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How to raise awareness of seismic risk? Lessons learned from case studies within European Projects

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Abstract

Awareness of at-risk population is a cornerstone of disaster risk management, and effective strategies should integrate sustainability to ensure long-term impact. While hazard and risk assessments are essential for prevention, their success is greatly enhanced when exposed communities are adequately informed.

This article presents lessons learned and follow-up insights into seismic hazard and risk awareness from case studies of two European projects - UPStrat-MAFA (Urban Disaster Prevention Strategies using Macroseismic Fields and Fault Sources) and KnowRISK (Know your city, Reduce seismic risk through non-structural elements). The discussion focuses on the rationale behind the selection of target audiences, how messages were adapted to meet diverse needs, and which educational tools were developed to address specific contexts. These experiences provided insights that were applied in national and international initiatives. Reflecting on experiences gained through European collaborations, this overview helps refine communication approaches and offers guidance for improving future earthquake risk mitigation efforts.

Keywords: Awareness raising; Seismic risk communication; Earthquakes; European projects; Seismic risk management

1. Introduction

Raising public awareness is fundamental to successful disaster prevention. The Hyogo framework for Action [UNISDR, 2005] and, more recently, the Sendai Framework for Disaster Risk Reduction [UNISDR, 2015] provided directives to increase engagement and resilience. Educating the public about potential risks and equipping them with response strategies empowers both individuals and communities. In the field of seismic risk, this knowledge allows people to take proactive steps toward mitigating the impact of future earthquakes. It also helps them make informed decisions, not only in preparing for emergencies but also in their daily routines.

Education and communication play an essential role in building resilient communities capable of facing seismic hazards [e.g.: La Longa et al., 2012; Balog-Way et al., 2020; Katsikopoulos 2021; Musacchio et al., 2023]. This highlights the importance of fostering awareness at both the individual and community levels to create a culture of preparedness.

Two projects, UPStrat-MAFA (Urban Disaster Prevention Strategies using Macroseismic Fields and Fault Sources, 2011-2013) and KnowRISK (Know Your City, Reduce Seismic Risk through Non-Structural Elements, 2015-2018), both funded by the European Commission's Civil Protection and Humanitarian Aid umbrella, provided insights into valuable strategies to increase public awareness in earthquake hazards [Musacchio et al., 2018; 2019]. These initiatives focused on identifying knowledge gaps among the public and developed tailored risk communication tools to address those gaps [Bernhardsdottir et al., 2016; Musacchio et al., 2016; Crescimbene et al., 2019; Musacchio et al., 2019; Platt et al., 2019; Ferreira et al., 2021; Lopes et al., 2021].

The strategies implemented were deeply rooted in sustainability and resilience, as they targeted schools and younger generations, ensuring that the knowledge was passed on to future citizens and decision-makers.

2. UPStrat-MAFA and KnowRISK: A framework for raising awareness in seismic risk

The UPStrat-MAFA project, conducted between 2011 and 2013, developed a framework for disaster prevention that integrated multidisciplinary strategies focused on risk analysis and public information dissemination [Musacchio et al., 2018]. A central aspect of this framework was raising awareness about earthquake hazard through education and communication. By assessing educational levels and

identifying gaps in knowledge, the project highlighted the need for tailored educational and awareness raising tools. This led to the creation of several resources listed in Table 1, such as the game-based learning tool "Treme-Treme" for schoolchildren [Cardoso Barreto, 2014; Cardoso Barreto et al., 2014], and audiovisual products aimed at the general public and addressing seismic hazard in Campi Flegrei, Vesuvius and Etna (Italy), Lisbon (Portugal) and Hveragerdni (Iceland) (Figure 1).

