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Dissemination: steps towards an effective action of seismic risk reduction for non-structural damage in the KnowRISK project

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Abstract

"Move, protect, secure" were the three key points that the KnowRISK (Know your city, Reduce seISmic risK through non-structural elements) project posed at the core of its communication and dissemination strategy. This three key points enable each person, professional or not, to reduce non-structural damage caused by earthquakes. Dissemination is usually the last but never the least step of a communication plan, and indeed it played a crucial role in KnowRISK project for conveying the three key-point message to the widest audience.
Standard dissemination activities, such as open-door events, and internet allowed us to achieve a wide spreading of ideas and best practices, reaching more than 4,000 non-professionals and almost 50,000 page views of the KnowRISK project website (in three years), respectively. As communication was recipient-targeted, the dissemination task of the project was addressed to professionals, layman, and schools. In particular, schools were chosen in order to profit from the chain-reaction action that is capable to spread a message from students to the surrounding environment.

Keywords: Seismic risk; Seismological data, Data dissemination; General or miscellaneous (Educational, History of Science, Public Issues); Environmental risk.

1. Introduction

Coping with high seismic hazard requires awareness of the need to minimize seismic risk and act accordingly. Unlike what is commonly assumed, pursuing this goal must not only come from political/administrative officials, but involves all citizen, collectively and individually. Individual commitment - even with very simple actions - can improve earthquake resilience at home, office, and school or at other important or high-occupancy structures, to withstand ground shaking.

Earthquakes abound in many European countries (Figure 1), leading to the potential risk of being hurt also in case of non-structural damage (henceforth NSD). This comes even when a building does not collapse, but internal or external parts of it are disrupted or lose their stability [Ferreira et al., 2018]. In Italy, in the aftermath of the 2009

L'Aquila earthquake and 2012 Emilia seismic sequence, many projects were financially supported in order to raise awareness of high-school students on the dangerous consequences of earthquakes on structural and non-structural elements [e.g., Peruzza et al., 2016 and references therein]. Apart from educational purposes, a special focus on NSE has come from economic evaluations encompassing the losses associated not only with the direct non-structural elements, but also with the disruption of business activities during past earthquakes [e.g., FEMA E-74, 2011; Ferner et al., 2014]. Despite the increasing number of research on the topic, there is insufficient information on NSD not only among laypersons, but also among professionals, who are not familiar with current knowledge on the seismic design and analysis of non-structural building components.

