journal of Geoethics and social Geosciences

Journal of Geoethics and Social Geosciences, 02, Special Issue, 2025; doi:10.13127/jgsg-56

The contribution of psychosocial research to earthquake and tsunami risk mitigation

Massimo Crescimbene and Federica La Longa*

Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

Article history: received October 29, 2024; accepted December 21, 2024; published February 21, 2025

Abstract

This article explores the psychosocial dimensions associated with the study of natural hazards, focusing on research activities and key experiences gained during Italy's major seismic emergencies from 2009 to the present. Particular attention is given to the perception of seismic and tsunami risks, based on research conducted by the Istituto Nazionale di Geofisica e Vulcanologia (INGV) in Italy since 2012. The article examines the memory of past disasters and its role in fostering community awareness of the natural hazards that affect their regions. It also highlights INGV's initiatives, including risk awareness campaigns targeting citizens and educational programs designed for schools. Furthermore, the seismic emergency information interventions conducted during the three most recent large-scale emergencies—Abruzzo (2009), Emilia-Romagna (2012), and Central Italy (2016–2017)—are presented. These emergency information activities not only meet the need for reliable information and counter misinformation but also offer opportunities for psychoeducational interventions. Ultimately, these efforts aim to offer psychosocial support and promote the restoration of local social networks. The themes discussed contribute to the development of effective strategies and actions for risk reduction.

Keywords: Psychosocial research; Natural hazards; Risk mitigation; Risk perception; Emergency psychology

1. Introduction

The growing emphasis on the human factor and community involvement in risk prevention, emergency response, and recovery from catastrophic events marks a significant evolution in disaster management over recent decades. This shift reflects a broader recognition that effective disaster management extends beyond infrastructure and technology—it fundamentally relies on the engagement and resilience of the people and communities impacted by these events.

1.1 The human factor in policies for reducing natural risks

The International Decade for Natural Disaster Reduction (IDNDR)[1], initiated on 1 January 1990, represented a concerted global effort aimed at mitigating the detrimental impacts of natural disasters. The primary goals were to minimize loss of life, damage to property, and the social and economic disruptions that often ensue from such events, particularly in developing countries. A significant aspect of the IDNDR was its focus on harnessing scientific and technical knowledge to enhance public awareness and shift perceptions from fatalism to proactive disaster risk reduction.

A landmark development during this decade was the adoption of the Yokohama Strategy for a Safer World[2] in 1994. This strategy marked a pivotal shift in the approach to disaster risk management, moving beyond a strictly scientific and technical focus to incorporate socioeconomic factors into risk analysis. It recognized that human actions play a crucial role in shaping a community's vulnerability to natural hazards. This shift laid the groundwork for a more comprehensive understanding of disaster risk that included the social dynamics at play within communities.

Building on the insights gained from the IDNDR and the Yokohama Strategy, the Sendai Framework for Disaster Risk Reduction (2015-2030)[3] further advanced the discourse by emphasizing the role of social sciences in disaster prevention and risk management. It underscored the necessity of adopting a more holistic, people-centred approach that considers the complexities of communities, geographical contexts, and social vulnerabilities.

From a psychosocial perspective, disasters can be seen as a 'failure' of a

[1] https://www.undrr.org/our-work/history (accessed 29 January 2025).
[2] https://www.undrr.org/publication/yokohama-strategy-and-plan-action-safer-world-guidelines-natural-disaster-prevention (accessed 29 January 2025).
[3] https://www.undrr.org/implementing-sendai-framework/what-sendai-framework (accessed 29 January 2025).

community's future expectations. In this framework, social resilience becomes a critical concept, defined as a community's ability to withstand and recover from disasters while maintaining its vision for the future. Resilience encompasses various capacities [Lorenz, 2013]:

- *Adaptive Capacity*: This refers to a community's ability to adjust its structures and processes to prevent potential future disasters. It involves learning from past experiences and proactively making changes to enhance safety and preparedness.
- *Coping Capacity*: This capacity is about how well a community can manage the immediate impacts of catastrophic events based on its past experiences. It includes the resources, strategies, and support systems that a community can draw upon in times of crisis.
- *Participatory capacity*: This refers to the extent to which a community can interact and influence other systems, as well as adapt collaboratively in response to external challenges. It highlights the importance of social networks, communication and inclusive decision-making.

In summary, the evolution of disaster risk management policies from the IDNDR through the Yokohama strategy to the Sendai Framework highlights the importance of the human factor in understanding and mitigating natural risks. In the next paragraph we describe how the inclusion of human sciences in the risk mitigation process has brought attention back to the importance of developing specific skills and training specialized personnel in emergency situations (primarily psychologists but also doctors, educators and social workers), with specific reference to the Italian experience.

1.2 The psychological impact of earthquakes: The birth of emergency psychology in Italy

Earthquakes pose significant challenges not only as natural disasters, but also as profound psychosocial and economic events that can dramatically affect communities and people's lives.

The historical discourse on the psychological effects of earthquakes can be traced back to Seneca, who addressed the seismic disaster in Campania in 62 AD in his work "Natural Questions." Seneca specifically noted the inverse relationship between the understanding of natural phenomena and the fear they evoke, a concept that resonates over time as communities deal with the psychological consequences of seismic events. In Italy, the study of psychological responses to

earthquakes gained traction after the catastrophic earthquake of Messina and Reggio Calabria in 1908. This marked one of the first instances in which psychology, together with psychiatry, addressed the repercussions of a major natural disaster [Ceccarelli, 2016]. Over the years, noteworthy contributions have emerged, including the insights of Tito Cancian, a psychologist who documented the psychological and social transformations he witnessed after the 1976 Friuli Venezia Giulia earthquake [Cancian, 2016]. His observations laid the foundation for understanding community psychological responses to disasters.