Figure 1. *Screenshots of the four videos created within the UpStrat-MAFA project (https://www.youtube.com/channel/UCg0VxYGPYa2bUGXIhZl35zQ, accessed 2 January 2025). The Campi Flegrei volcano (Italy) appears as the hidden threat for the densely populated city of Naples with Vesuvius in the background (a); damage from low-magnitude earthquakes caused by faulting in the Mt Etna area, Italy (b); a view of the 600 thousand inhabitants Great Lisbon city (Portugal) with housing not compliant with modern building codes (c); non-structural damage surprising the city of Hveragerdni (Iceland) during the M5.9 earthquake in 2008 (d).*

The KnowRISK project, carried out between 2015 and 2018, further advanced this awareness-raising framework with a strong focus on communication. Its goal was to help European citizens and institutions address the issue of Non-Structural Elements (NSE; furnishing and equipment, architectural components and building utilities), which under seismic stress can cause unexpected damage and reduce resilience [e.g., Lopes et al., 2019]. KnowRISK identified schools, citizens, and business groups as key audiences to implement its communication actions [Musacchio et al., 2018]. Much

of the project was dedicated to designing tools that would promote preventative actions and raise awareness about best practices among various stakeholders.

This framework for communication and awareness raising aimed to empower stakeholders by increasing their knowledge and encouraging proactive risk mitigation. Practical and easy-to-apply solutions were developed to reduce the vulnerability of NSEs, and were disseminated through various media channels. Table 2 reports the project's key resources, which included a Portfolio of Solutions [Ferreira et al., 2018] for professionals and business groups, a Practical Guide for citizens [O'Neill et al., 2019], and a Students' Short Guide [Solarino et al., 2021a]. These tools were designed to raise awareness of the risks posed by NSEs in homes, schools, and workplaces, and to provide simple mitigation strategies.

The Practical Guide outlines a path to making homes safer, implementing progressively more complex and costly measures, focusing on moving, protecting, securing, and retrofitting vulnerable items. The Students' Short Guide depicted familiar school settings—classrooms, science labs, cafeterias, gym locker rooms—as well as home environments like bedrooms, living rooms, kitchens, and bathrooms, all under the effect of seismic shaking. Both guides were instrumental in raising awareness.

The major stakeholders of the project were schools that had a different level of engagement in the three countries involved (Portugal, Iceland, and Italy), mostly in response to local needs (Figure 2).

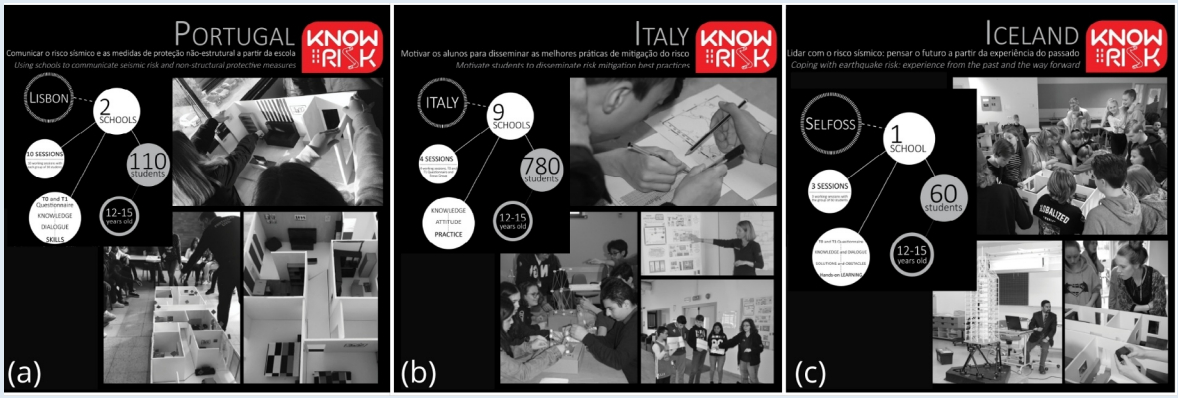

Figure 2. *Overview of school initiatives presented at the KnowRISK project's final meeting in Lisbon. The summary was provided in Portuguese to better engage local school representatives invited to participate. Each of the three countries involved, Portugal, Italy, and Iceland, developed strategies specifically tailored to address the unique needs, priorities, and challenges faced by schools in participating in the project's activities.*