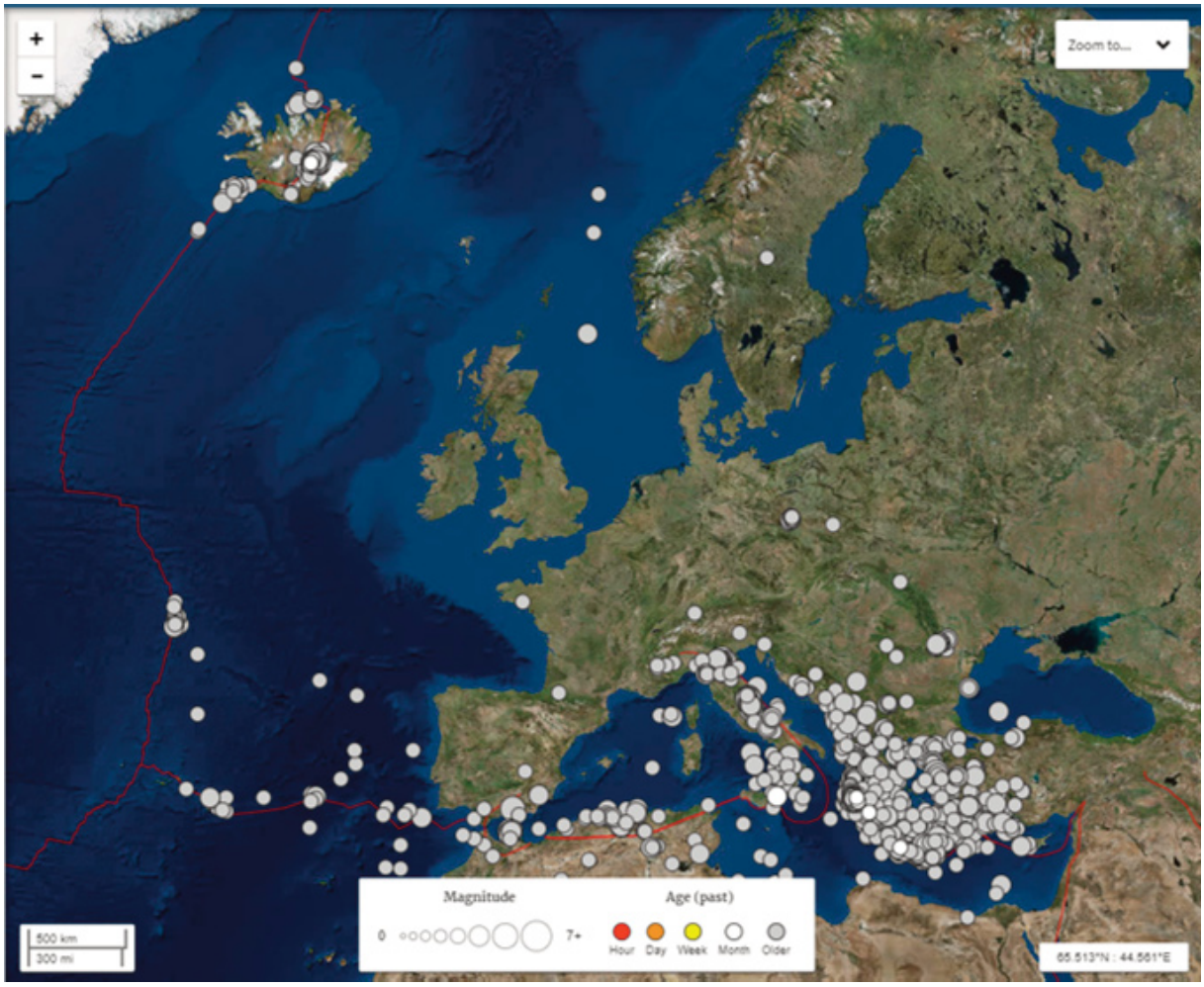

Figure 1. 10-year map of earthquakes in Europe from 1 January 2009 to 1 January 2019. Magnitude is from 4.5 to 6.9 (from USGS, https://earthquake.usgs.gov/earthquakes/map).

The present study puts forward the centrality of scientific dissemination in implementing educational initiatives on NSD, as students and families are largely unprepared. In particular, this paper features the contributions the European project KnowRISK (Know your city, Reduce seISmic risK through non-structural elements; Grant agreement ECHO/SUB/2015/718655/PREV28) provided as part of dissemination activity in pilot areas of three countries: Portugal, Italy, and Iceland. Incorporating knowhow of engineers, seismologists, architects, and sociologists, the project promoted preventive action to reduce the level of NSD from ground shaking by using a public engagement approach [e.g., Musacchio et al., 2019]. The core of such a preventive action is contained in three key points: *move, protect and secure*. In the following sections, we describe KnowRISK dissemination actions,

which were the last step of a strategic communication plan aimed at capturing attention of targeted audiences throughout various channels, including the application of new techniques such as Augmented Reality. Such actions were standard and strategic. Standard dissemination activities were chosen not just taking into account the widest audience that could be reached, but a special care was paid to include the topic of NSD caused by earthquakes in the right framework. This is the case of dissemination events that were devoted to safety, science festivals, and events dealing with natural hazards. Dissemination through the internet was also done, through the KnowRISK website, the Portuguese parishes' social media platforms such as Facebook and LinkedIn (to share the KnowRISK videos). Also, dissemination was performed strategically, using schools in the three pilot areas, as vehicles capable to spread a message from students to the surrounding environment and therefore ensuring a self-sustained domino effect. This paper shows how strategic dissemination can strengthen effectiveness of actions aimed at raising risk awareness.

