

Seismic risk communication: an opportunity for prevention

G. MUSACCHIO¹ and S. SOLARINO²

¹ *Istituto Nazionale di Geofisica e Vulcanologia, Amministrazione Centrale, Rome, Italy*

² *Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Nazionale Terremoti, Genoa, Italy*

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ABSTRACT Risk communication is a major opportunity to turn scientific knowledge into preventative actions. In order to understand to what extent and how such opportunity is caught by the academia and supported by funding programs in Europe, we scanned recent international projects that had risk communication as a major target. We focussed on seismic hazard and retrieved a data sample of nine research projects, funded by major European Programs over the time span 2010-2017. We analysed the following three parameters: the public rated crucial to foster prevention; the approach used to reach the public, and the interaction with recipients. According to our results, the academia rates schools be the most relevant public to implant preventative action that foster a more resilient society. Face-to-face is chosen as the most efficient approach to trigger preventative actions. The acknowledgment of recipients' needs contributes to better tailor communication campaigns. Our study highlights two major constraints to the implementation of risk communication campaigns: the assessment of campaigns' efficacy and the still low relevance that communication has within funding agencies. Often communication is limited to a publicity task and, when it is set as a major goal, it can count only on little resources.

Key words: disaster prevention, risk communication, seismic hazard.

1. Introduction

Organisations and statements concerning disasters management encourage risk communication as an added value capable to enhance effectiveness of mitigation strategies. The Sendai Framework for Disaster Risk Reduction (2015-2030) emphasises that prevention should be implemented with integrated and inclusive educational actions (UNISDR, 2015). Aligned with this, the UN Office for Disaster Risk Reduction (UNISDR) suggests schools be key recipients of structural mitigation actions and communication of risks. One of the three pillars of the Comprehensive School Safety pursued by the UNISDR to help vulnerable groups and act on critical infrastructures is Risk Reduction and Resilience Education, also quoted as a promising investment on a more resilient future society (GADRRRES, 2017).

Communication is thus a non-structural approach to the management of risks, granting that technology and regulations may not be successful if they are not properly communicated to the relevant recipients. It has a great potential to successfully overcome barriers at all stages of the

disaster risk management cycle – prevention, reduction, preparedness, response and recovery (Poljanšek *et al.*, 2017). It is a growing field that includes actions such as mitigation of impact, preparation of vulnerable areas and communities, in the pre-disaster phase; actions devoted to validation, sharing, dissemination and combination of information from various sources during the emergency and in the recovery phase.

Risk communication requires a proper strategy that should firstly rely on the understanding of recipients' perspective, including the level of knowledge they have on the topic, their needs and obstacles to implement mitigation measures. Because long lasting mitigation actions depend on the role the chosen beneficiaries have in the society, the selection of strategic recipients turns to be one of parameters that may grant the success of the communication.

This paper examines how and to what extent the academia addresses risk communication as a major opportunity to turn scientific knowledge into preventative actions. We focus on the communication of risk related to seismic hazards and review a selection of recent international projects financed by European funding agencies. We address communication under the building-back-better principle (UNISDR, 2017) that encourages actions before the next disaster's crisis. Under the assumption that the driving forces to make a change in disasters mitigation should firstly come from the academia, we expect scientists be using risk communication to trigger preventative actions. For this purpose, science projects are scanned with respect to three major parameters: the public that institutions rated crucial to foster prevention; the approach used to reach the public; the interaction with recipients. The assessment of effectiveness of communication campaigns and the allocated financial and human resources are also taken into account for additional esteems.

The review is not meant to be a comparison among different projects; conversely, the aim of the debate is to uncover the different approaches to the general principles of communication that can assist prevention on seismic risk and to estimate how effective they proved to be.

The projects are thus described focussing on the aims, means, method, type of public, products. This is necessary since the field of application and the boundary conditions may be very different.

2. Seismic risk communication: key concepts

Communication is a big challenge. When it comes to risks, we enter that realm of uncertainties that everyone may find difficult to unfold and face. The large literature published on how individuals are influenced by risk information summarises four theoretical models of risk communication (i.e. in Covello *et al.*, 2001; Infanti *et al.*, 2013): *risk perception*, *mental noise*, *negative dominance*, and *trust determination*. Individuals that fall in the *risk perception* model consider actual risks the same than perceived risks; they might need face-to-face meetings with experts in order to identify specific concerns (Covello *et al.*, 2001). On the other hand, those belonging to the *mental noise* model (Fischhoff, 1989; National Research Council, 1989; Baron *et al.*, 2000) may have the ability to process information severely impaired, when in stress; they might need conceptual maps or mental model to be recalled when they are in stress. The *negative dominance* model (Maslow, 1970; Covello *et al.*, 2001; Glik 2007) includes people putting higher value on losses and negative info when they are upset; they might need to counterbalance negative message by larger number of positive solution oriented messages (Covello, 1998). The *trust determination* model (Peters *et al.*, 1997; Slovic, 1999; Covello *et al.*, 2001) includes people not trusting authorities when they

are upset; they might need a proactive and well-balanced communication that should take place far away from crisis (Santos *et al.*, 1996)

Whatever is the approach, when the goal is prevention and the perspective is that of a long lasting action the choice of the target public, in terms of relevance, becomes crucial. A relevant public is a vulnerable group that, if it undertakes prevention, it may act as hub to increase the number of people involved and to build in the future the fundamentals for a more resilient society.