UPStrat-MAFA project			
Awareness raising Tools			
Description	Name and/or Internet site	Type	Scientific Reference
Leaflet of the UPStrat-MAFA project	UPStrat-MAFA brochure	booklet	doi: 10.1007/s10518-015-9782-6
Layman's report	UPStrat-MAFA Layman's report	booklet	doi: 10.1007/s10518-015-9782-6
Multimedia platform	UPStrat-MAFA multimedia platform	SW tool	doi: 10.1007/s10518-015-9782-6
Website of the UPSTrat-MAFA project	http://upstrat-mafa.ov.ingv.it	website	doi: 10.1007/s10518-015-9782-6
UPSTrat-MAFA social media	Facebook webpage devoted to raise awareness of general public on earthquake hazard https://www.facebook.com/pages/Before-it-is-too-late/364231290361280	webpage	doi: 10.1007/s10518-015-9782-6
	Facebook webpage specifically targeted to earthquake preparedness using serious games https://www.facebook.com/pages/Treme-Treme/731295750254697?ref=bookmarks	webpage	doi: 10.1007/s10518-015-9782-6
YouTube channels	Before it's too late https://www.youtube.com/user/beforeitis2late/feed	webpage	doi: 10.1007/s10518-015-9782-6
	UPSTrat-MAFA project https://www.youtube.com/channel/UCg0VxYGPYa2bUGXlhZl35zQ/feed	webpage	doi: 10.1007/s10518-015-9782-6
Treme–Treme educational game		software tool	doi: 10.1007/s10518-015-9779-1
Public outreach events: ScienzAperta		meeting & workshop	doi: 10.1007/s10518-015-9779-1
Needs-priorities-obstacles assessment			
Questionnaire: Prevention and preparedness in emergency situations for schools and health/welfare institutions		questionnaire	doi: 10.1007/s10518-015-9771-9
Unstructured interviews	"Before it's too late" https://www.youtube.com/watch?v=yZ2TXGnOcMU; https://www.youtube.com/watch?v=kaZM5SPIZOg; https://www.youtube.com/watch?v=PxXo8QcLSS4	video tool	doi: 10.1007/s10518-015-9779-1
	"Hveragerði… in compliance with nature"	video tool	doi: 10.1007/s10518-015-9779-1
	"Campi Flegrei" https://www.youtube.com/watch?v=t1idxbKXDBA	video tool	doi: 10.1007/s10518-015-9779-1
	"Mount Etna" https://www.youtube.com/watch?v=HOPYFcyXA_8	video tool	doi: 10.1007/s10518-015-9779-1
	"Voices of earthquake preparedness" https://www.youtube.com/watch?v=1S5NWg3mbhY	video tool	doi: 10.1007/s10518-015-9779-1

Table 1. *A list of risk and hazard communication products developed within the UPStrat-MAFA project's framework (all links: accessed 2 January 2025).*

In Lisbon (Portugal) the low level of awareness [Silva et. al., 2019a] required a more in-depth engagement with 10 sessions of activities; in Italy the activities were grouped in 4 sessions in favour of a more diffuse engagement that reached 780 students and 9 schools; finally, in Iceland the high-level of awareness allowed to have only 3 sessions of activities that were tested in 1 school. All the activities were subjected to an assessment of effectiveness through customized strategies. In Lisbon the evaluation had to be more qualitative and required a more in-depth interaction with the students [Silva et al., 2019b]. In Italy and Iceland, the assessment was carried out through a specific questionnaire designed and submitted to the student ex-ante and ex-post [Crescimbene et al., 2019; Plat et al., 2019] proving the communication strategy to be effective (Figure 3; Musacchio et al. [2021]).