2. Addressing targeted communities

Each community has its own language and its favorite channels for communication. Therefore, the choice of the most effective strategies of communication is of paramount importance for the implementations of activities aimed at creating and or increasing public awareness. An effective communication strategy should stand on a recipient-targeted, robust dissemination activity, capable to strengthen the message and yet broaden the audience.

There are differences in the perception and interpretation of seismic risk, as many factors may affect public perception leading to personal interpretation of beliefs and truths [e.g., Crescimbene et al., 2014, 2015; Musacchio et al., 2016; Peruzza et al., 2018]. Even the inhabitants of an earthquake-prone country cannot be attuned to major earthquakes as a possibility [Mutch, 2015; Peruzza et al., 2018]. Also, Árvai [2014] states that technical information are not enough to obtain positive outcomes, as these can only be consequence of effective risk perception. Complying with the findings of these analyses, our dissemination task was addressed to professionals, layman, and schools in order to widely spread the KnowRISK message among the population of all ages and levels of education. The dissemination action of the project started conveying answers to the questions: "Do you know that small earthquakes can cause serious damage? How can you know if you live in an earthquake-prone area? What can you do to reduce non-structural damage?". These are three key-questions that we considered strategic to be disseminated in order to prompt the use of project results in their own work and daily life by selected stakeholders.

The first question may sound surprising; it caused indeed the most striking reaction among the attendees in the KnowRISK dissemination events. It is usually ignored that: i) between 70% and 85% of the construction costs cover non-structural parts [FEMA E-74, 2011], and ii) NSD can severely affect the prompt recovery from earthquakes. Even though hazard maps are nowadays a fundamental tool for the application of seismic codes, they are actually ignored by non-professionals. Generally, people overlook whether or not they live in an earthquake-resistant residential building. Consequently, our communication plan encompassed actions to convey easy-to-understand messages and scientific outcomes of the project.

"What we should do in case of earthquake" is a topic dealt by many social institutions (e.g., Civil Protection) and educational centers worldwide mainly to suggest a correct behavior during and immediately after an earthquake. Good practices before an earthquake are however equally or more important, not only to increase the building structural resistance to shaking, but also to reduce the fall and destruction of non-structural elements both outside (e.g., windows, balconies, chimney's) and indoor (e.g., partition walls, furniture, equipment). "*Move, protect and secure*" was the slogan KnowRISK launched, explaining that small gestures can make a big difference for the reduction of NSD (https://knowriskproject.com/move-protect-secure/). Firstly, we invited our audience to identify potential NSD at home, school or workplace; then, we offered examples of how to fix this potential threat. A few actions have no cost at all, such as moving heavy objects from high shelves to lower ones; others require only a small expense (a few euros) and relatively little efforts, such as fasten hanging pictures and mirrors, or strap cabinets and cupboards to a wall. More complex and expensive actions require technical expertise, such as brace masonry chimneys and water heaters, or inspect gas lines and electrical systems. With a simple text and visual descriptions, the KnowRISK Practical Guide [Ferreira et al., 2018; https://knowriskproject.com/practical-guide/] explains to non-professionals how to "move, protect, secure", i.e., safety tips to have a safer house in case of earthquakes, minimizing their dangerous and damaging impact. Also, it graphically provides indications on the cost of each action and the

level of expertise required. As losses from equipment and pipe systems can largely exceed those from structural damage [e.g., Filiatrault and Sullivan, 2014], special care was posed by project's members also to the preparation of a portfolio containing useful information addressed to professionals on how technically reduce NSD. The KnowRISK Portfolio of Solutions [Ferreira et al., 2018] offers detailed instructions and guidelines especially useful to structural engineers, architects, and so-called MEP (mechanical, electrical and plumbing) engineers. It can be freely downloaded from https://knowriskproject.com/portfolio/.