It is also crucial to establish a dialogue with the public in order to show that the speaker is keen to discussion; this may help gain trust from the public. Nowadays risk communication is moving away from the deficit-model (Nisbet and Mooney, 2007), that used to address the public as an empty vessel to be filled with information. The so-called engagement-model, with a more democratic approach, considers valuable a dialogue with recipients and their direct involvement in the communication. This is normally pursued with the assessment of needs, priorities, obstacles of the target public. Such assessment consists of interviews and focus groups; it also includes roundtables and workshops implemented as opportunities for mutual learning between scientists and the public (Stilgoe *et al.*, 2014). The assessment on how much recent European projects followed the engagement-model gives back a metric on how much their risk communication campaigns had the chance to be effective.

Given the above parameters, the approach and the interaction with the public are fundamental in delivering effectual messages. Although the Internet, digital- and mass-media allow a wide dissemination of the communication, a face-to-face approach has the uniqueness of being capable to trigger the needed empathy that has a better chance to turn knowledge, of the hazard and related risk, into actions, towards prevention and preparedness.

The “what” (i.e. the topic) has, then, the potential to help recipients decide if and which mitigation actions are worth to be undertaken: practical information (i.e. conceptual maps) together with positive and proactive solutions may satisfy the full range of mental models summarised in risk communication theories.

3. Seismic risk communication in the European context

The diverse level of hazards, their level of prevalence, building performance, and diverse level of enforcement of regulation is framed into the challenge of the European context. In addition, knowledge, awareness, and cultural contexts of communities play a crucial role in the communication of risks. All of these should be addressed when setting a communication strategy.

While one of the most damaging seismic sequence in the last ten years was striking Europe (e.g. Anzidei and Pondrelli, 2016), and precisely central Italy (2016-2017), the EU parliament was discussing measures on prevention and preparedness that should be prioritised. In that framework the Commission highlighted that advancement on implementation and use of Eurocodes must be supported by risk communication “and hence by risk awareness and knowledge in local communities, with particular attention to vulnerable individuals” (Parliamentary questions E-006821-16). At that time the on going co-financing by the Commission included three risk communication projects, and precisely ‘Raising earthquake Awareness and Coping with Children’s Emotions’ (RACCE, 2010), ‘Awareness of Disaster Prevention for vulnerable groups’ (ADAPT,

2014) and 'Know your city reduce your seismic risk through non-structural elements' (KnowRISK, 2015). These projects share the action by European Commission concerning promote the raise in awareness of vulnerable groups, local and future (i.e. young people) communities.

However, since in Europe earthquakes are a threat for many countries and local communities, large efforts were already put in deriving regulations to limit human losses and damage by raising buildings performance in case of earthquake shaking. Peoples' awareness (communities and policy makers) and performance of buildings are diverse across Europe, similarly cultural contexts vary, at the point that risk communication campaigns always need to be tailored to local needs.

A complete inventory of the most recent projects dealing with communication of risk in Europe should include also those proposals financed within a single country, that are likely to be written in national languages. We limited our discussion to transnational projects completed within the time interval 2010 to 2017 and surfed the EU portal to locate projects that were addressing risk communication using search terms such as awareness, earthquake, communication, seismic, disaster, risk mitigation. The start date was chosen to be after the L'Aquila earthquake (2009) an event that had a significant impact on risk communication in Italy, Europe, and worldwide. We then limited our search to those projects that were coordinated by a research institution or that mostly involved research institution.

We retrieved the following projects listed according to a timeline (Tables 1 and 2):

1. RACCE (Raising earthquake Awareness and Coping Children's Emotions);
2. UPStrat-MAFA (Urban Disaster Prevention Strategies using Macroseismic Fields and FAult sources);
3. O3E (European Educational Observatory for Environment);
4. NERA (Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation);
5. TACTIC (Tools, methods And training for CommuniTies and Society to better prepare for a Crisis);
6. EVANDE (Enhancing Volunteer Awareness and education against Natural Disasters through E-learning);
7. E-PreS (Monitoring and Evaluation of Natural Hazard Preparedness at School Environment);
8. SASPARM 2.0 (Support Action for Strengthening PAlestine capabilities for seismic Risk Mitigation);
9. KnowRISK (Know your city, Reduce seISmic risk through non-structural elements).

The expectations of projects that rely on risk communication as an opportunity to raise or trigger prevention and preparedness can be framed into a three steps path. At its simplest level, the primary purpose of risk communication is to provide information to individuals. At this stage, people are aware that they may be in danger but they do not know to what degree, so they often do not act to reduce their vulnerability. In the second step, the public should be able to perceive risks and may already include risk-reducing practices. At this stage the public is informed about the potential damage, the seriousness of the possible loss and the variance of all possible negative consequences of a given event. In the third step, communication leads to mitigation. Individuals have now understood the level of danger, they feel it as possible, but they have likely acquired the skills and techniques to reduce their vulnerability. The magnitude of their actions depends on the individual's defensive return on safety communication. This last step is the more demanding for both those who provide the information as well as for those who should undertake preventative

actions. In fact, raise risk perception without adequately addressing risk reduction may increase distress and induce inaction.

The projects listed above cover a wide range of natural hazards, countries, and audience. Our goal is not to make comparison between projects and their results but to find common strategies for the most effective way to trigger prevention through risk communication and set a thread.

