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Crowdsourcing with mobile techniques for crisis support

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ABSTRACT

The responsibilities deployed from the central authorities to local levels acting as first actors of civil protection are a changing pattern in natural hazard management. Prevention and preparedness are long-term goals, rooted in the competence of volunteers, and on the awareness of the citizens as local inhabitants. MAppERS (Mobile Application for Emergency Response and Support) relies on people as "crowd-sourced mappers" through mobiles application. The feedback received from testing and training courses aims to raise participation in a networked disaster response. The goal was to design a mobile application with a real-time dashboard for public citizens and volunteers of civil protection. Two pilot study cases were selected that included trainings on modules, verification of the usability and the quality of the product. The synchronized platform shows the activity of the cloud data collection with a central data dashboard. A first section of the application focuses on floods processes by gathering data from local population, and contributes to awareness and long-term preparedness. The second section of the application tests pre-emergency actions on field with rescue teams, collecting the condition of the hazards.

Keywords: natural processes, crowdsourcing, mobile, citizens and volunteers

INTRODUCTION

The collective effort of users as "crowd" for problem solving is an innovative approach developed in recent years (Nguyen et al., 2016), especially for rescue services and government authorities (Pedersen et al., 2013, Sievers, 2015). The crowdsourcing method creates a network of citizens-scientist to update a specific content, and governance gradually spreads the responsibilities from central to local authorities, reducing costs for data acquisition (Fienen & Lowry, 2012). MAppERS project deals with human sensors towards mobile application (MA) as crisis support for natural hazards and prevention of exposed people. The MA splits into module MAppERS-V (MP-V) for volunteers and module MAppERS-C (MP-C) for citizens, as first actors within the strategies of surveillance (Frigerio, 2015). Training and piloting fulfil a long-term objective of participation and crowdsourcing, according to the priorities set by the Hyogo Framework. The empowerment of the population reduces the complexity of emergency management and the training curricula promotes

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awareness with the right terminology through a MA. The Graphical User Interface (GUI) implemented within MA offers a communication scheme. The usability of MA integrates efficiency, effectiveness, accuracy, easiness and error tolerance (Quesenbery, 2003). The review of other existing solutions suggests layout, navigation, accessibility, icons setup and text guidelines (Graham et al., 2011, Wong, 2011).

MAPPERS APPROACH

The modules MP-V and MP-C empower "crowd-sourced mappers" with geo-located information and field survey tests. Citizens and volunteers promote self-awareness and contribute with hazard-relevant information through the mobile.

Frederikssund-Halsnæs Fire & Rescue Service manages 372 km² in Denmark; subject to powerful storms it requires a distributed vigilance implemented through the support of the local population. MP-C offers a *Citizens Kit* available for citizens that are voluntarily registered, maintaining proper training for safety measures, and providing geo-located data required by rescue service. Consequently, MP-C improves the people's awareness as long-term aim and offers the possibility to provide real-time information within crisis.

Helsinki City Rescue Department coordinates a complex multi-risk reality for the entire capitol city of Finland. The primarily target of the organization is the safety of life. MP-V aims to simplify the management of resources and roles of the volunteers, by growing the quality of on-field reports and set quickly a local-based prioritization of personnel. MP-V is a *Volunteers Kit* for rescue crews, to organize real-time and standard information for damages during crisis. Crowdsourcing offers decentralization of skills and rapid data gathering without being invasive for emergency procedure.

ARCHITECTURE AND SERVICES

MAppERS includes data transfer services, set of modules and a dashboard. During piloting, the participants feedback was essential for both modules, while the test provided criteria of content aggregate, bug-fixing and optimization in an Android environment. With the mobile phone, any measurement is in real time and in an easy-to-use kit. The service links an ID number and a photo, with control on image size. In Figure 1 for example, the water level gage indicates in continuous the height (centimetres). The "Send" button updates the tables in MySQL DB and within dashboard by PHP Webserver. Within the water level chart, an image URL shows the photos and a slide bar controls visibility by date range.

Several dropdown menus allow users to select by long lists of text and updates personal profiles, that can be observed through the dashboard. Within the "protection measures" as example, users can enlarge menu and check text in own profile as a sort of personal guidelines. The kit offers capacity to update the profile that is automatically saved after editing.