3. Access to information

Internet has led to a rapid paradigm shift in the field of access to information, with billions of users that reached about 42% of the world's population in 2014 [UNESCO, 2015]. Our dissemination activity took advantage of Internet, as it allowed us to easily spread information widely within the digital community. The KnowRISK website (https://knowriskproject.com) was a user-oriented and friendly-surfing portal. It was translated in English, Portuguese, Italian, and Icelandic in order to facilitate access to information that is intended to impact safety in daily life.

A specific menu is dedicated to schools with items to raise awareness on risks posed by NSE at school (e.g., check lists) and educational games (e.g., "Do it right, be safer", https://knowriskproject.com/practical-guide-board-game/ and "Treme-Treme", https://knowriskproject.com/jogo-treme-treme/).

The KnowRISK website offered digital news (e.g., the newsletters, announcements of KnowRISK conferences and open-door events) and also promoted more standard dissemination ensuring information for all interested users, in the form of links to radio and television interviews as well as freely downloadable material, such as brochures, project reports, the KnowRISK Portfolio of Solutions and the Practical Guide. In this way, the dissemination of good practice and scientific achievements of the project was conveyed to users even with specific exposure to non-structural vulnerability and different levels of education. For example, newsletters were straightforward channels for sharing information with stakeholders, highlighting the development of the project over time. The two newsletters prepared by the KnowRISK team were the results of a fruitful collaboration established with the Master of Scientific Journalism and Institutional Communication of Science at the University of Ferrara (Figure 2). This collaboration also yielded to the design of specific outcomes especially addressed to youths. The first one is a 3D cartoon on potential NSD at home (Figure 3; https://knowriskproject.com/brochures/). The print of the cartoon allows one to build a 3D edifice (consisting of kitchen, living room, terrace, bathroom, and garage) and a separate child's room, highlighting potential damage in case of earthquake and how to reduce it. Two 2D-cartoons offer graphical examples of NSD in a classroom (the school card of the "Students' Short Guide"; https://knowriskproject.com/wp-content/uploads/2017/12/Guida-Scuola-eng-Portugal.pdf)), and in a child's bedroom (the house card of the "Students' Short Guide"; https://knowriskproject.com/wp-content/uploads/2017/12/Guida-Casa-eng-Portugal-1.pdf).

Several videos were also made in the framework of KnowRISK to promote action for prevention of NSD. Dissemination activities in Italy throughout the project were the subject of a video (https://knowriskproject.com/video-knowrisk-dissemination-activities-italy/), which provides a selection of images taken during the many events involving schools (~2,000 children) in the pilot areas of northern and southern Italy.

A thorough series of tests were performed by using a large shaking table [Candeias et al., 2017], where a room to represent a youngster place was built. Two types of ground motion to simulate the shaking at the lower and upper floors of a building were used. Techniques to fix the objects to the walls were implemented and tested under various seismic input levels. Such footage is contained in a video clip of the project depicting how common furniture can topple down in case of earthquake, and suggesting the three key points "*Move, protect and secure*" to reduce and avoid NSD (https://knowriskproject.com/move-protect-secure/).

Last but not least, the "Layman Report" video contains a synthesis of the tasks developed within the project. It is its legacy, which will be also spread in the future (https://knowriskproject.com/knowrisk-layman-report/).

KnowRISK project was also widely presented and referred to in several Portuguese TV and radio programs. With the occurrence of Amatrice and Norcia earthquakes in Italy in 2016 [Goretti et al., 2018], interviews in TV of the coordinator and other members of the project were made along with a series of talks in the Academic Forum, where interested researchers and academicians participated (Figure 4). All the information is available on the KnowRISK website / News & Events.