The most relevant funding program for risk mitigation in Europe is that provided by the civil protection mechanism, and more specifically by the DG-ECHO. We have scanned the financial resources allocated in the 2010-2017 time-span to proposals addressing seismic hazard and the communication of related risk (Figs. 1 and 2). Our analysis shows the still small relevance that such topic has in funding programs. The amount of allocated funds was never higher than 13% of the total program (Fig. 2). This observation is even more discouraging if we consider that, within the data sample, only a few projects had communication as a major target. This also points out how is expected that communication is either a low-cost action or it deserves little resources only.

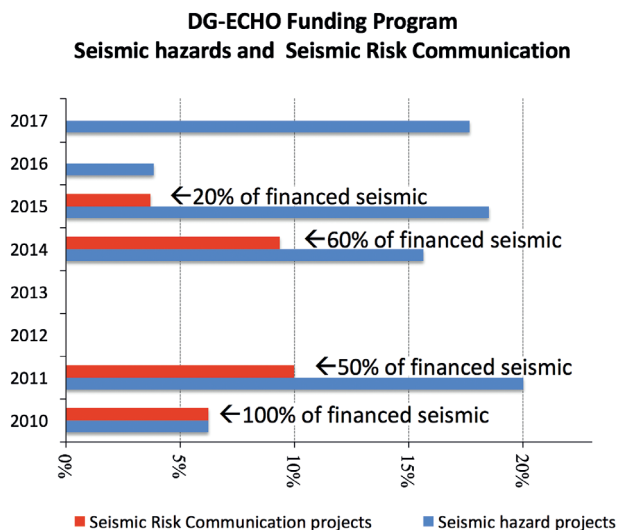


Fig. 1 - Percentage of projects funded in the last seven years by the DG-ECHO program with respect to the total number: projects that addressed seismic hazard and communication of risk are compared. The percentage of projects, among those addressing seismic hazard, that included communication is also shown (arrows and their text to the right).

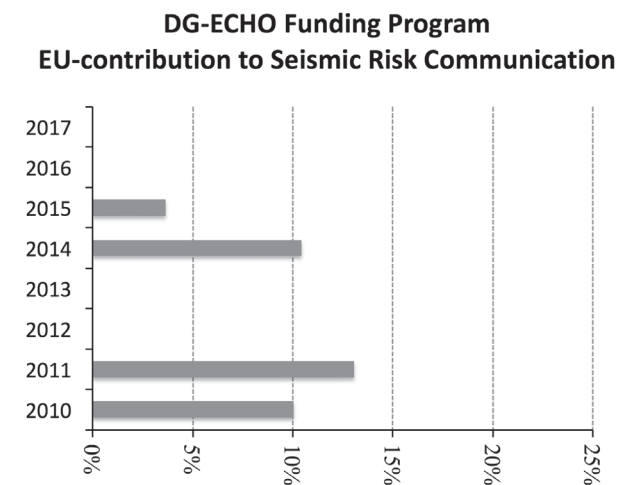


Fig. 2 - Percentage of funds provided to seismic risk communication projects by the DG-ECHO program in the last seven years.

Here below we will analyse the selected projects according to the three major parameters: the public that institutions rate crucial to foster prevention, the approach used to reach the public, and the interaction with recipients.

3.1. RACCE project

The RACCE project rated children be a relevant public. It was entirely addressed to children's emotions triggered when an earthquake or volcanic eruption turns into a disaster. The focus here is the raise in awareness, knowledge and education on best practice and on the state of art responses. The approach is double-sided: from one hand children's knowledge has increased and on the other hand people in children's surrounding environment were trained to provide help and relieve distress in case of a disaster. Products are based on a need analysis study describing the risks, the current situation, good and bad practices and the needs in each participating country. Beside a literature research, questionnaires and video interviews were used. People interviewed belong to the academia, the civil protection and were experts in education, emergency and psychology.

Projects products are posters, educational kit, and programs (Table 2). Posters are part of a travelling exhibition that addressed the phenomena, related disasters, suggested preparation measures and psychological support for children. The educational kit includes books, a list of activities (Fig. 3), videos, presentations, case studies, and evaluation material. It is written in English and national language (Greek, Italian, and French), connected to school curricula and aimed at relieving the emotional burden and help children cope with seismic disaster, by raising awareness and improving knowledge on earthquakes. Special activities were devoted to children with movement disorders. The evaluation sheet included two questionnaire having different questions in the *ex-ante* and *ex-post* data collection. Questions concerned knowledge of the phenomena, of appropriate behaviours and the opportunities gained by the educational program.

3.2. UPStrat-MAFA project

In UPStrat-MAFA the analysis of the level of risk and the communication of risk are the two pillars upon which the project was based. It was considered relevant the implementation of communication actions for children and general public in the countries belonging to the project's consortium, namely Italy, Portugal, Iceland, and Spain. The assessment of needs of local communities and target groups (i.e. hospitals) was pursued through questionnaires meant to derive the accessibility of information on earthquakes, volcanoes and risk mitigation actions, and the way such accessibility was achieved (Bernharðsdóttir *et al.*, 2015). In order to understand how a country approaches education based prevention of disasters, a comparative analysis of curricula at compulsory school level was undertaken. The study revealed crucial weaknesses such as the age -not early enough- at which seismic hazard and risk are addressed, the short teaching time devoted, the incompleteness of textbooks, and lack of in-depth studies (Musacchio *et al.*, 2015, 2017).