A geo-located upload by the users combines a real time mapping with spatial data, as example of public involvement (See et al., 2016). In Figure 2, a family team can upload the details required by rescues service for safety in case of crisis. The "jQuery autocomplete service" wraps the geo-located database by the public registry office. The data appears visible in the dashboard and linked to external QGIS project. The multi-users access by GPS with classified dots is active simultaneously.

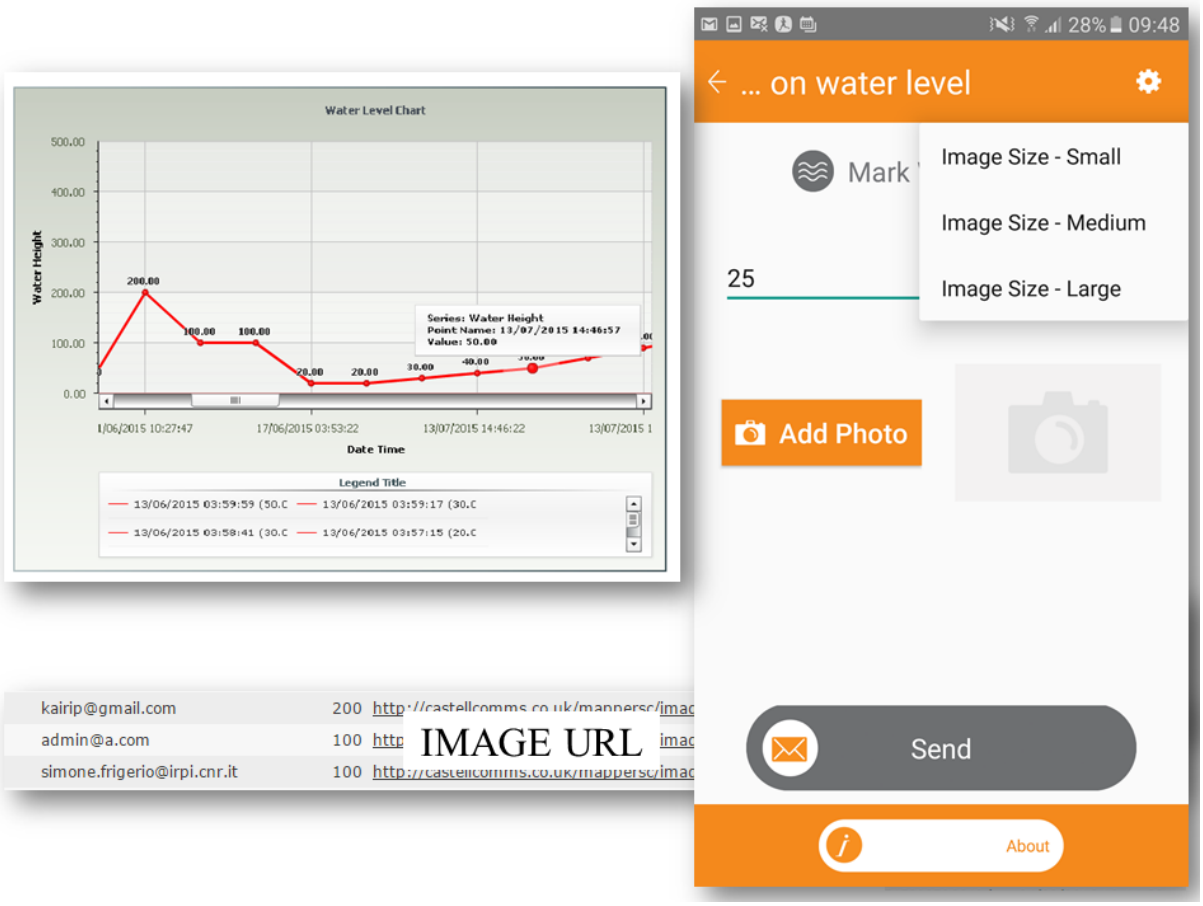

Figure 1. Screen for water level chart. Tool and dashboard graph.