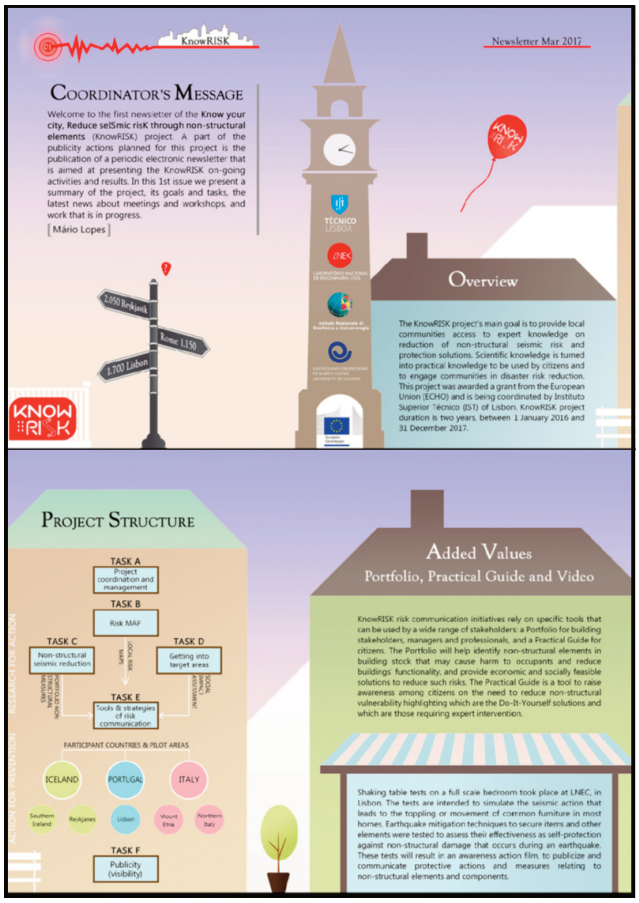

Figure 2. First two pages of the first newsletter of the project. Rigorous information is provided in an intriguing format (for the complete content of the KnowRISK newsletters see https://knowriskproject.com/wp-content/uploads/2017/12/KR-Newsletter-Nov-2017.pdf).

Figure 3. 3D cartoons on potential NSE at home (freely downloadable from https://knowriskproject.com/brochures/). Designed by Lisa Orlando & Marco Faggioli.