The analysis of textbooks uncovered a major concern in the many mistakes that can lead misconceptions (Oldershaw, 2004; King, 2010; Benton *et al.*, 2012; Komac *et al.*, 2013; Musacchio *et al.*, 2015).

Digital communication was preferred to that paper based or face-to-face. A video game and audio-visual products were implemented to address children and general public, respectively



Fig. 3 - RACCE: a snap-shot of the activities for children that are described on the project’s portal.

(Musacchio *et al.*, 2015). The game “Treme-Treme” - in English, Portuguese, and Italian - is a drill on the *dos* and *don'ts* during an earthquake and provides suggestions on what might be needed in the case of evacuation. The aim is to reach the third step of mitigation above mentioned, when individuals have acquired the skills and techniques to increase preparedness. By providing a mental model to be recalled when children, and future adults, are in danger their ability to act is increased.

The five audio-visual products (Fig. 4) - in local language and English subtitles- are strongly linked to the social, historical and cultural background and needs of each country. However, some of the videos, (e.g. “Voices of earthquake preparedness”) still follows the deficit-model as they only present the experts’ perspective without acknowledging that of local communities.



Fig. 4 - Screenshots of the videos tackling the rise of awareness on seismic hazards in Lisbon, Reykjavik, Naples, and Catania, four urban areas prone to earthquake disasters. Up to down and left to right: “Campi Flegrei”, tourists at the Solfatara muds; “Mount Etna”, steep slope landscape related to the Timpe fault system; “Before it’s too late”, street interviews; “Hveragerði... in compliance with nature”, a child describing his experience of the 2008 earthquake; “Voices Of Earthquake Preparedness”, Polat Gulkan describing his experience of an earthquake as a child (Musacchio *et al.*, 2017; redrawn).

3.3. O3E project

O3E (Berenguer *et al.*, 2010a, 2010b) was aimed at promoting a responsible behaviour of young citizens by means of scientific information about natural risks and dealt with earthquakes, floods, storms, and avalanches. The project was a cooperation between three countries (Italy, France, and Switzerland) and the public rated relevant for the communication was students and teachers. The main strength of this program was the creation of a school network in the Alpine and Mediterranean areas equipped with environmental semi-professional sensors installed in the schools. Profiting from the concept of “learning by doing”, the data by seismometers, weather stations, river’s flows, and soil moisture, recorded in the schools and processed by the students, were collected on dedicated servers and then made available through an Internet platform to the entire education community. The database was, then, used for several studies and research, but especially to learn the importance of the monitoring of natural phenomena and the limits of data

In order to make students and teachers able to manage the instruments, two sets of activities were organised. On one hand, researchers were visiting schools and delivering lectures to students about environmental hazards, how to use the instruments, the importance of good and reliable data. Groups of selected students attending the lectures became tutors of other students in the same or other schools, under the supervision of teachers (Fig. 5). On the other hand, teachers attended meetings with the intent on learn, to exchange ideas, and teaching methods and to create a network among schools of the participating countries.

The main aims of the project were to develop a sense of autonomy and responsibility of the young people, to support a rational awakening in the prevention of natural risks and to get the feeling about the importance of data. Communication was a secondary goal, the first being awareness of natural hazards in the involved countries, and it was carried out by means of the engagement-model

The project produced quite a number of deliverables, including two books for students on earthquakes and seismic hazard, one book for older students and teachers about the weather and the meteo hazards (Luyet *et al.*, 2011), one cookbook for teachers for each hazard [weather and earthquakes: Berenguer and Luyet (2011) and Berenguer *et al.* (2010a, 2010b)], two series of USB keys with novel and freely available software to process data and leaflets relative to the great 1887 western Liguria earthquake. Most products were made available in four languages (Italian, French, German, and English).



Fig 5 - O3E project. Top, the logo of the project. Bottom left: students tutoring their peers. Right: evaluation diagram of the seminars and lectures as compiled by the teachers.

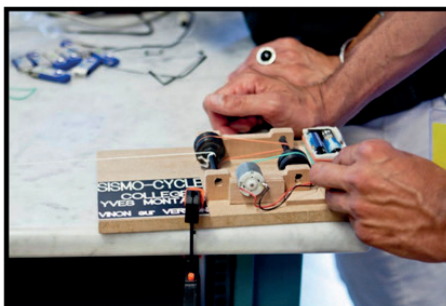
3.4. NERA project

The overall aim of NERA was to achieve an improvement and a long-term impact in the assessment and reduction of the vulnerability of both constructions and citizens to earthquakes. The project was organised in diverse working packages, and many countries contributed to the different aspects the program was dealing with. One of the working packages considered schools be a relevant public to implement risk communication (Zollo *et al.*, 2014). It was aimed at enlarging the network of schools owning and operating seismometers by installing new instruments in the participating countries and involving local projects into a more comprehensive network to share worldwide collected data. In this package, four countries were involved, namely UK, Italy, France, and Switzerland. Communication was a secondary target for the project. The analysis of needs was undertaken following the engagement-model but only published in the internal reports of the project. The communication task was performed with all means (face-to-face, digital and printed).

In the frame of the project, three summer schools were organised to gather teachers from interested countries. Classes, given by the researchers of the projects and guests, laboratories, round table, discussions are some of the undertaken activities. Teachers showed activities and/or research studies using the data collected in the project conducted by and with students in their schools (Fig. 6). Although the assessment of effectiveness in turning communication into prevention was not performed within the project, a questionnaire submitted at the end of the activities provided feed-back on the summer schools and the implemented educative tools (Fig. 6).