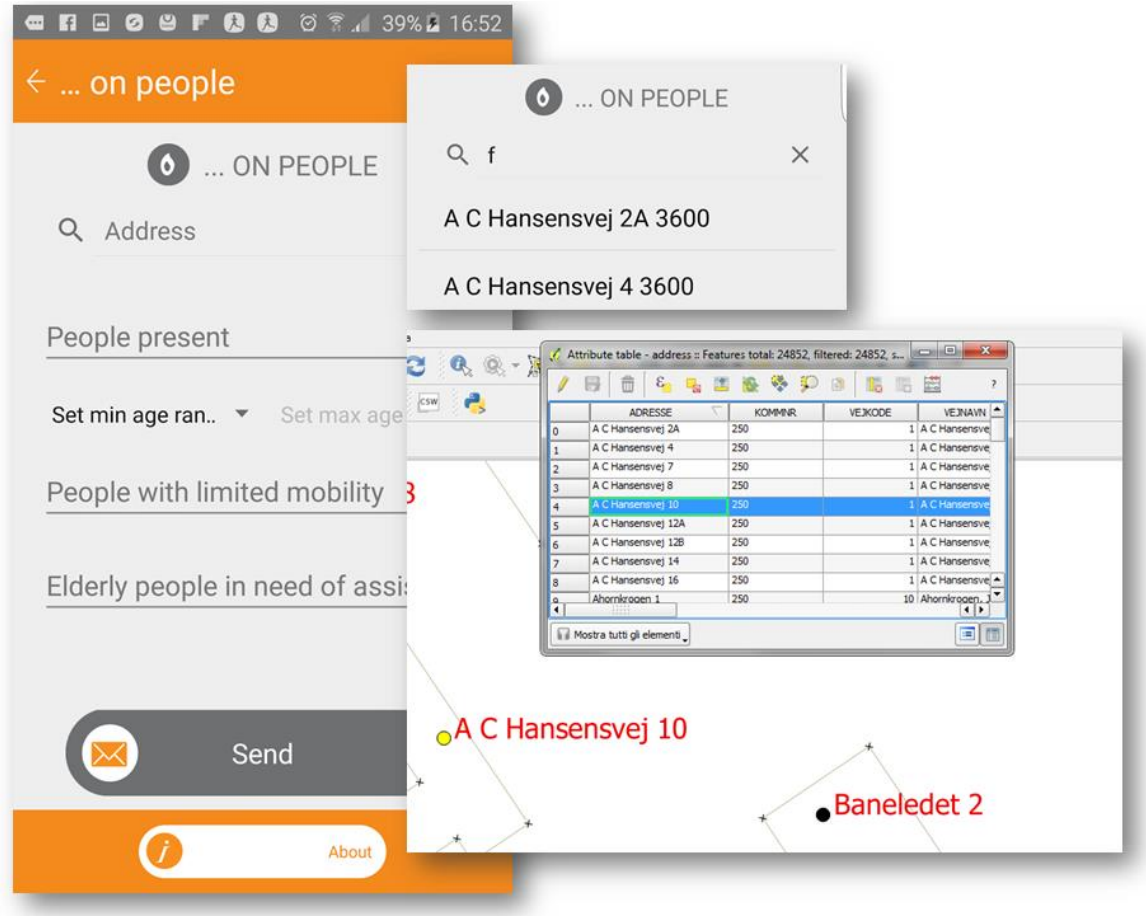

Figure 2. Upload details required with geo-location.

Clusters of visualization are customized into the kits. As example in Figure 3, volunteers allow geo-positioning recognition and survey the threat of live as required. The presence of *not on-going life threat* as green dot or *on-going life threat* as red dot is represented by easy-to-use buttons. The location and tracking of each mobile are visible and classified by life threat status for volunteers on field. ID codes of all volunteers on field are visible within *priority map* of rescue squads, while details of the contacts are visible only in the dashboard.

A free text upload appears as an active tool in dropdown lists and a pop-up display emerges for update. The service is able for single users, while the author and the text appear in the dashboard. In a list "Type of Event" for example, a new text enriches a menu if it is confirmed by other users. The update of the list is not automatic, as the rescue managers evaluates content and practicability.

A geo-located service for emergency message fixes a text, that is previously prepared and request for safety. The text can be modified and saved within the profiles, while geographical coordinates depends on the user location. *Retrieving phonebook contacts* loads a list by mobiles and not by profile. Multiple contacts, previously added and customizable, are available for direct send by mobile.

The dashboard allows data management in real time toward PHP Web Server and MySQL DB (Figure 4), this is essential for bug-fixing during piloting and data control for evaluation. Users

have access to proper module (MP-C or MP-V) or both (Administrator). Dataset has the same graphic criteria and order as the MA, and the tables cope with full dataset in real-time. The field "Damage" as example, or "Search for" are criteria for order and filtering data, allowing visualization and furthermore analysis.