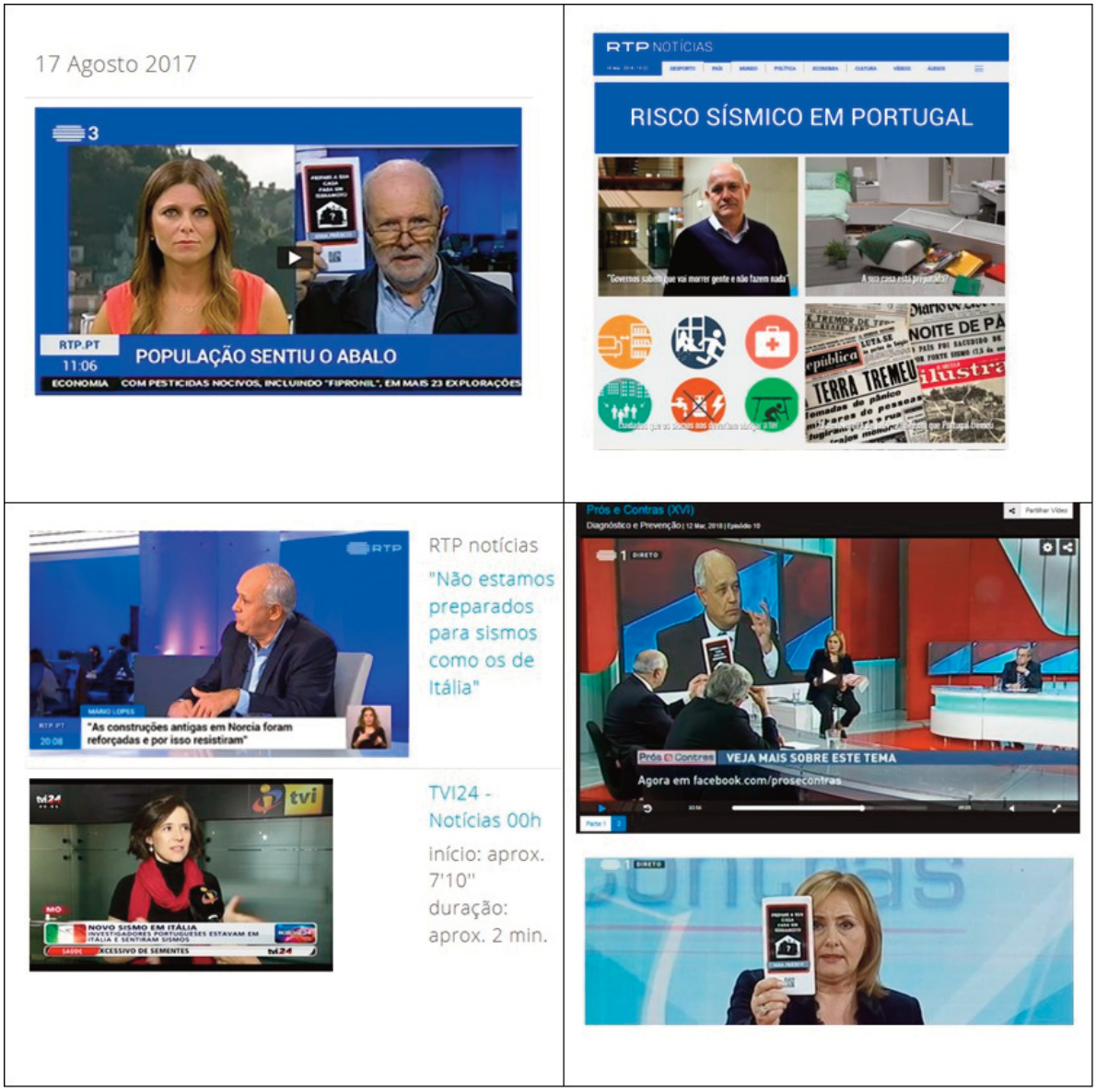

Figure 4. KnowRISK project in the News.

Talks involving experts and local community also occurred in several occasions. In the Olivais parish (Lisbon, Portugal), talks along with street actions took place to show the Practical Guide, raise seismic risk knowledge, and help communities to reduce such a risk. Beside regular talks, engagement of public in NSD risk reduction was promoted with the participation to festivals (i.e., Festival Sons do Vale Sustentabilis, 8-11 September 2016, organized by the Olivais parish) and conferences (see Supplementary Material).

4. From hands-on activity to virtual techniques

The important role of schools in a community's disaster response and recovery in case of earthquakes is well recognized worldwide [e. g., Mutch, 2015]. On the other hand, schools are vulnerable to structural and non-structural damage as yet. For this reason, youths were a targeted group to which we devoted special attention. For them, in the light of the KnowRISK communication plan, we mainly followed a hands-on approach that allowed to trigger their interest and enhance learning. Besides being a targeted audience, students also have an active role in spreading

news within local communities at present, making changes in the future society as well. Such a role is extremely relevant for the further dissemination of best practice and the raise of new attitudes towards seismic risk. Schools, which benefitted of our dissemination activity, were secondary institutes in all pilot-areas of KnowRISK project, with students between 13 and 17 years old. The column "Schools" in Table 1 (see Supplementary Material) lists many of our dissemination events during which children practiced, for example, with marshmallow and spaghetti to build stable earthquake-resistant structures (Figure 5), played with "Do it right, be safer" board game based on the content of the KnowRISK Practical Guide, or identified potential NSD using Augmented Reality (AR).

Figure 5. Shaking test of an earthquake-resistant structure built by students with marshmallow and spaghetti during ScienzAperta 2017.

The latter is a technique working on mobile devices, such as tablets and smartphones, which adds virtual information of any kind (e. g., images and videos) to the real environment (Figure 6). An AR exhibit - especially designed for KnowRISK - allowed us to explain NSD and "unveiled" potential NSD after a debated visitors' analysis at selected snapshots depicting external and internal parts of edifices. The exhibit made them aware of the potential danger of heavy furnishings above their bed or close to doors, causing injures or hindering escapes in case of fall. We address the interested reader to Reitano et al. [2019], who provided a description of this exhibit.