3.5. TACTIC project

The TACTIC project focussed on improving community preparedness for cross-border hazards through the implementation of an efficient communication strategy. The countries involved were Germany, United Kingdom, Greece, Poland, Turkey; the action not site-related, but hazard-related, included the preparedness on terrorism, floods, epidemics, and earthquakes in a cross-

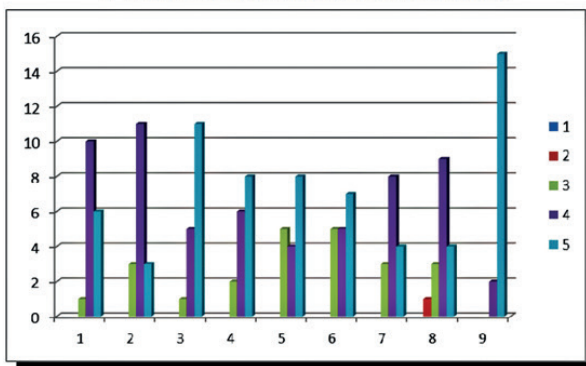


EVALUATION SESSION
FEEDBACK

(QUESTIONS 1 – 9)

17 teachers took part in the evaluation session*

Questions #	Rating Scale					Variable
	1	2	3	4	5	
1			1	10	6	
2			3	11	3	
3			1	5	11	
4			2	6	8	1
5			5	4	8	
6			5	5	7	
7			3	8	4	2
8		1	3	9	4	
9				2	15	



- 1. Overall, how would you rate the course?
- 2. Was your interest held?
- 3. Would you recommend this course to others?
- 4. Would you recommend these trainers to others?
- 5. Did the trainers encourage participation and questions?

- 5. Did the trainers encourage participation and questions?
- 6. Was the length of training appropriate?
- 7. Were the methods used to deliver the training effective?
- 8. How was the amount of material covered?
- 9. How would you rate the organization?

*2 of them replied to the questions 4 and 7 adding "variable" – their answers are not included in the summary table

Fig 6 - NERA project. Top left: teachers attending seminars. Top right: experiment on an instrument made by the students. Bottom: screen shots from the evaluation session.

border scenario. The project rated as relevant public for the communication the accountable organisations for risk mitigation and communities at risk. Stakeholders for the project products and activities are actually at both ends of the communication chain, namely organisations for the communication and communities exposed to the selected hazards. The main product of project was a self-assessment tool for both these stakeholders. The tool helped responsible organisations evaluate how effective were being their communication activities and how these could influence residents' knowledge, motivation, and networks. The output offers suggestions for improvement and tips on developing a comprehensive communication strategy able to suitably influence the public. Similarly, a self-assessment tool was built to address individual citizens (Müller *et al.*, 2016). The resource allowed residents to assess their own preparedness; it includes the provision of a short feedback report as well as selected links to useful websites where citizens could fill their gaps in facing hazards. Additionally, the preparedness assessment also allows responsible organisations to evaluate how effective their communication activities are and how they influenced residents' knowledge, motivation, networks, etc.

Practices that TACTIC considers valuable for efficacy are those based on the engagement-model.

3.6. EVANDE project

The EVANDE project aimed at creating a learning tool to educate and train civil protection volunteers and local authorities. This was done through identification of best practices and knowledge to develop a web platform that hosted e-learning courses and training activities, as well as to organise and implement local-based dissemination and training actions. The project rated that volunteers and local authorities' staff are a relevant public for risk communication. The four countries involved were Bulgaria, Greece, Italy, and Spain. Communication was a primary target and, given the kind of public, the approach was the engagement-model type. The main mean for communication was the digital one.

The outcome was a web-platform for e-learning activities used as a communication and educational tool and to share information collected by the partners to the public. In particular, web-based games and mobile location-based educational games were uploaded. Web-based e-seminars about floods, wild fires, earthquakes, and European policies specified for volunteers and civil protection operators, including multimedia presentations, lectures, practice tests were also made available to the public.

Dissemination of the project results was promoted during several project trainings and public events. The e-learning tools and trainings, developed in collaboration with civil protection actors, includes training and educational seminars for volunteers and local authorities' staff in each participating country, national meetings for volunteers and an international volunteers training event in Italy.

3.7. The E-PreS project

The E-PreS project had as a primary goal to establish preventative actions by design and evaluation of drills and exercises. The project rated the schools a relevant public for the actions: staff and students were trained to understand possible consequences of hazards in their surrounding and be prepared to react appropriately. The communication was a secondary target and it occurred by training, drills and implementing and disseminating best practices. Studies on the special needs

for each participating country were performed in a manner similar to the RACCE project. A smart tool to support drills exercises was implemented. In addition, face-to-face communication to train students and school's staff occurred. It was assessed the effectiveness of the smart tool implemented, but not that of the communication action.

3.8. The SASPARM 2.0 project

The SASPARM project had as major objective the raise of risk perception in Palestine. The project rated students, practitioners and citizens be the relevant public for its goal. The project implemented a web-based platform (WBP) that helped to define the seismic risk that was threatening individuals' properties. The WBP integrated a database (DB) to collect vulnerability data on buildings, self-assessment tools to allow citizens and support practitioners to understand potentially unsafe situations and how to mitigate the risk related to critical situations. The final goal of the project was risk communication. There was no assessment on recipients' needs or effectiveness of communication. The preferred media for communication was the Internet, although brochures, videos, and multimedia material were also used.