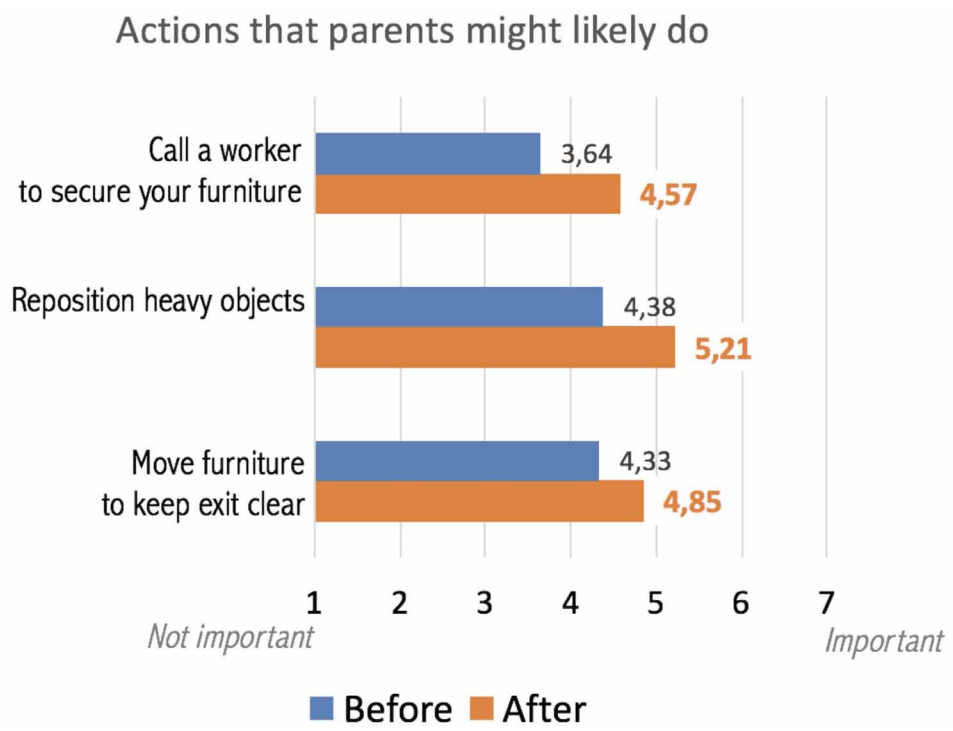

Figure 3. *Graph illustrating the evaluation of preventive actions before and after the school training session. It shows the average likelihood of parents adopting preventive measures presented during awareness-raising initiatives with schools. The values represent averages based on a Likert scale ranging from 1 (not important) to 7 (important). The graph highlights the domino effect of knowledge dissemination, emphasizing how awareness in schools can influence family behaviors (adapted from Musacchio et al. [2021]).*