Figure 6. Example application of Augmented Reality. The 3D image of the Earth is "overlapped" to the poster of the INGV dissemination event "Dentro il terremoto: percorso "animato" in realtà aumentata per la conoscenza e la riduzione dei danni non strutturali" (Inside the earthquake: "animated" path in augmented reality for the knowledge and reduction of non-structural damage". The event was organized in the framework of the Italian "Settimana del Pianeta Terra" (Week of Planet Earth); (http://www.settimanaterra.org/node/2468). Photo credits: Pier Raffaele Platania.

5. Dissemination in numbers

Members of the project attended national and international meetings (congresses and conferences) with thousands of worldwide visitors to present KnowRISK and its scientific outcomes [e.g., Musacchio et al., 2016; Oliveira et al., 2016]. In Iceland, during the "International Conference on Structural Dynamics and Earthquake

Engineering (ICESD 2017)", a special session was dedicated to present the results of the KnowRISK project. The main aim of this activity was to disseminate the achievements of the project to a wider range of experts, to share experience and knowledge with them, and to get feedback from them regarding the activities of the project. Our contributions to the presentations in these meetings also allowed us to discuss on NSD, exchanging information with professionals with various expertise, such as seismologists, engineers, experts in communication, filmmakers, and architects.

Apart from that, public exposure was a core aspect of our dissemination action among laypersons, promoting awareness of NSD and debates on self-protective measures. In particular, such debates were a fundamental part of the meetings, as the majority of people involved in our open-door events ignored what they could do to reduce NSD.

Table 1 (in the Supplementary material) summarizes dissemination events either organized or attended by members of the KnowRISK project. The events are grouped according to the targeted audience, i.e., professionals, general public, and schools. The table reports name, date(s), location, and kind of action (e.g., talk, poster presentation, hands-on activity) for each event. Also, it indicates the approximate number of attendees whenever possible, with the exclusion of national and international conferences and congresses for professionals for which the dissemination was also conveyed through abstracts, posters and oral presentations.

To evaluate the extension of our action, we grouped the 40 events in Table 1 for typology in order to get the total number of people directly (face-to-face) reached by our message (Figure 7). Apart from the European Researchers' Night, all other events were at national (Settimana del Pianeta Terra, ScienzAperta, Security Day in Schools) and local level. Totally, we had 4,010 participants in the time span January 2016 – April 2018 (Table 1 in the Supplementary material). It is worth noting that, after the end of the project and in collaboration with Metropolitano de Lisboa, was launched the "*Move, protect and secure*" awareness campaign in all Metro lines and Facebook, for two weeks (12-26 October 2018). The campaign was aimed at raising preparedness and resilience for the hundreds of thousands of its passengers (Figure 8). In Lisbon, more than 200,000 Practical Guides on paper were distributed to households through local parishes (by postal mail and parish services). In other cities, such as Mafra (Lisbon) or recently, in 2019, Portimão and Loulé (Algarve, south Portugal), the Practical Guide was printed and distributed among the population at the aim to raise awareness on NSE. In Portimão and Loulé, the Practical Guide was distributed in Portuguese and English because of the large number of tourists visiting the cities.