3.9. KnowRISK project

The KnowRISK project had communication as a primary goal. It aimed at helping European citizens and institutions to deal with the problem of performance of non-structural elements which under seismic loads may cause underestimated damage and affect resilience (e.g. Lopes *et al.*, 2019). The project rated schools (Musacchio *et al.*, 2019b), citizens and business groups (Musacchio *et al.*, 2019a) be the relevant public to implement the communication action.

Research conducted within the project on non-structural damage and vulnerability was used as a toolbox for the communication strategy. However, the assessment of level of awareness, needs, priorities, and obstacles were the milestone upon which the communication was built. The approach is that of engaging stakeholders in the implant of a culture of safety. Interviews, questionnaire, and focus groups allowed to tune-up the communication campaign and design products that were not just addressing needs but could overcoming obstacles to prevention.

Face-to-face, on paper, and digital medias were all used. For each target public, specific tools judged suitable for effective communication were implemented. A cross-media tool, specifically implemented in the KnowRISK project, is based on Augmented Reality (Reitano *et al.*, 2019). The tools, designed to take into account cultural peculiarities of local communities, provides the opportunity to be used by other European countries. It was privileged the provision of a mental model to solve problems of people in need and raise their ability to act (Fig. 5). Practical and easy to implement solutions to reduce vulnerability on non-structural elements were provided to empower communities. The aim was here again the third step of mitigation above mentioned, when individuals have acquired the skills and techniques to increase preparedness.

4. Discussion

Compared to projects carried out in the late 1990s, those above described have important peculiarities in terms of communication: they mirror the transition from the deficit- to the engagement-model in risk communication. A fundamental requirement of the engagement-



Fig 7 - KnowRISK practical guide: the cover of the leaflet (left) and the conceptual map showing mental model approach to support citizens in reducing vulnerability on non-structural elements (right). The analysis of citizens' point of view revealed their need for support for identification of accredited experts as well as their attitude to delegate actions to others. These were addressed in various ways in the practical guide (Ferreira *et al.*, 2018; O'Neill *et al.*, 2019).

model is that the point of view of the public, essentially summarised into needs, priorities, and obstacles, has to be explored. Studies on communication of risk have proved that the engagement of public(s) (plural to drive attention to the multiplicity) is an opportunity to raise efficacy (Infanti *et al.*, 2013; Stilgoe *et al.*, 2014). However, the engagement-model is not always welcome in the academia, as it requires acknowledging to the public(s) at a peer-to-peer level with scientists and experts. Often the term *engagement* is just mistaken with the opportunity to rely in the public(s) as hubs to spread best practice on risk mitigation. Among the selected projects, KnowRISK engages the public with the intention to understand needs, priorities and obstacles towards prevention (Musacchio *et al.*, 2019a).

Only RACCE, O3E, NERA, TACTIC, and KnowRISK pursue the assessment of needs. Experts are considered relevant by RACCE, O3E, and NERA to explore risks, good and bad practices, and the necessities in each participating country. TACTIC establishes a thorough rationale for such assessment. KnowRISK engages local communities and selected stakeholders, including non-experts, citizens in needs and those who were not aware to be in needs, designs and implements an assessment procedure.

Aside from rating relevant addressing schools in their risk communication campaign, our data sample shares three main common aspects.

- First, they often use a face-to-face approach towards the recipient and that is considered among the most efficient to address individuals falling in the risk perception model. In our data sample researchers were meeting the public in several events not as expert supporting stakeholders but as communicators. This participation was realised in several forms as round tables, conferences, summer schools (Table 2). In terms of communication, direct contact to the public, mostly non-expert and even not-interested people, implies a careful choice of language and tools.

It also implies gaining trust from the audience, who is in general not giving credit to people not in their circle of already known people or institution's representatives. Finally, it requires predisposition to dialogue, since communication is, by definition, an exchange of information between two interlocutors. The success of this kind of relationship depends on many variables and should be considered a "trial and error" process where the improvement may be provided by the assessment of efficacy. This is the main reason why it is very important to assess the efficacy of communication. However, as we will later discuss, often such an estimate is neglected and its importance underestimated.

- Second, to widen the number of contacts and make the educational initiatives longer lasting and replicable, the Internet is used extensively. This feature was not possible in the previous decade due to technological limitations (speed of the web network, costs for connections, limited number of connection points), but the current availability of smartphones, personal computer, and tablets makes "being on line" not only suggest but even make Internet compulsory. However, being on-line is not enough to get satisfactory results in terms of communication. This approach is, in fact, highly demanding. Besides the technical issues, it implies the need to adapt the message to standards of the social network, which are often very simple and straightforward and overall different from the scientific language.
- Third, in part as a consequence of the previous two points, an extensive usage of multimedia has been made. Many videos, e-lectures and presentations have been uploaded on the web page of each project or disseminated through other means (USB keys, DVDs). Also in this case, an additional effort is required to render the communication more appealing to the public. In some cases, the advice of experts in visual communication techniques was required.
- The mentioned projects provided, at different level and extent, tools suggesting clear indication and conceptual maps as well as providing solutions to support individuals falling in the mental noise and negative dominance models of risk communication. As already stated, the efficacy of communication is a basic prerequisite that allows to implant preventative actions. It demands that communication campaigns should acknowledge needs of target public and undergo assessment of their efficacy and a trial-and-error procedure in order to trigger a change in preventative practice of the recipients. A fundamental step is, then, to assess to what extent in terms of how-much and for how-long the content of communication is put in practice as well as to what degree it is turned into prevention.