Another significant advance came from Giulia Villone Betocchi, a noted professor at the University of Naples Federico II, who published her research on the psychological aspects of the 1980 Irpinia earthquake [Villone Betocchi, 1982]. These early studies laid the foundation for recognizing the psychological ramifications of earthquakes and the need for psychological support in emergency settings.

However, it was the 1997-1998 earthquakes in the regions of Umbria and Marche that catalysed the formal incorporation of psychological support into emergency response efforts. The prolonged nature of the seismic sequence, characterized by approximately 9,000 shocks in six months, prompted responders to recognize emerging psychological problems in the affected populations. This awareness led to the establishment of psychological support services, emphasizing the importance of addressing not only the immediate physical needs of disaster victims, but also their psychological well-being, in line with Maslow's hierarchy of needs [Maslow, 1962].

In the following years both the United Nations Inter-Agency Standing Commitee [IASC, 2007] and the World Health Organization (in 2011[4]) recognized the critical importance of emergency psychology in addressing the mental health needs of individuals and communities during crises, promoting integrated responses that combine physical and mental health care. Their frameworks and guidelines aim to inform and improve the psychological response to emergencies, ultimately contributing to the overall recovery and well-being of affected individuals and communities. In Italy, the 1997-1998 Umbria-Marche earthquakes was an opportunity to test a new approach to psychological support for disaster-affected populations. As part of the emergency response, Listening Centres were established in temporary tent cities, staffed by psychologists from the Social and Health Services of the Local Health Authorities (AUSL) in the affected regions. These centres provided essential psychological support, laying the foundation for the field of emergency psychology in Italy. After the 1997-1998 Umbria-Marche earthquakes, a vibrant community of psychologists began to emerge, organizing

[4] Psychological first aid: Guide for field workers: https://www.who.int/publications/i/item/9789241548205 (accessed 29 January 2025).

meetings, conferences, and initiatives aimed at developing a structured approach to emergency psychology. This movement culminated in the founding of the *Società Italiana Psicologia dell'Emergenza*[5] (Italian Society of Emergency Psychology, SIPEM) in June 1999 in Rome, under the presidency of Maura Mauri. Shortly thereafter, on 22 November 1999, the voluntary association *Psicologi per i Popoli*[6] (Psychologists for the People) was founded in Bolzano, led by Luigi Ranzato [Ranzato, 2018].

1.3 Guidelines for psychosocial interventions in emergencies

The evolution of emergency psychology interventions reflects a significant shift in focus from individual responses to community-oriented approaches in the aftermath of major natural disasters. This transformation is evident in both Italian and international frameworks, which emphasize the collective well-being of affected populations rather than just addressing individual psychological needs.
In Italy, starting from the establishment of the National Civil Protection Service (Law n. 225/1992[7]), over the course of a decade, the establishment of the Directive of the President of the Council of Ministers "General criteria for psychosocial interventions to be implemented in disasters"[8] in 2006, aimed to create a structured response to crises, marked a milestone. This directive underlined the importance of forming Psychosocial Teams for Emergencies (EPE) comprised of volunteers, local authorities, and professionals. The team's primary goals include:

- *Physical and Psychological Protection*: Implementing programs that prioritize the safety and mental health of citizens, leveraging personal and community resources.
- *Cultural Sensitivity*: Ensuring that the dignity of individuals is respected during rescue operations, with attention to cultural differences.
- *Information Dissemination*: Providing the affected population with knowledge about stress management, responses to crises, and practical needs, along with tools for effective communication.

On the international stage, the 2007 guidelines from IASC emphasized the necessity of social support in the initial stages of emergencies to safeguard mental health

[5] http://www.sipemsos.org/ (accessed 29 January 2025).
[6] https://www.psicologiperipopoli.it/ (accessed 29 January 2025).
[7] https://www.protezionecivile.gov.it/static/9572d8eb1b17f9519e9cbb2c66af7431/Legge_225_24febbraio1992.pdf (accessed 29 January 2025).
[8] https://www.protezionecivile.gov.it/static/f6a9303090af15510fa231923586d9a3/decreto13giugno2006criterimassima.pdf (accessed 29 January 2025).

and psychosocial well-being. These guidelines advocate for a tiered intervention approach, as illustrated in a pyramid model where the majority of interventions focus on community and family support, with only a small percentage requiring specialized psychological care (Figure 1).

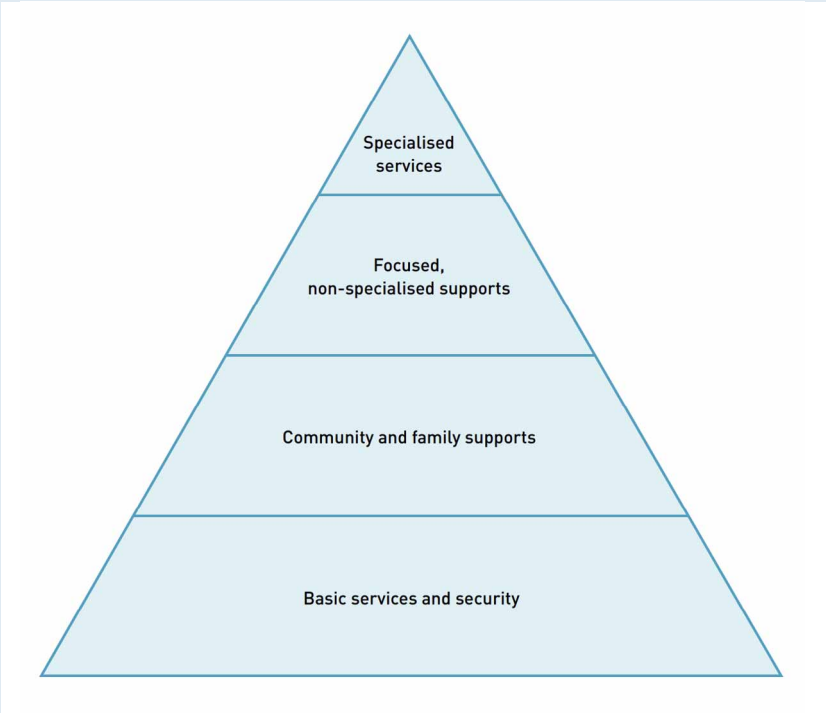

Figure 1. *The intervention pyramid for mental health and psychosocial support in emergencies [IASC, 2007].*

This shift in focus acknowledges that human behaviour in emergencies is deeply influenced by the socio-environmental context, interpersonal relationships, community characteristics, familial roles, and the social meanings attributed to disasters. The integration of these factors is essential for effective emergency response.

