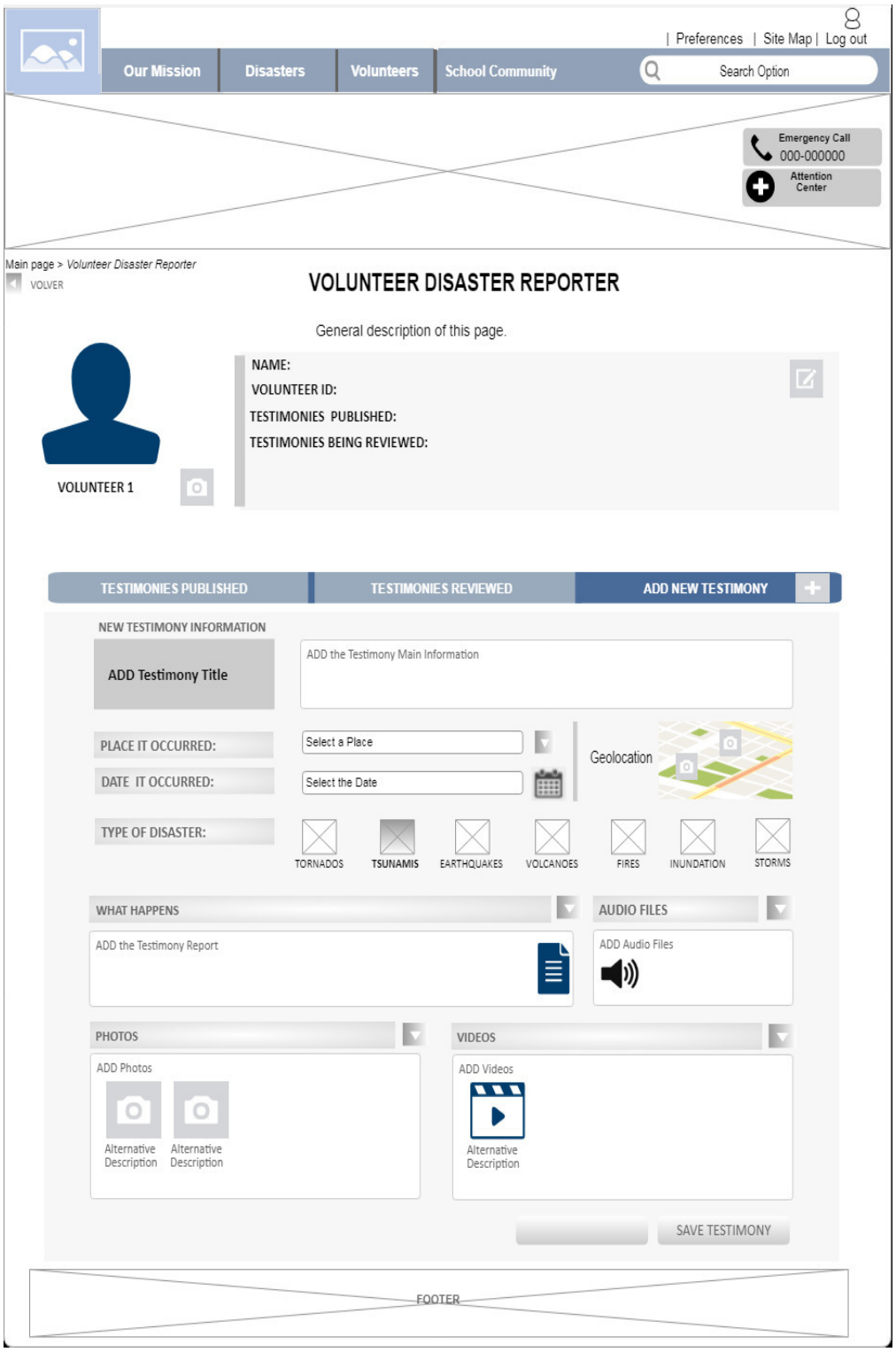

Figure 2: Wireframe of the site for collecting input from citizens

Similarly, user experience for end-users of the system such as risk communicators, teachers, or urban planners shall be smooth. One feature of the proposed system is to arrange contents related to specific contexts / situations. This could be specific disasters, as displayed in Figure 3.