Only a few projects foresaw tasks about assessment of efficacy either in a quantitative or in qualitative way and for some of them such assessment stood on a theoretical framework. For example, in NERA the teachers were asked to compile a questionnaire about the pros and cons of the summer schools they attended and invited to suggest what and how to improve their contents to a better understanding.

Table 1 - List of projects retrieved scanning the EU funding programs for the years 2010-2017.

Name	EU Programme	Countries involved	Risk communication: major	Financial resources (Overall)	Hazards
RACCE http://racce.nhmc.uoc.gr	ECHO-Civil protection 2010 Call for Prevention and preparedness projects" https://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/raising-earthquake-awareness_en	Greece Italy Bulgaria Italy France	yes	Cost: € 573 K EU Contribution: € 430 K	seismic volcanic
UPStrat-MAFA http://upstrat-mafa.ov.ingv.it/ UPStrat	ECHO-Civil Protection. 2011 Call for prevention and preparedness projects" http://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/urban-prevention-strategies_en	Italy Portugal Spain Iceland	no	Cost: € 605 K EU Contribution: € 454 K	seismic volcanic
O3E http://O3E.geoazur.eu	Interreg: 2007 - 2013 Italy - France ALCOTRA (IT-FR)	France Italy Switzerland	no	Cost: € 666 K	seismic hydrogeologic meteorology
NERA	FP7-INFRASTRUCTURES 2007-2013 https://cordis.europa.eu/project/rcn/96282_en.html	Switzerland, Italy, France, United Kingdom for the WP dealing with education and risk assessment	no	Cost: € 12 000 K EU Contribution: € 972 K	seismic
TACTIC	FP7-SECURITY 2014-2016 https://cordis.europa.eu/project/rcn/185509_en.html	Germany United Kingdom, Greece, Poland, Turkey	yes	Cost: € ND EU Contribution 309 K	Terrorism, floods, pandemics and earthquakes
EVANDE http://www.evande.eu	ECHO-Civil Protection. 2014 Call for prevention and preparedness projects" http://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/enhancing-volunteer_en	Greece Spain Italy Bulgaria	yes	Cost: € 556 K EU Contribution: € 417 K	seismic floods wild fires
E-PreS	ECHO-Civil Protection. 2014 Call for prevention and preparedness projects" http://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/monitoring-and-evaluation_en	Greece Italy Bulgaria Romania	no	Cost: € 604 K EU Contribution: € 453 K	seismic floods volcanic
SASPARM 2.0 http://www.sasparm2.com/	ECHO-Civil Protection. 2014 Call for prevention and preparedness projects" http://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/support-action-strengthening_en	Italy Palestine	no	EU Contribution: € 500 K	
KnowRISK https://knowriskproject.com/	ECHO-Civil Protection. 2015 Call for prevention and preparedness projects" http://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/know-your-city-reduce-your_en	Portugal Italy Iceland	yes	Cost: € 711K EU Contribution: € 513 K	seismic

Table 2 - Synopsis of risk communication in the nine selected projects.

Name	Target public	Assessments of needs	Communication products* (paper/digital/multimedia)	Multilanguage	Face-to-face: seminars, round tables, lectures	Assessment of effectiveness
RACCE	Schools	yes	20 posters 3 books 12 activities 4 videos	Mostly Yes: Greek, Italian, French and English	Lectures	yes
UPStrat-MAFA	Schools General Public	yes	Video game Multimedia platform 5 videos	Only the video game and the 5 videos	Science outreach events	no
O3E	Schools	yes	3 books 2 cookbooks 1 leaflet 2 usb keys web portal	Yes. English, French, Italian, German	Summer schools, lectures	Yes (in part)
NERA	Schools	yes	Software for data processing 1 software manual	Yes. English, French, Italian	Summer schools	yes (in part)
TACTIC	Risk communication agencies Citizens	yes	Library of good practices Assessment tool	Yes. English, Turkish, Polish and German	Workshops	Yes
EVANDE	Volunteers Local authorities	yes	Web portal e-learning courses 8 videos 1 app for Android O.S.	Yes. English, Italian, Spanish, Bulgarian	Training activities	no
E-PreS	Schools	yes	Smart tool leaflet videos	English	Training activities	no
SASPARM 2.0	Schools Practitioners Citizens	no	Internet, videos multimedia	English		no
KnowRISK	Schools Citizens Business groups	yes	2 videos 3 videos-spots Augmented reality products 3 public-specific leaflets 3 protocols of intervention in schools 1 game 2 hands-on tools 1 pop-up leaflet	Yes all: Portuguese, Italian, Icelandic English Pictograms	Seminars, round tables, lectures, Science outreach events	yes

*Products only meant disseminate the project contents (i.e. brochures, newsletters, portal, layman report) are shared by all projects and here not included. The portal is considered here only if it was a relevant support for the communication (e.g. it was used as an e-learning facility)

In RACCE the assessment was based on two questionnaires submitted before and after the exposure to projects' products.