As highlighted in the literature [e.g., Pietrantoni and Prati, 2009; Sbattella, 2009], the approach to emergency psychology has transitioned from a predominantly clinical model—centred on diagnosing conditions like post-traumatic stress disorder (PTSD)—to a more holistic psychosocial model. This model prioritizes the understanding of normal psychological reactions in abnormal situations, emphasizing prevention, community resilience, and the recovery of cultural resources.

In summary, contemporary emergency psychology recognizes the importance of community dynamics and collective support in disaster response, moving away from a focus on individual pathology to a broader understanding of psychosocial well-being, privileging a collective approach. This new approach also paves the way for prevention and developing an educational process aimed at the entire population as a fundamental strategy for risk mitigation.

2. Risk education

This section discusses the importance of integrating psychology, social sciences, and emergency management to enhance community resilience against various risks. It emphasizes the need for proactive risk education, which should provide a comprehensive understanding of different risk types—natural disasters, health emergencies, and technological hazards—enabling individuals to identify and respond to potential threats. Key elements of a risk education process should include:

- *Psychological Resilience*: Programs should address emotional responses to threats, offering coping strategies like mindfulness and open discussions to foster community support [Reivich and Shatté, 2003].
- *Community Engagement*: Collaboration through drills and workshops is vital for building support networks and ensuring inclusivity, particularly for marginalized groups [Paton and Johnston, 2001].
- *Empowerment through Knowledge*: Practical skills training and hands-on experiences are essential for boosting confidence and promoting a culture of preparedness [Chally, 1992].
- *Utilization of Digital Tools*: Technology can enhance risk education and communication, providing real-time information and fostering community connections.
- *Cultural Sensitivity*: Educational programs should reflect local contexts and practices, involving community leaders to ensure relevance and acceptance [Tierney and Waugh, 2007].
- *Continuous Learning and Adaptation*: Regular updates to risk education programs based on new research and community feedback are necessary to remain effective [Wenger et al., 2002].

In addition, the DIKW Framework (Data, Information, Knowledge, Wisdom) offers an approach for transforming risk data into actionable strategies [Wisner, 2006; Wallace, 2007], further enhancing the integration of knowledge into practical disaster management, including risk education activities.

The next sub-sections (2.1 and 2.2) discuss the Italian experience of the EDURISK[9] project, a multi- and interdisciplinary initiative for the mitigation of seismic and volcanic risk aimed at schools, as well as a specific application of the project on the occasion of the centenary of the Messina and Reggio Calabria earthquake of 1908.

2.1 A project designed for prevention: the EDURISK project

The EDURISK project is a key example of the implementation of educational pathways for risk reduction. Originating in the 1990s within the Gruppo Nazionale per la Difesa dai Terremoti (National Group for the Defense Against Earthquakes, GNDT-CNR[10]), EDURISK represents the culmination of a line of studies and research that envisioned information and training on earthquakes as central to risk mitigation strategies. The project's aim is to raise awareness of risk and promote the active role of citizens in its reduction. While earthquakes, volcanic eruptions, and other natural events can be very dangerous for humans, whether they become a risk depends largely on human actions—the way we interact with and modify the territory, and the choices we make every day. The project was conceived and developed with the support of, and within, the Italian National Civil Protection System, which views it as a 'service' in which every citizen is an essential component. Table 1 shows the main stages of the EDURISK project, tracing its evolution and developments over more than 20 years of activity.

EDURISK was created for schools to provide teachers with the tools needed to design classroom courses on seismic and volcanic phenomena. To this end, the project has developed educational materials and organized training programs for teachers, while also drawing upon their expertise and experience. Over the years, EDURISK has engaged more than 4,000 teachers and over 70,000 students across 14 Italian regions, implementing annual or multi-year risk education projects in nearly 250 schools. A distinctive aspect of the project is its multidisciplinary team, which integrates expertise in research, communication, and training. The research group includes specialists from diverse disciplines that contribute to understanding the multifaceted nature of seismic and volcanic risk. These disciplines include geology, seismology (seismic hazard and historical seismology), seismic engineering, and psychology.

When the project was first conceived, it was based on the belief that educational initiatives targeting schools could lead to lifestyle changes and inspire concrete actions for risk reduction.

[9] https://www.edurisk.it/ (accessed 29 January 2025).
[10] https://emidius.mi.ingv.it/GNDT2/ (accessed 29 January 2025).