KnowRISK project			
Awareness raising tools			
Description	Name and/or Internet site	Type	Scientific Reference
Booklet of the KnowRISK project	Photographic documentation with observed NSD during recent earthquakes at Etna volcano	booklet	doi: 10.4401/ag-8412
Data obtained from notes appearing in national newspapers as published at the time		newspapers	doi: 10.4401/ag-8412
Fire Brigade data		data	doi: 10.4401/ag-8412
Testimonials from people who experienced the earthquake	http://sismo1969.ipma.pt	Website	doi: 10.4401/ag-8412
Practical Guide	https://knowriskproject.com/practical-guide/	Polyptych	doi: 10.4401/ag-8439
Students Short Guide	https://knowriskproject.com/students-short-guide/	Polyptych	doi: 10.4401/ag-8439
KnowRISK Portfolio of solutions	https://knowriskproject.com/portfolio/	Polyptych	doi: 10.4401/ag-8439
"Move, Protect & Secure" videos awareness campaign	https://knowriskproject.com/move-protect-secure/	Webpage	doi: 10.4401/ag-8439
Exhibit based on Augmented Reality	http://www.settimanaterra.org/node/2468	exhibit	doi: 10.4401/ag-8439
Educational tools for students	House model activity after shake test	exhibit	doi: 10.4401/ag-8439
	Table game "Do it right: be safer!" doi: 10.4401/AG-8436	board game	doi: 10.4401/ag-8439
	"Treme-Treme 2.0" serious game https://knowriskproject.com/jogo-treme-treme/	video game	doi: 10.4401/ag-8436
	Find the difference: be safer!	board game	doi: 10.4401/ag-8436
KnowRISK - risk communication campaign for schools	"Know your school: be safe"	meeting & workshop	doi: 10.4401/ag-8533
Website of the KnowRISK project	https://knowriskproject.com/	website	doi: 10.4401/ag-8394
Newsletter of the project KnowRISK	https://knowriskproject.com/newsletter/	newsletter	doi: 10.4401/ag-8394
3D cartoon on potential NSD at home	https://knowriskproject.com/brochures/	brochures	doi: 10.4401/ag-8394
Shaking test of an earthquake-resistant structure	Shake it!	hands-on activity	doi: 10.4401/ag-8394
Layman's report	https://knowriskproject.com/knowrisk-layman-report/	video tool	doi: 10.4401/ag-8394
Shaking table test on bedroom	https://knowriskproject.com/move-protect-secure/	video tool	doi: 10.1080/15583058.2016.1238975
Lisbon Metro launched the KnowRISK awareness campaign - October 2018		poster campaign	doi: 10.4401/ag-8394
National and international dissemination events	https://knowriskproject.com/news-events/	meeting & workshop	doi: 10.4401/ag-8394
Public outreach venues: ScienzAperta	https://knowriskproject.com/project-dissemination/	meeting & workshop	doi: 10.4401/ag-8436
Needs-priorities-obstacles assesment			
Questionnaire inside Portuguese KnowRISK communication campaign designed to generate awareness and knowledge inside schools		meeting & workshop & questionnaire	doi: 10.1007/978-3-319-78187-7_33
Italian seismic risk perception questionnaire - KnowRISK project		questionnaire	doi: 10.1007/978-3-319-78187-7_35
Common(European)Tool to Assess Earthquake Risk Communication		questionnaire	doi: 10.1007/978-3-319-78187-7_37

Table 2. *A list of the products developed within the KnowRISK project's framework (all links: accessed 2 January 2025).*

Innovative tools that were developed to effectively engage different stakeholders, including young people and general public, also stood on Augmented Reality (AR) applications [Reitano et al., 2019]. They were tested within science outreach events, such as the Italian national meeting “Settimana del Pianeta Terra” (Week of Planet Earth) in 2017 (Figure 4). In particular, the “Talking poster” was designed as a display interactive stand with customized information, in which “augmented” posters could tell the AR user their own content and allow an effective engagement on seismic risk reduction [Falsaperla et al., 2022].

Figure 4. *Augmented Reality (AR) applications were implemented as part of the KnowRISK project to engage and raise public awareness about the seismic risk posed by NSE. The photo is from the exhibition at the “Settimana del Pianeta Terra” in 2017, which enabled the AR experience [from Falsaperla et al., 2021].*

3. Discussion

Strengthening disaster preparedness in the field of earthquake risk requires effective communication in terms of tools and channels that can reach different audiences [e.g., Audru et al., 2013]. Cultural and/or economic disparities lead indeed to a different perception of risk [Herovic et al., 2020].

The projects presented in this work allowed to draw lessons that were grounded on the ethical principles of responsibility to inform at risk-communities, equity and inclusivity of information and its long-term commitment.

The ethical responsibility of information includes the principles of accessibility and understanding of diverse audiences. By fostering informed communities, we can empower individuals to take appropriate actions to mitigate risks and be prepared for potential disasters. This access should be equitable, particularly for the most vulnerable groups of populations, such as the elderly [Bernhardsdottir et al., 2016].