In KnowRISK the assessment of efficacy had a step forward as it was systematised with a quantitative approach, a double blind procedure and a theoretical framework. The purpose was to measure differences in the understanding on earthquake as hazard and the associated risks, in attitude towards them and practice on mitigation actions in respondents before and after the exposure to the communication (Crescimbene *et al.*, 2019; Platt *et al.*, 2019).

5. Conclusions

It must be remarked that in any action aimed at prevention, an actual increase can only be verified when the next natural disaster occurs. This may need a long time, longer than any project's duration. Since projects cannot be extended beyond a deadline, their efficacy on preventative actions must, then, be established by means other than the impact of disasters, selecting reference parameters for an absolute or relative estimate.

In this study we assessed the potential to turn communication into preventative actions by analysing nine European projects that were focussed on seismic hazard. The projects were selected by scanning, over a time span -operation till completion- ranging between 2010 and 2017, the main funding program by the European Union, and more specifically the European Civil Protection And Humanitarian Aid Operations, the FP7, Horizon2020, and the Interreg programs. We choose those projects where coordinators, or major partnership, had been research institutions. The results show how funding programs rate poorly relevant seismic risk communication. If we consider the DG-ECHO, supposed to be the most relevant European risk mitigation program, only three projects with a major target on communication, over a total number of 160, were co-financed in the selected time span. On the other hand, this also gives a feedback on how little is the effort that research institutions put at supranational level into seismic risk communication.

The projects we analysed in this work had common expectations (to inform, form, and foster preparedness) that were obtained with different aims and means. In order to explore to what extent and how the academia deems risk communication a major opportunity to turn scientific knowledge into preventative actions we considered three main parameters: the public that institutions rate crucial to foster prevention; the approach used to reach the public (face-to-face, printed, digital or cross-media) and the interaction with recipients. We also considered if academia took into account the understanding of the recipients' point of view in terms of needs, priorities and obstacles to undertake preventative measures. We addressed to what extent the projects tackled the challenge of evaluate the effectiveness of the implemented campaigns. An additional parameter was the level of dissemination the information could reach.

In our data sample the academia, by rating schools as a privileged public, was able to catch on the high potential to foster a culture of prevention in a future society. Generally speaking, the prevalent approach is that of a bottom-up strategy, which entails to directly involve citizens who are the potential victims of disasters and, in particular, the younger ones who will be the actors of tomorrow.

Only a few projects within our sample approached public engagement in risk communication taking into account the recipients' point of view towards preventative actions (Musacchio *et al.*, 2019a). It is not surprising that public engagement in risk communication is not a welcome approach in the academia, as it requires acknowledging the public(s) at a peer-to-peer level with scientists and experts and a mutual learning framework. Often public engagement is just mistaken with the opportunity to rely in the public(s) as hubs to spread best practice on risk mitigation.

Moreover, most of the projects in our sample consider valuable the direct contact with the public (i.e. the face-to-face mode). However, in all projects, the relationship between researchers and the public was established through people supposing already involved or interested in the topic of natural hazards (teachers, stakeholders). This puts a bias on the communication actions, since the efficacy of the result cannot be extended to other categories. However, we argue that

by involving students it is possible to address that part of public who is not (yet) aware and does consider itself at danger, and in other words to overcome the bias.

In terms of efficacy, the direct contact with the public has the greatest impact, but it is limited to small audiences (conferences, lectures, classes) and may not include people “outside” the sphere of interest, which can be instead involved with multimedia and digital media. In this case there is no direct contact between researcher and the public, but the chance that non-interested people can come across the digital tool is greater, overpassing any form of shyness and the difficulty to reach the source of information. The non-direct contact enlarges the number of hit people. However, the amount of information and especially the level of deepening for each recipient is much lower. This derives from the specific format of the digital communication, which requires short messages straightforward and capable to get the attention of the surfer. Digital contents last longer and are cheaper than, for example, classical deliverables like a printed book, and can be easily updated and/or changed. However, information delivered through the Internet (and on social media) may need IT and communication experts to be compliant with the rules of the web, that are not always known by the scientists.

Although in some cases the assessment of communication effectiveness has been carried on, the evaluation procedure proved not to always be robust, showing how this remains one of the unresolved challenges in risk communication and is one of the major constrain for the implementation of risk communication campaigns. The theoretical framework to be used, the data collection analysis procedures are all key issues that should be taken into account when trying to quantify at what extent a communication campaign just provides information or if these have the potential to be turned into best practices. If we assume, with the rule of thumb, that the message to be conveyed is correct, the level of improvement in knowledge and the consequent preventative actions depend on the way the concept is transferred to the public. In such a view, effectual communication is thus a prerequisite for prevention: its effectiveness can be considered proportional to it. A robust way to assess effectiveness of communication is by submitting questionnaires, before and after the campaign, that can retrieve information on preventative actions undertaken by a statistical representative sample of recipients. However, it must be remarked that, even when a positive assessment is acknowledged, this may not turn to a raise in prevention and preparedness in the long run.

Our study points that one major constraint to the implementation of risk communication campaigns is its still little relevance within funding agencies. Often communication is limited to a publicity task and, when it is set as a major goal of a project, it can count only on little resources.

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Corresponding author: Gemma Musacchio
Istituto Nazionale di Geofisica e Vulcanologia
Via di Vigna Murata 605, 00143 Rome, Italy
Phone: +39 02 23699655; e-mail: gemma.musacchio@ingv.it