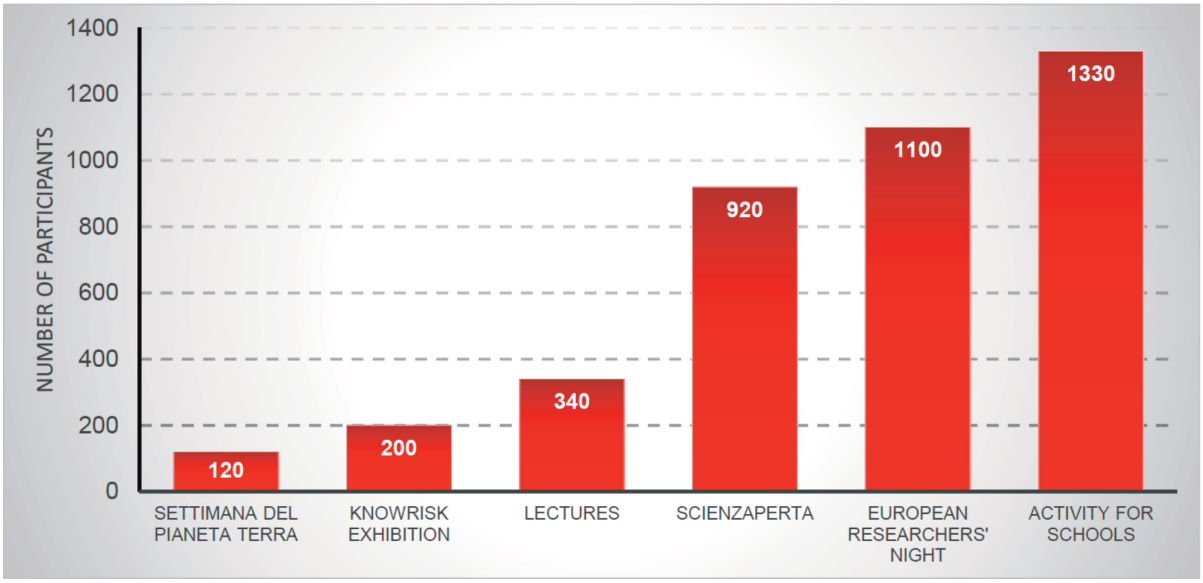

Figure 7. Number of participants at dissemination events for non-professionals (laypersons and schools) organized by members of the project. Apart from the European Researchers' Night, all other events were at national (Settimana del Pianeta Terra, ScienzAperta, Security Day in Schools) and local level, with venue in Italy and Portugal (see Table 1 for details).

Finally, our dissemination action took advantage from the KnowRISK website, which allowed us the public disclosure of all the results achieved by the project, widely spreading news and information. Based on Google Analytics (accessed August 2019), the website of the project achieved more than 49,300 page views during ~11,600 sessions throughout three years (2016-2018).

Figure 8. The Lisbon Metro launched the KnowRISK awareness campaign from 12 to 26 October 2018. For this campaign, 350 posters were placed inside the Metro carriages. Designed by Hugo O'Neill.

6. Conclusions

The achievement of seismic risk reduction requires awareness of seismic hazard and a proactive behavior from each citizen. Communicate the earthquake risk to professionals, layman and schools - through a number of initiatives which can be replicated in other regions with minimum adaptation - was a goal of paramount importance

for the KnowRISK project. Communication and dissemination were fully embedded in the project. In particular, dissemination was planned to maximize the awareness of NSD and the diffusion of good practices to reduce this kind of damage. Spreading the NSD knowledge to multiple audiences was carried out by using many tools that were also easily searchable on the web.

The impact of a dissemination action in a project is given by the number of people that were reached and/or attracted by its products. Our dissemination activity resulted into ~ 50,000 project portal views during 11,600 sessions over three years, along with more than 4,000 persons we met face-to-face during the 40 events we organized or attended on behalf of the project. Our efforts for the transfer of knowledge aimed at promoting the active role of each person in risk reduction as well as the identification of the best solutions to adopt. The dissemination action has even overcome the end of the project, with the reuse of the project outputs in outreach events and presentations at national and international level [e.g., Langer et al., 2019]. This action - strictly linked with the communication task - has allowed us the further exploitation of our main findings from scientific research as well as products for outreach activity.

Past 3 to 4 years since the closure of KnowRISK Project, we assist to a great deal of increase of awareness connected to the remembrance of 50 anniversary of the 1969 earthquake (M 7.8) in SW Portugal and of the 40 anniversary of the Azores January 1st earthquake (M 7.2), by the great attention given by the population and traduced in the interest in promoting the new knowledge gathered by those events. KnowRISK is absolutely part of that success.

7. Data and sharing resources

Data of the epicentral map of earthquakes in Europe from 1 January 2009 to 1 January 2019 (Figure 1) were taken from USGS, https://earthquake.usgs.gov/earthquakes/map.

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