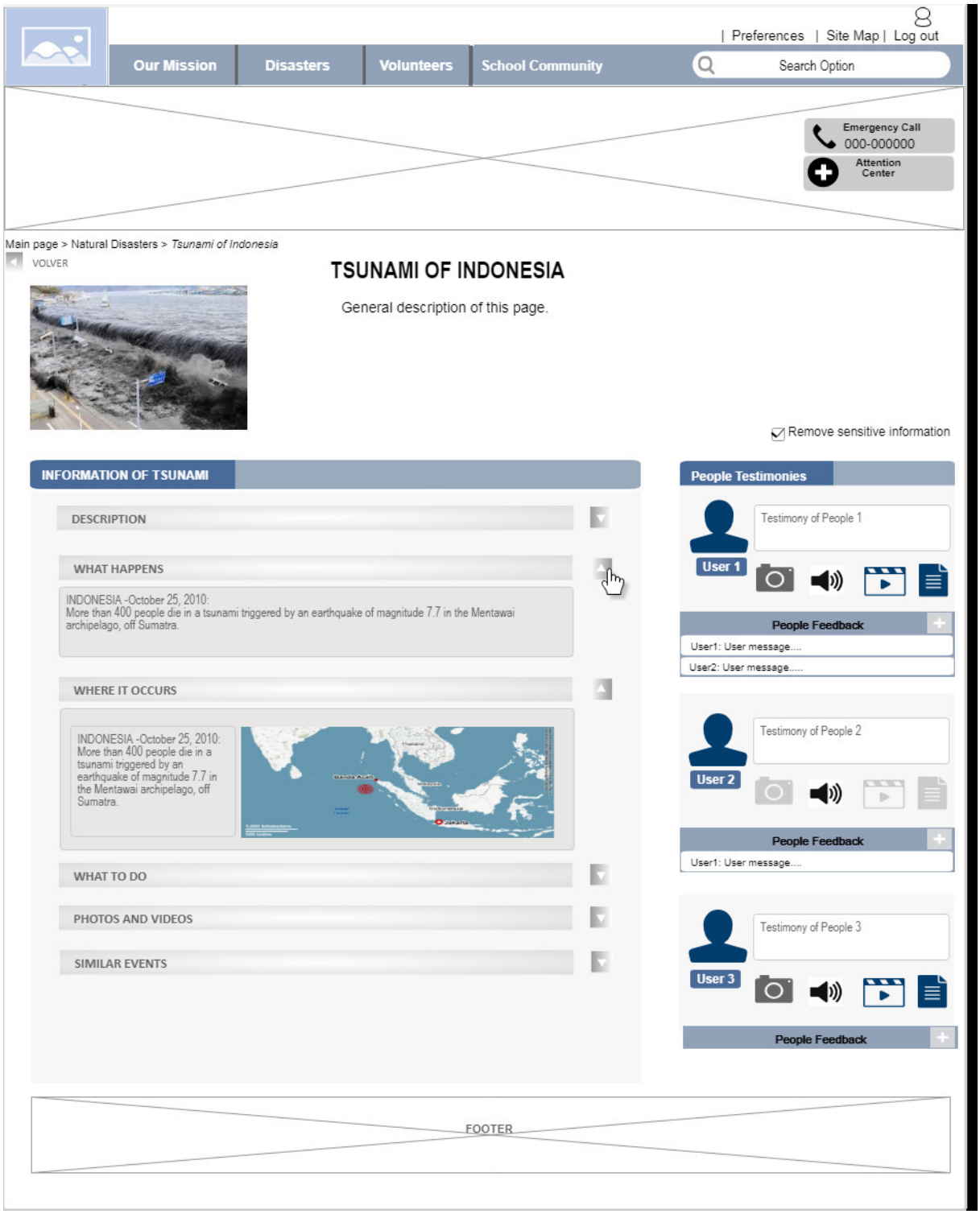

Figure 3: Situation-based view providing materials related to a defined incident

Additional screens to be included in the application shall be a map-based view, as well as a site to query the data base content in line with customized search parameters.