Year	Description
1999	On 29 September 1999, with the decree establishing INGV, GNDT merged with INGV. A group of researchers from GNDT presented the EDURISK project as part of the 2000-2002 Framework Project funded by the Civil Protection Department (DPC).
2002-2004	EDURISK was officially approved, with partial funding, by the DPC for the 2002-2004 biennium.
2003	The production of the first educational materials for schools: 'What if there's an earthquake?'[11] for preschools, "Earthquake Lesson"[12] for primary schools, and "Earthquakes how and why"[13] for secondary schools.
2004	With the collaboration of teachers from schools in the Friuli, Emilia Romagna, and Calabria regions, the educational guide "A Prova di Terremoto"[14] (Earthquake-proof) was created, featuring 24 teaching units for primary and secondary schools.
2005-2007	The second EDURISK project was approved, with educational projects on volcanic risk added to the seismic risk education courses. Schools near major Italian volcanic areas—such as Mount Vesuvius, the Phlegraean Fields, Etna, and the Aeolian Islands—are involved.
2006-2008	A new educational tool, "Earthquakes and Ghost Towns in Sicily"[15], is produced. This is the first DVD dedicated to "virtual itineraries in Italian seismic history", illustrating the virtual reconstruction of abandoned places in Sicily after earthquakes.
2008-2009	The third EDURISK project began. From that moment on, EDURISK became part of the Agreement between INGV and DPC as a permanent service activity.
2009	EDURISK's website changed its look to include a section hosting materials produced in the classroom by students.
2009-2010	The EDURISK project, already active in Abruzzo since 2007, added new training courses dedicated to supporting teachers and students of schools affected by the 2009 earthquake.
2010-2012	After the seismic sequence that affected the province of Frosinone, central Italy, in the autumn of 2009, and in agreement with the DPC and the Lazio Region administration, information and teacher training meetings were held, involving schools of 25 municipalities in the area over two years. The project ended with a public event in May 2012.
2011	The EDURISK project promoted the "Terremoto Dentro" (Earthquake Within) project, an internship with the Liceo di Scienze Sociali "Alessandro da Imola" and the Department of Mental Health of Imola (northern Italy). The project produced a video, a CD of songs, a theatrical performance, and a book of stories about the emotional experience of the earthquake.
2015	With the update of the Vesuvius and Phlegraean Fields emergency plans, the DPC, in collaboration with the Campania Region administration and the Regional School Office, promoted the extension of the project to municipalities within the respective "red zones" (these are areas where preventive evacuation is the only safeguard measure for the population in the event of an alert due to a volcanic eruption). In January 2015, training meetings were held with teachers from 35 schools in the Vesuvius and Phlegraean Fields municipalities.
2015	The new edition of the educational guide "A Prova di Terremoto" (Earthquake-proof, see footnote 14) was created, collecting and expanding upon ideas that emerged from the experiences of the earthquakes in L'Aquila in 2009 and the Po Valley in 2012.
2016-2021	The EDURISK project launched the "100 anni dopo" (100 years later) initiative aimed at reconstructing the memory of past earthquakes. The activities aimed to preserve the memory and give meaning to the traces and symbols present in areas affected by earthquakes. The first activity was carried out in Calabria during the 2008-2009 school year (the centenary of the 1908 Messina and Reggio Calabria earthquake). In the following years, a series of interventions were carried out to mark the anniversaries of earthquakes in the central-northern Apennines from 1916 to 1920.
2021-Present	The EDURISK project has continued to offer training opportunities for teachers and school children and to organize information and communication meetings in complex situations, such as seismic events in the Phlegraean Fields.

Table 1. *The main stages of the EDURISK project.*

[11] https://www.edurisk.it/book/what-if-theres-an-earthquake/ (accessed 29 January 2025).
[12] https://www.edurisk.it/book/earthquake-lesson/ (accessed 29 January 2025).
[13] https://www.edurisk.it/book/earthquakes-how-and-why/ (accessed 29 January 2025).
[14] An updated version published in 2015 (only in Italian), is available at: https://www.edurisk.it/book/a-prova-di-terremoto/ (accessed 29 January 2025).
[15] https://ingv.it/en/newsletter-no.-7/3740-earthquakes-and-ghost-towns-in-Sicily-a-journey-through-the-places-of-memory (accessed 29 January 2025).

The core idea was that the project itself would act as a catalyst for change. However, insights gained during the first decade revealed that the transitions from knowledge to awareness, and ultimately to action, rarely happen spontaneously. Instead, these transitions require guidance and, at times, deliberate encouragement to move individuals and communities toward action. This realization led to the conviction that achieving meaningful change—whether at the individual or collective level—requires careful consideration of the human factor [Crescimbene and La Longa, 2012]. This awareness also spurred the development of psychosocial research within the project, focusing on critical themes such as risk perception and disaster memory, enriching its approach to risk education and disaster preparedness.

2.2 Traces of Memory: the centenary of the 1908 Messina and Reggio Calabria earthquake and beyond

Many studies highlight the role of the transmission of memory of past disasters and more generally of cultural memory as an effective tool for reducing disaster risk [Friedman, 1987; Van der Kolk, 1998; Shenk et al., 2009; Fanta et al., 2019; Pisa, 2024]. Remembering is a dynamic process in continuous evolution that reshapes its contents in accordance with the present, the context and time. In this process some parts emerge (memory) while others are submerged (oblivion). Memory and oblivion are therefore parts of the same process. The mind's archive does not have static and passive characteristics but can be defined as an active constructor (also with regard to oblivion/removal) of representations of the world [Agazzi and Fortunati, 2007]. Collective memory, which is based on an oral tradition shared by a specific group, most commonly the family, tends to disappear with the death of the last eyewitness of the event (the limit of three generations) [Connerton, 1989; Olick, 1999; Hirsch, 2008; Brondi, 2021]. To address the limitations of oral transmission in preserving collective memory, communities use various documents, such as newspapers, archives and images, as well as monuments, which serve as tangible reminders of the emotions, meanings and interpretations associated with disasters. In the context of natural disasters, extending the duration of collective memory is essential. This is because the intervals between such events often exceed the duration of our memories of the disasters themselves, leading to a tendency to forget. In Italy, the average return time of earthquakes with a magnitude greater than 5.5 varies by region due to the complex tectonic situation of the country. A study by Cinti et al. [2004] provides a probability map for the occurrence of such earthquakes over a 10-year period. The results indicate that

some regions, including Friuli, Umbria-Marche, the Southern Apennines and the Calabrian arc, are more likely to experience earthquakes M ≥ 5.5 within a decade. Furthermore, research assessing seismic design risks in Italy suggests that earthquakes with magnitudes of 4.5, 5.5, and 6.5 have return periods of approximately 10, 50, and 500 years, respectively. The average return time of tsunamis in the Mediterranean region is highly variable and depends on the specific sub-region and tectonic setting. Studies estimate that significant tsunamis (those causing substantial impacts) in the Mediterranean have an average return time of approximately 100 to 150 years but smaller, localized tsunamis can occur more frequently, with return periods as short as a few decades [Triantafyllou, 2023]. The way in which memory is constructed and nurtured significantly influences both individual and collective perceptions of disasters and associated risks. Recognizing that collective memory is dynamic and evolves over time can promote the implementation of effective strategies to preserve and share experiences and lessons across generations and social groups. This, in turn, fosters greater awareness of disaster risk.