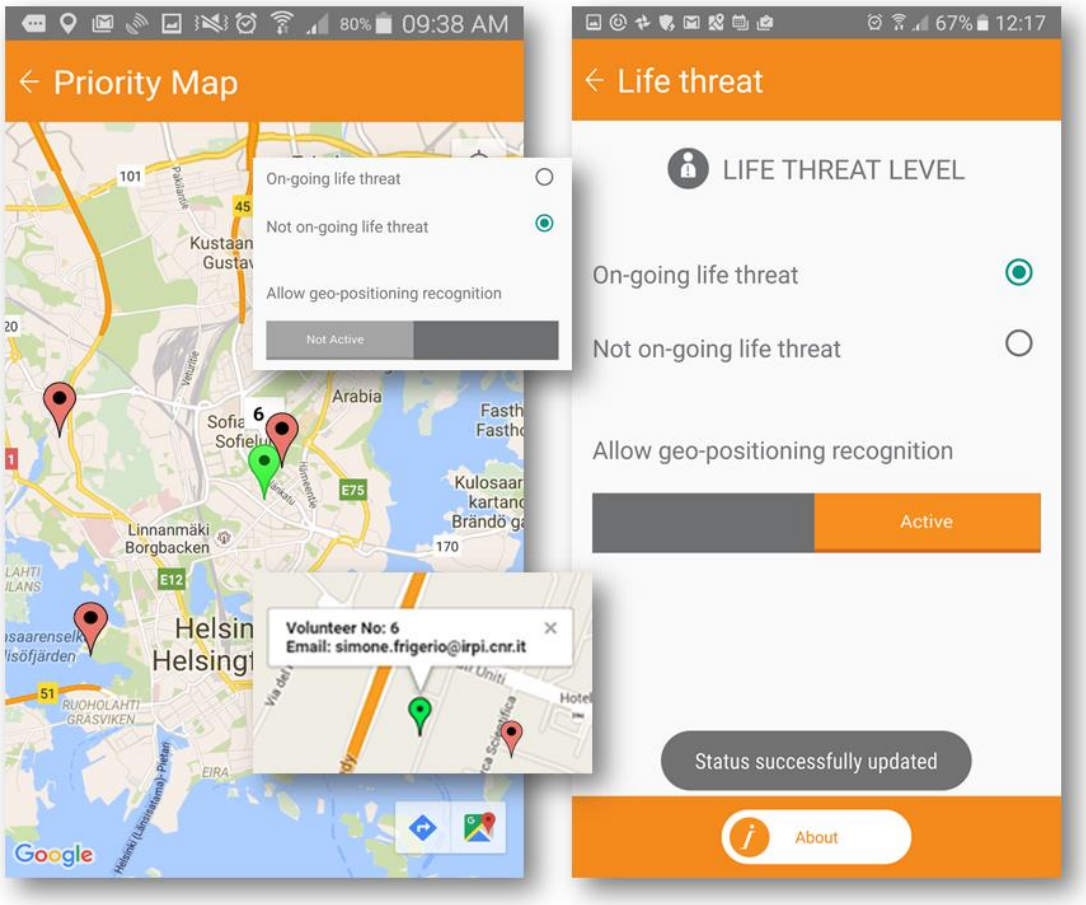

Figure 3. Level of threat of life located by GPS, classified on screen (Map data©2016 Google).