3 Conclusion and Outlook

This paper provides an initial idea how qualitative information and multimedia materials on historic disasters may be collected using a citizen science approach and an IT tool, and how this material may be made accessible to stakeholders such as risk communicators or urban planners. Please note that at the current state, the presented solutions display the authors' own initial ideas, and have not yet been discussed in depth with possible end users. Once a detailed requirement analysis has been completed, the proposed approach will need to be adapted, detailed, and refined.

4 References

American Society of Landscape Architects (2016). *The Copenhagen Cloudburst Formula: A Strategic Process for Planning and Designing Blue-Green Interventions*. https://www.asla.org/2016awards/171784.html (accessed June 4th, 2018)

Center for Research on the Epidemiology of Disasters (2018): *EM-DAT – The International Disaster Data Base*. http://www.emdat.be/ (accessed March 23rd, 2018).

Cremer E., DeCicco A., McCann C., Rivas A. (2013) Managing climate change - Sjællandsgade as a Green Corridor, Worcester Polytechnic Institute, Worcester, MA https://web.wpi.edu/Pubs/E-project/Available/E-project-050613-135037/unrestricted/eCDR_Managing_Climate_Change.pdf (accessed June 3rd, 2018)

Dahlstrom. M. F. (2014): *Using narratives and storytelling to communicate science with nonexpert audiences*. In: Proceedings of the National Acadamy of Sciences of the United States of America 111(4), 13614-13620.

Davis, Fred D. (1985) *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. Cambridge: Massachusetts Institute of Technology, 1985.

Gao, H.; Barbier, G.; Goolsby, R. (2011): *Harnessing the Crowdsourcing Power of Social Media for Disaster Relief*. In: IEEE Intelligent Systems 26(3), 10-14.

Jannsen, E.; van Osch, L.; de Vries, H.; Lechner, L. (2013): *The influence of narrative risk communication on feelings of cancer risks.* In: Health Psychology 18(3), 407-419.

Jarosz E., Gierczyk M. (2016) *Photovoice in social research and activities*, Pedagogika Społeczna 60, 167 – 181.

Jezierska K. (2015) Dialog obywatelski w Szwecji, http://partycypacjaobywatelska.pl/wp-content/uploads/2015/09/2d_dialog_obywatelski_szwecja_raport_z_desk_research2.pdf (accessed June 3rd, 2018).

Lernort Technik und Natur (2017). Themenkatalog. https://www.lernort-whv.de/fileadmin/Dokumente/Themenkatalog_2017.pdf (accessed June 4th, 2018).

Mee, K.; Duncan, M.J. (2015): *Increasing resilience to natural hazards through crowdsourcing in St. Vincent and the Grenadines*. Nottingham: British Geological Survey.

Mucha, H. (2017). *In Nature's grasp – the snow catastrophe in February 1979 in Friesland and Wilhelmshaven: Production and Conceptual Design of a Radio Feature* (in German). Bachelor Thesis, Wilhelmshaven: Jade University of Applied Sciences.

Restrepo, S. (2016). *¿Por Qué Desbordan los Rios?*, Catalejo 9, 10-11.

Ricketts, M.; Shanteau, J.; McSpadden, B.; Fernandez-Medina, K.M. (2010): *Using stories to battle unintentional injuries – Narratives in safety and health communication*. In: Social Science & Medicine 70(9), 1441-1449.

Siemiński W. (2007). *Goals and participles of social participation in spatial planning*, Człowiek i Środowisko 31, 37-59.

Sobiesiak-Penszko P. (2013) (Ed.). *Prawo a partycypacja publiczna pod redakcją*, Instytut Spraw Publicznych, Warszawa.