The EDURISK project has dedicated specific initiatives called "100 Years Later" to the reconstruction of the memory of past events, as a starting point for keeping memories alive and giving meaning to the traces and symbols present in the territories hit by earthquakes. The first, launched in Calabria in the 2008-2009 school year, is part of the activities dedicated to the celebrations of the Centenary of the great earthquake of 1908 in Messina and Reggio Calabria and involved over 500 teachers from 13 schools. The second one was born from one hundred years of anniversaries of a series of earthquakes in the central-northern Apennines. In fact, 2016 opens a five-year period of northern Apennines anniversaries (1916-1920). This is a series of centenaries of significant earthquakes that are still close enough to touch memory, located on an imaginary line that leads from the Adriatic to the Tyrrhenian Sea, in territories that are not only neighbouring but similar in many ways. These anniversaries have provided an opportunity to deepen understanding of the events themselves while also raising awareness among local communities about a risk that defines these territories. This risk not only faces the danger of being forgotten but also of being excluded from daily practices—both by citizens and local institutions. Such neglect can influence decisions that affect material and social vulnerability, ultimately increasing the overall risk. In 2016-2017, seven comprehensive schools and three higher education institutions between Pesaro (Marche region) and Rimini (Emilia-Romagna region) participated in the project. In 2018, 30 teachers from the Santa Sofia and Civitella di Romagna (Emilia-Romagna region) schools participated. In 2019, 30 teachers and 12 classes of primary and secondary schools in the Mugello area participated.

3. Risk perception studies

The topic of risk perception has undergone significant development since the 1960s, gaining particular prominence in Italy after the 2009 L'Aquila earthquake. This event attracted great attention because of the subsequent trial of the members of the Civil Protection Commission for Major Risks. In the first phase of the trial, seven experts were convicted, a decision that had a profound impact on both the scientific community and public opinion [Cocco, 2015].

Studies on risk perception originated in the USA in the 1960s, based on evidence that knowledge alone cannot explain why people perceive a certain risk in a more or less severe way. From this evidence, some authors introduced the concept of risk perception and defined methods and theories to study it [Slovic, 1987]. More recently, cognitive psychology, through the study on the Prospect Theory, proposed by Kahneman and Tversky [1979], Frame Theory [Tversky and Kahneman, 1992] and Mental Model Approach [Morgan et al., 2002], has highlighted how perception is able to influence human behavior regarding risk [Braisby and Gellatly, 2012]. From an anthropological and sociological point of view, the contribution of the Cultural Theory of Risk [Douglas and Wildavsky, 1983] must certainly be considered. The Cultural Theory of Risk takes into account the influence of culture, type of society and institutions on risk perception. Later, an effort to synthesize perception studies from psychological, sociological, and communicative perspectives has been made through the concept of the Social Amplification of Risk [Kasperson et al., 1988; Pidgeon et al., 2003], which describes how social and individual factors contribute to amplifying or reducing risk perception.

To study risk perception today, it is essential to consider various models and theoretical frameworks from cognitive science, sociology, cultural anthropology, institutional policy approaches, and social context [Af Wåhlberg, 2001; Rohrmann and Renn, 2000; Wachinger and Renn, 2010]. This complex theoretical framework is summarized in Figure 2 [Renn, 2008].

3.1 The first research on seismic risk perception in Italy

Following the 2012 Po Valley earthquake, the Italian Civil Protection Department (DPC) funded a large national project to improve the knowledge of seismic hazard (Project S2-2014-2015 Constraining Observations into Seismic Hazard, Task 8: Risk Perception and communication, coordinated by Laura Peruzza, OGS, Trieste; Francesca Pacor, INGV, Milan; Agostino Goretti, DPC, Rome). As part of this project, a questionnaire for the perception of seismic risk was developed. In the first year

of the project, the questionnaire was tested and validated via web, and in the following year, a telephone survey (Computer Assisted Telephone Interview - CATI) was conducted on a sample of over 4,000 Italian citizens. Figure 3 summarizes the results of the project on the perception of seismic risk, comparing the data collected via the web (Dot lines. Blue: PGA<0.15 and Red: PGA>0.15) with those of the telephone survey (Solid lines. Blue: PGA<0.15 and Red: PGA>0.15) [Crescimbene et al., 2014, 2015].