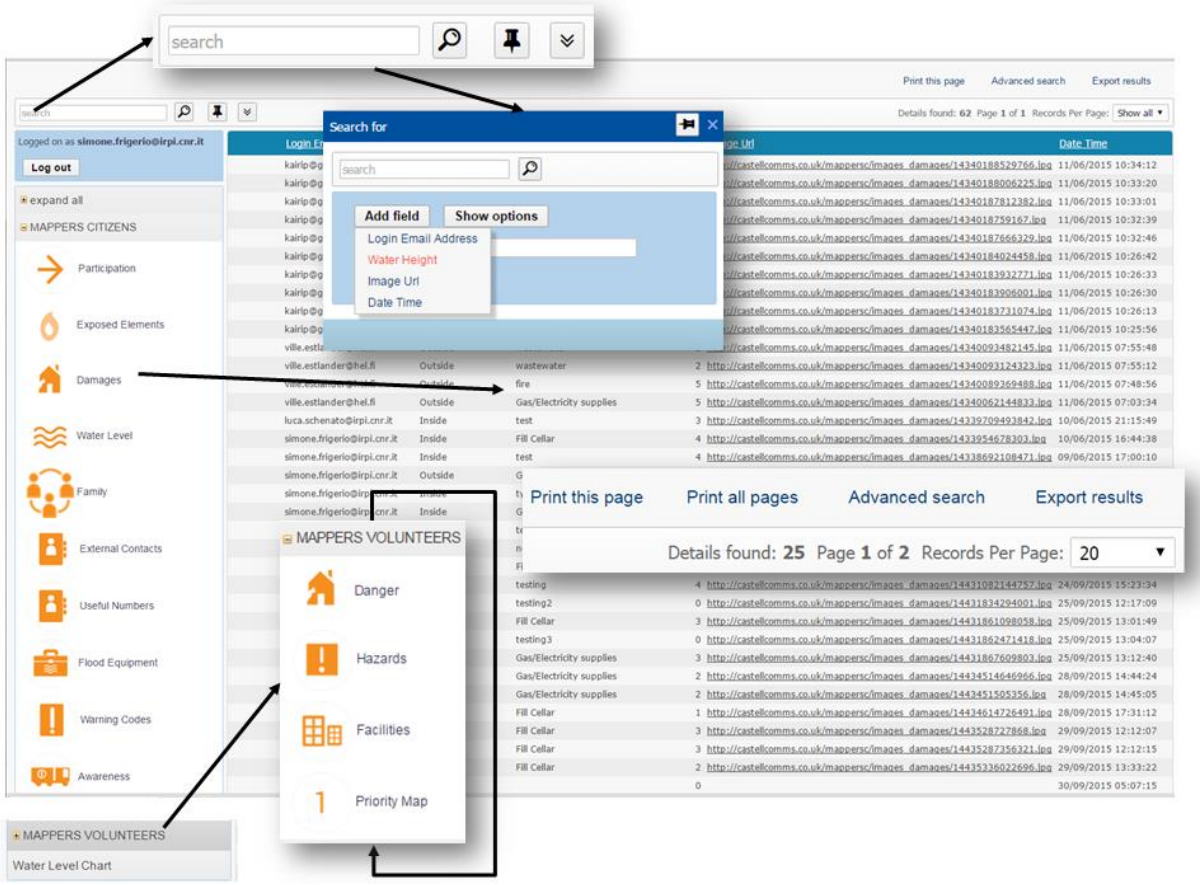

Figure 4. Dashboard architecture with services and dropdown menu.

CONCLUSIONS AND PERSPECTIVES

MAppERS works with mobile technologies and a dashboard to support rescue services. Data transfer is available and bi-directional between users and rescue teams, while contents and guidelines are enriched with active updates during piloting. The MA includes a large research for those parameters crossed on existing examples at world level, identifying best solutions as guideline. Users accede both modules (MP-C and MP-V) with a common screen for registering and sign-in. The MA assumes local languages after installation (Danish for piloting experience).

MP-C includes a crowdsourcing tool for personnel preparedness and real-time reporting. Each citizen participates after a training, including personal information of family, and geo-located vulnerable data (inhabitants, age range, people with limited mobility and elderly people with need of assistance). The kit includes a real-time tool to report infrastructural damages inside or outside buildings, involving supplies, basements and people present. Citizens can also mark water level, writing water height in cm. Both crowd contributions validate surveys by a compulsory photo within a slide bar. In addition, the MP-C includes a tool of long-term preparedness for a familiar group. Citizens access to a user-friendly kit of flood protection measures, organized by contents

(e.g. flood boards, sand bags, flood controls, drain sealers), combined with preparedness measures to check and tick the proper materials available. The update of dataset appears constantly in the personal profiles and it is visible in the dashboard (e.g. documents, energy supply, medicine measures, food and water).

The MP-V embraces a fast data crowd during crisis, for trained squads of rescue services. Users acquire real time information on visible state of danger that is associated to the capacity to localize a source. The MP-V gathers details on the event (e.g. type of accident, material state, spilling on course, oil level) followed by facilities exposed (e.g. numbers and type of buildings, kind of surroundings, services damaged). Volunteers can reveal the threats of life or "peace time" during the surveys. MP-V integrates in real-time the geo-location of field surveys, tracking the users who appears classified by life threat. In addition, the volunteers map shares position of users, offering automatically a geo-tracking of rescue teams.