The assessment of at-risk community's needs-priorities and obstacles undertaken in both projects followed these principles [Bernhardsdottir et al., 2016; Crescimbene et al., 2019; Platt et al., 2019; Ferreira et al., 2021]. Furthermore, by reaching out the school community, these projects recognized that raising awareness on seismic risks is not a one-time effort, but rather an ongoing process. Educational initiatives should be designed with long-term sustainability in mind, ensuring that communities remain engaged and informed over time.

What made unique these projects was the international framework. Seismic risk awareness is the result of communication that is typically pursued at local, regional or national levels [Musacchio et al., 2023]. However, the international framework is an opportunity to learn from different perspectives and address the ethical issue of being inclusive while being specific. In Europe, quantitative information on the effectiveness of seismic communication is scarce, despite the high potential hazard in several countries. This is a crucial aspect, as targeted audiences differ in gender, education level, financial income, religion, as well as personal experience of previous earthquakes. For example, in the three countries involved in the KnowRISK project, namely Portugal, Italy and Iceland, seismic risk communication to increase resilience was tailored to local needs, taking into account past earthquake experience. Ground shaking is frequent in Italy and Iceland, enabling an effective science-practice interface for the implementation of good practices, such as "move, protect, secure" at home, school and office. On the other hand, effective efforts to improve seismic resilience are a low priority in Portugal, where earthquakes are relatively rare and the memory of past disastrous seismic events is weak.

We have understood that addressing issues closer to what the communities could actually do on their own is an effective way to engage and empower them.

Another lesson we have learned regards the need to implement engaging formats that could trigger curiosity at any age. By transforming complex scientific concepts into engaging formats, such as serious games (Treme-Treme) and augmented reality tools (the talking poster), UPStrat-MAFA and KnowRISK helped at-risk communities better understand seismic risk, making communication accessible to diverse audiences [Botellho, 2019; Reitano et al., 2019; Lopes et al., 2021; Solarino et al., 2021b; Falsaperla et al., 2022].

The actions rooted in the described projects had a fruitful follow-up that ranged from addressing different audiences, such as healthcare's staff, to capitalizing on know-how for a different hazard, such as the sea level rise, to implementing different tools, such as an exhibition addressing non-structural elements of buildings.

Finally, the projects extended beyond immediate outcomes, leading to exhibitions at international science festivals (Figure 5), the development of serious videogames [Goretti and Musacchio 2024; Solarino et al., 2024], and the application of their communication methods to other hazards [Solarino et al., 2023; 2024] or other stakeholders [Zidarich et al., accepted]. Their successes underline the critical importance of tailored communication strategies in turning technical data into practical knowledge. When this information is understood and applied, it can positively influence behaviour and enhance resilience in areas prone to disasters.

4. Conclusions

Raising seismic risk awareness among at-risk communities is foundational to effective disaster risk management. Insights from the European projects UPStrat-MAFA and KnowRISK demonstrate that communication strategies are most effective when inclusive, accessible, and adapted to the cultural and economic contexts of the targeted communities [Audru et al., 2013; Herovic et al., 2020].

A key lesson from these projects is that awareness and preparedness education must be a continuous, sustainable effort. Engaging younger audiences through interactive tools has shown promising in fostering lifelong preparedness [Reitano et al., 2019; Lopes et al., 2021]. Moreover, these projects underscore the unique value of an international framework, which enhances the adaptability and inclusivity of risk communication methods through cross-border knowledge sharing.

An important takeaway is the need to assess communication effectiveness. Future work in the field of awareness raising should also include guidelines that practitioners should follow.

Figure 5. *Images from the exhibition "Terremoti: Attenti agli Elementi! Dettagli che salvano la vita" (Earthquakes: beware of Elements - Saving life Details) displayed at the Genova National Science Festival in 2019. The exhibition included 3D mock-up items, videos, educational shake-table and games. It has been displayed in several cities across Italy [INGV, 2024].*

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