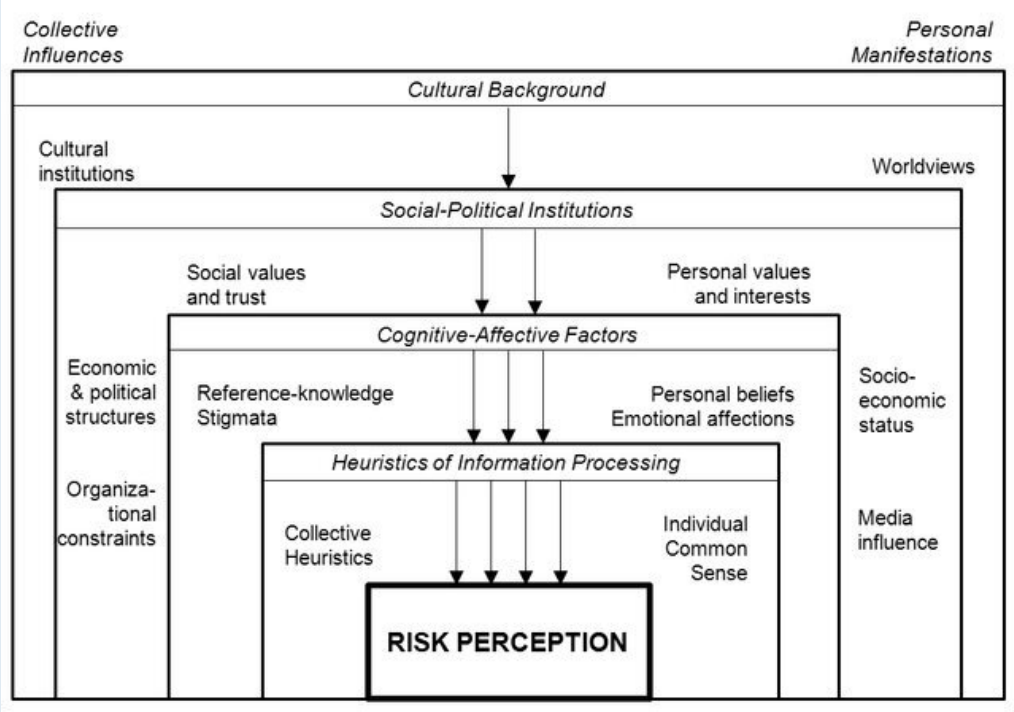

Figure 2. *Levels of risk perception [Renn, 2008].*

3.2 The INGV Tsunami Warning Center (CAT): research on the tsunami risk perception

The INGV-CAT has been promoting, since 2018, the study of tsunami risk perception in Italy. Between 2018 and 2021, a semi-structured questionnaire on the perception of tsunami risk was administered to a sample of 5,842 citizens residing in 450 Italian coastal municipalities, representative of more than 12 million people [Cerase et al.,

2019; Cugliari et al., 2022]. The survey was conducted with the computer-assisted telephone interviewing (CATI) methodology. The large sample and the sociodemographic stratification give an excellent representation of the resident population in the surveyed Italian coastal municipalities. Moreover, in 2021, an optimized version of the questionnaire was also administered via Telepanel (a tool for collecting proportional and representative opinions of citizens) ensuring a sample of 1,500 individuals reflective of the Italian population nationwide.

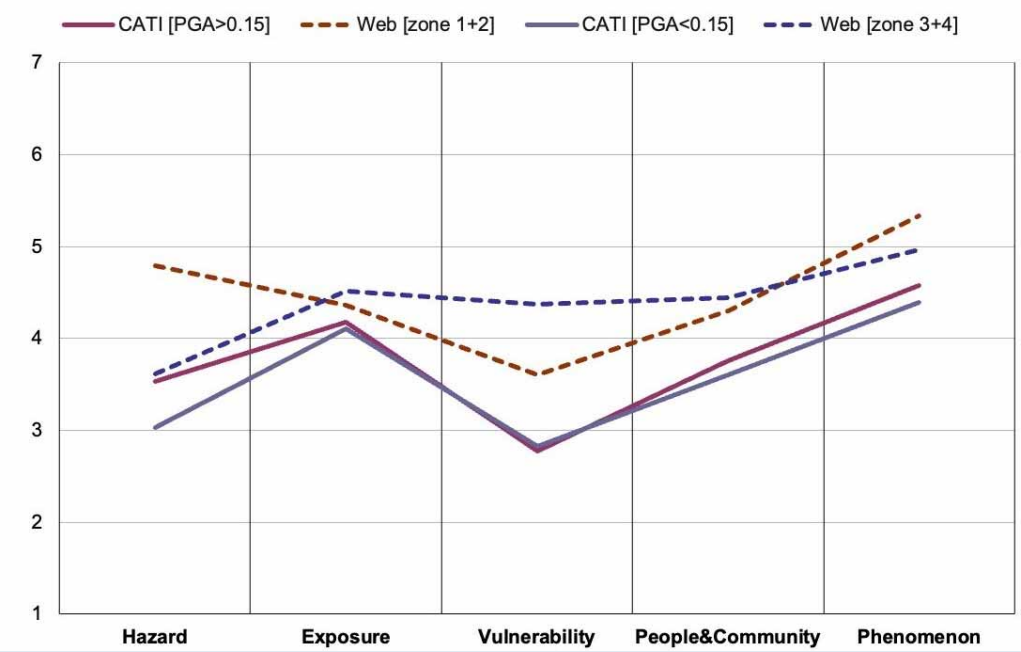

Figure 3. *Comparison of data collected via web and CATI survey data for the indicators of Hazard, Exposure, Vulnerability, People and Community (Capacity), and Phenomenon.*

Data analysis (Figure 4) reveals heterogeneous and generally low tsunami risk perception. Some seaside populations, in fact, show a good perception of tsunami risk, while others, such as in Apulia and Molise, reveal a lower perception, most likely due to the long time elapsed since the last event and lack of memory. No significant differences are observed in relation to the socio-demographic characteristics (age, gender) of the sample, whereas the level of education appears to influence risk perception. The Telepanel survey, based on a nationwide sample, indicates a lower level of tsunami risk perception compared to the average levels found in the coastal-

municipality sample [Cugliari et al., 2022]. These findings are being utilized to inform communication strategies aimed at reducing tsunami risk in Italy, support data-driven dissemination and educational programs, address data gaps on tsunami risk perception in the North-Eastern Atlantic, Mediterranean, and connected seas (NEAM) region, and implement multilevel civil protection actions at both national and local levels through both top-down and bottom-up approaches. Additionally, the results contribute to the further development of the UNESCO Tsunami Ready program in Italy.