The idea of crowdsourcing was tested directly in two study areas, for involvement and self-preparedness. The piloting supported bug-fixing during the experience and the collection of a first dataset for testing (Table 1).

DATA ID	SLIDE TEXT	DATA NAME	DATA RECORDS	KIT
Citizens Kit (MP-C)				
1	Participation	Crowd Sourcing Participation	22	CROWDSOURCING
2	Exposed Elements	Crowd Sourcing Exposed Elements	13	
3	Damages	Crowd Sourcing Damages	62	
4	Water Level	Crowd Sourcing Water Level	45	
5	Basic Info	Save Family	21	PERSONAL FLOOD PLAN
6	Basic Info	Save External Contacts	21	
7	Useful Numbers	Save Useful Numbers	21	
8	Flood Equipment	Save Flood Equipment	21	
9	Warning Codes	Save Warning Codes	21	
10	Awareness	Save Awareness	20	
11	Insurance Cover	Save Insurance Cover)	21	
Volunteers Kit (MP-V)				
1	Danger	Danger	74	DANGER SURVEY
2	Hazards	Hazards	59	
3	Facilities	Facilities	42	

Table 1. Slide text and data collected within piloting.

Within simulations the MP-C assembles the reports with predominance of water levels and damages, as cause-effect of a floods event, often redundant for single-family team. The kit for the personal flood plan emerges homogeneous within all users datasets, because it offers a long-term kit and therefore completed once and updated if required. Data records of MP-V are abundant and homogeneous, due to a synchronized "quick danger" survey. The data crowd is suitable within crisis, and thus the MA is user-friendly and quick data gathering tool (Bianchizza & Frigerio, 2015).

Most of dropdown menus have a final choice: “Other”, originally introduced to update lists with benefits of users. The idea was a feedback during piloting to enlarge data catalogues, but then kept permanent to allow customization after periodic check on dashboard by rescue service (Figure 5).