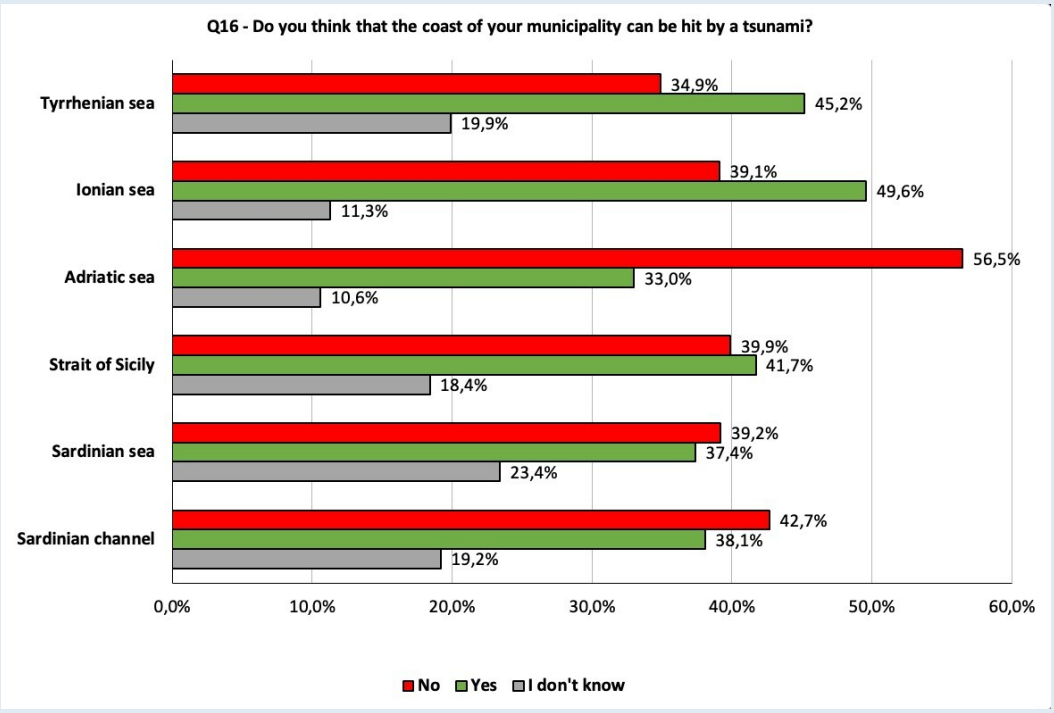

Figure 4. *Q16 - Tsunami risk perception in respondents' municipalities by coastal regions.*

4. After the earthquake: information activities for the citizens and rescuers along with some experiences in schools

After an earthquake, providing information and training to affected communities is essential for recovery, preparation and mitigation of future risks. This type of activity can be schematically distinguished based on the objectives of the interventions.

The first is aimed at citizens and local institutions that have suffered the event (mayors, local officials, social and health workers, etc.). The second specifically concerns the world of schools.

With regard to citizens and local institutions, the Guidelines on Mental Health and Psychosocial Support in Emergency Contexts of the Inter-Agency Standing Committee [IASC, 2007] report that emergencies tend to destabilize conventional channels of information and communication. Communication infrastructures can be destroyed, and existing communication channels can be abused by those with specific agendas, for example, spreading rumours or hate messages or fabricating stories to cover up neglect of duties. Rumours and the absence of credible and accurate information tend to be the main sources of anxiety for people affected by an emergency and can create confusion and insecurity. Furthermore, a lack of knowledge about rights can lead to exploitation of vulnerable individuals, as they may be misled, manipulated, or denied access to essential resources and support. Therefore, it is crucial to provide the population and institutions with appropriate and timely information. A responsible mechanism should proactively disseminate such useful information. Information and communication systems can be designed to help community members play a role in recovery processes and thus be active survivors rather than passive victims. Information and Communication Technologies (ICTs) and traditional methods of communication and entertainment, such as sketches, songs and plays, can play a fundamental role in disseminating information about rights and survivors' rights, while appropriate information about rescue operations and the location of displaced people can help reunite families. In addition to the specific actions to be implemented, it is important to ensure good governance during emergencies through transparency, accountability and participation, all of which will help improve access to information and active participation by citizens and institutions.

According to the IASC [2007] guidelines, education is a key psychosocial intervention. Indeed, it provides a safe and stable environment for students and restores a sense of normalcy, dignity and hope by offering structured, appropriate and supportive activities.

It is important to (re)start formal and non-formal educational activities immediately, giving priority to the safety and well-being of all children and young people, including those who are at greater risk or who have special educational needs. Educational loss is often among the greatest stressors for students and their families, who see education as a path to a better future. Educators, whether formal classroom teachers, non-formal learning instructors, or educational activity facilitators, have a crucial role to play in supporting students' mental health and psychosocial well-being. Too often, educators struggle to overcome the challenges they and their

students face, including their own mental health and psychosocial issues related to the emergency. Training, supervision, and support for these educators enables a clear understanding of their roles in promoting student well-being and helps them protect and foster the development of children, youth, and adult learners during the emergency.

The following sections outline the activities undertaken in response to the earthquakes in L'Aquila (2009), the Po Valley (2012), and central Italy (2016–2017), which impacted citizens, local institutions, rescuers, and the school system.