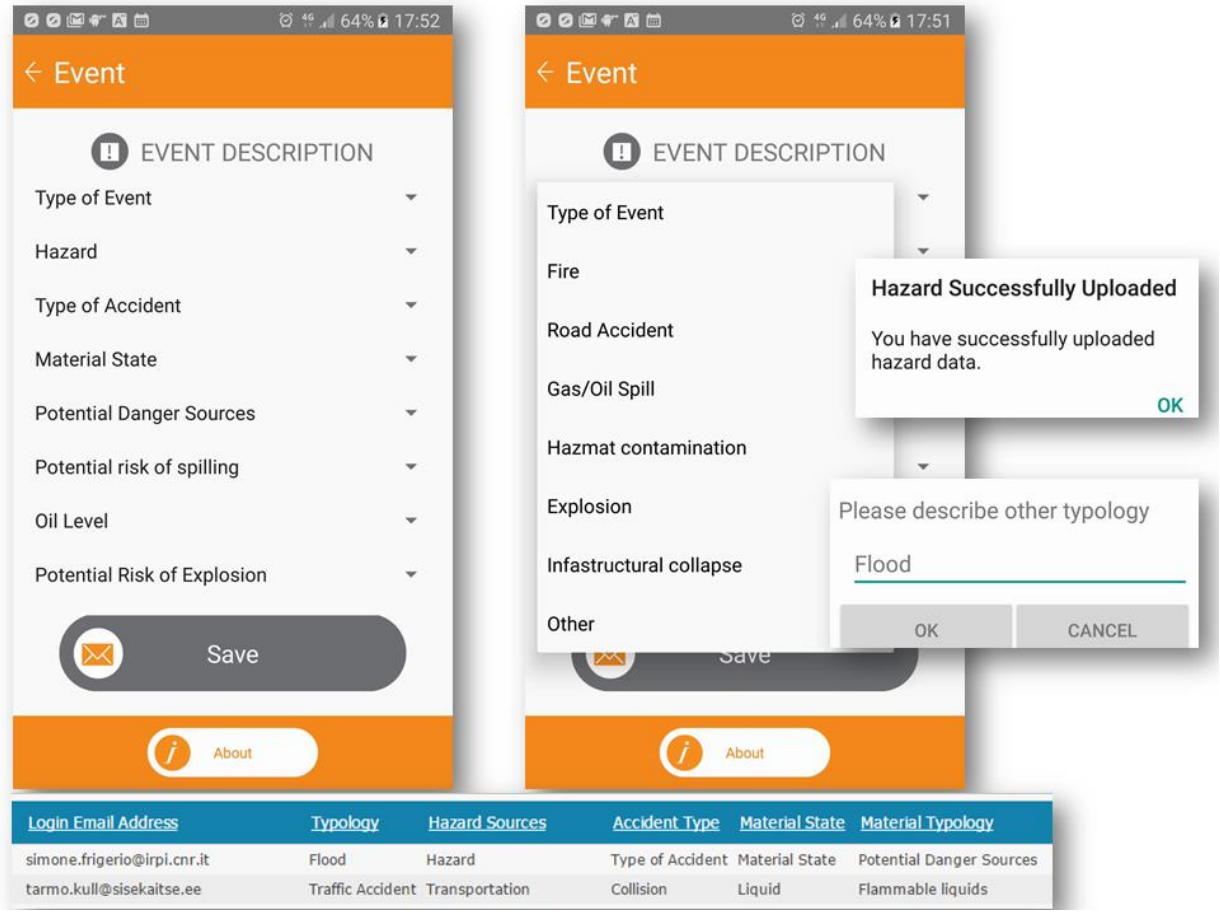

Figure 5. Custom dropdown menu with « other » function by crowd.

The button “add photo” creates real-time photos in various slides, set with image size reduction in case of limited bandwidth. The action is compulsory in MP-C to check contributions by citizens about damages and water levels, but not present in MP-V due to their priority of quick field surveys.

Every slide contains a “guideline”, completed with useful opinions and suggestions by crowdsourcing. Users compile proper instructions and guides after piloting, finally combined within official MA. Future work should involve the customization of the platform for adapted task involved to natural hazards, especially linked to new technology of sensors, as low cost solutions for data collection by crowd taking the advantage of the contest of human sensors.

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REFERENCES

Bianchizza C., Frigerio S. 2015. Il coinvolgimento dei cittadini nella gestione del territorio. Il laboratorio del progetto MAppERS. *Rend. Online Soc. Geol. It.* 34, 110-113.

Fienen MN., Lowry CS. 2012. Social.Water. A crowdsourcing tool for environmental data acquisition. *Comput. Geosci.* 49, 164–169.

Frigerio S. 2015. MAppERS for crowdsourcing. Citizens and volounteers as human sensors. In: Geomatics Workbooks n° 12 – "FOSS4G Europe Como 2015", 657-658.

Graham EA., Henderson S., Schloss A. 2011. Using mobile phones to engage citizen scientists in research. *Eos Trans. Am. Geophys. Union* 92, 313–315.

Nguyen C., Tahmasbi N., Vreede T. de, Vreede GJ. de, Oh O., Reiter-Palmon R. 2016. A Definition of Community Crowdsourcing Engagement and Application. In: D'Ascenzo F, Magni M, Lazazzara A, Za S (eds.) Blurring the Boundaries Through Digital Innovation, Lecture Notes in Information Systems and Organisation. Springer International Publishing, 283–296.

Pedersen J., Kocsis D., Tripathi A., Tarrell A., Weerakoon A., Tahmasbi N., Xiong J., Deng W., Oh O., de Vreede GJ. 2013. Conceptual Foundations of Crowdsourcing: A Review of IS Research. IEEE, 579–588.

Quesenbery W. 2003. The Five Dimensions of Usability. In: Albers MJ and Mazur B (eds.). Content and Complexity: Information Design in Technical Communication, Lawrence Erlbaum Associates, Mahwah, NJ, 2003.

See L., Mooney P., Foody G., Bastin L., Comber A., Estima J., Fritz S., Kerle N., Jiang B., Laakso M., Liu HY., Milčinski G., Nikšič M., Painho M., Pődör A., Olteanu-Raimond AM., Rutzinger M. 2016. Crowdsourcing, Citizen Science or Volunteered Geographic Information? The Current State of Crowdsourced Geographic Information. ISPRS *Int. J. Geo-Inf.* 5, 55.

Sievers JA. 2015. Embracing Crowdsourcing A Strategy for State and Local Governments Approaching "Whole Community" Emergency Planning. *State Local Gov. Rev.* 47, 57–67.

Wong B. 2011. Color blindness, *Nature Methods*, 8.6: 441.