4.1 The 2009 L'Aquila earthquake

During the night of 5-6 April 2009, at 3:32 local time, an earthquake with a magnitude of Ml 5.9 (source: BSI-INGV[16]) struck a large area of the province of L'Aquila (central Italy), resulting in 309 fatalities, with 200 occurring in the city of L'Aquila, along with 1,600 injuries and more than 70,000 people left homeless. In the following days, several aftershocks occurred, some exceeding magnitude 5. In total, approximately 20,000 earthquakes were recorded in the area throughout 2009. The severe impact of the earthquake created an urgent demand for information and training on emergencies, necessitating prompt responses. As described in Section 4, information, in all its forms, is crucial in helping individuals and communities manage emergencies effectively. In response to the pressing information needs of both victims and rescuers, a series of training initiatives were launched to support different target groups with varying levels of earthquake knowledge. These interventions were tailored to different emergency phases and the specific needs of each group [La Longa and Crescimbene, 2010]. The information and psychological support activity, activated at the Seismic Emergency Operations Centre (COES) of the DPC in the days immediately following the seismic event of 6 April 2009, was characterized by the extemporaneous requests of a heterogeneous user base: rescuers (firefighters, volunteer associations, financial police, police, etc.), affected population (adults, children, families) and INGV colleagues on duty at the facility or engaged in field activities. In the case of the L'Aquila earthquake, the COES coordinated for the first time with the National Department of Civil Protection (DPC) within the Command-and-COntrol DIrectorate (DiCOMAC), the DPC's official structure for emergency management. The interventions were structured on three operational objectives:

- provide basic knowledge elements on seismology and seismicity in Italy to

[16] https://bsi.ingv.it/en/ (accessed 30 January 2025).

understand and interpret the evolution of the ongoing seismic sequence;
- offer scientific information on the progress of the seismic sequence, through an updated seismicity map, graphs on the magnitude trend, number of events from 6 April onwards;
- provide basic knowledge elements on the emotional reactions associated with the earthquake and, upon request, psychological support interventions for the emotional management of experiences related to the emergency.

This activity enabled field observations to identify the training and informational needs of both victims and rescuers [Moretti et al., 2011]. The analysis of the needs observed in the first weeks facilitated the design of structured interventions, as outlined in Table 2. Notably, for the first time, INGV incorporated psychological support within an emergency service for its personnel involved in the response. This initiative was regarded as both beneficial and strategic by those who participated. The specific location of the COES (DPC technical-scientific consultancy structure) within DiCOMAC, an area accessible to rescuers, volunteer organizations, police officers, Carabinieri, public officials, and regional school offices, made it possible to reach a significant portion of the personnel engaged in emergency operations.

In conclusion, the entire experience of the L'Aquila earthquake highlighted the importance of addressing the information emergency from the outset. Most importantly, it underscored the need to structure meetings with the population as psychosocial interventions aimed at restoring the local social network, as outlined in the IASC [2007] guidelines. This experience prompted reflection on the importance of tackling seismic risk reduction in its entirety, through prevention strategies that consider various levels of intervention, including initiatives to be implemented before or after a seismic event [Camassi et al., 2009; La Longa et al., 2012].

Similar reflections and strategies have been developed following major earthquakes and tsunamis in other regions.

For example, following the 2011 Tōhoku earthquake and tsunami in Japan, the Japan Society of Mechanical Engineers (JSME) outlined four key points to improve response and prevention for future disasters [JSME, 2014]: 1) the development of an approach to system integration of large-scale systems; 2) a review of how the design basis is determined and how to prepare for events beyond the design basis; 3) better communication of risks associated with new products to the public; 4) the incorporation of lessons learned into codes and standards and the fostering of engineers with the skills to address disaster-related tasks, with the goal of passing these lessons on to future generations. At the end of the report is reported the following sentence: "The internationally accepted definition of safety is the 'freedom

from unacceptable risk'. Under this definition, whether a large-scale system is regarded as safe or not depends on the recognition of an acceptable risk by the public. As mentioned above, after a design basis is chosen and a chain of accident-prevention measures are taken, there will be one remaining risk. If that risk is acceptable, the system is safe. However, if the public does not regard that risk to be acceptable, the system would not be regarded as safe. In this regard, it should be noted that people tend to regard a risk as unacceptable if it is unfamiliar. Therefore, once a system is designed and the designer determines it as safe, they should persuade the public that the remaining risk is acceptable. This is why risk communication is important in developing new technologies. Without appropriate risk communication, no new technology can be accepted by the public. Therefore, engineers should incorporate the basic concepts and techniques required for risk communication into their skill set".

Project (period)	Activity and goals	People engaged
EmerFOR (April-May 2009)	Training meetings with teachers in tent camps: to address the information and training needs of the education sector, particularly for teachers involved in resuming the school year within tent camps immediately after the event, specific support, guidance, and tools were provided. This initiative enabled teachers to quickly acquire essential knowledge, tools, and fundamental skills to independently manage the emergency phase and offer psychological support to children and young people during the crisis [Camassi et al., 2009].	A total of 492 teachers from schools of all levels in the areas affected by the seismic emergency.
"La Terra tretteca... Ji No!" (The Earth trembles... Not me!) (June-August 2009)	Information meetings with the population in the tent camps: the goal was to address the earthquake emergency through a multidisciplinary approach (seismological, historical, psychological, social) to help the affected population understand the event within the broader context of the area's hazards and risks. The meetings aimed to provide resources and strategies for emotional and psychosocial adaptation during the post-emergency phase. These meetings typically featured recurring emotional stages: aggression and distrust, a heightened need for information, self-awareness in relation to one's environment, gratitude, and a human-centred encounter.	1,895 participants attended 11 meetings held in the tent cities.
"La Terra Tretteca... Ji No!" "Back to School" (September 2009)	Meetings in schools: considering the actual training and informational needs that emerged during the Abruzzo emergency, it was decided to take advantage of the start of the new school year to develop more structured interventions on educational pathways [Crescimbene et al., 2010].	2,706 people, including teachers and headmasters, participated in a total of 33 information meetings held in schools across the damaged municipalities.

Table 2. *Projects and activities carried out after the 2009 L'Aquila earthquake.*

4.2 The 2012 Po Valley earthquake

In May and June 2012, a major seismic sequence (with a maximum event magnitude of Ml 5.9) struck the central part of the Po Valley (northern Italy), primarily affecting the provinces of Modena, Ferrara, Reggio Emilia, Bologna, Mantua, and Rovigo. The earthquake caused 26 fatalities, hundreds of injuries, and severe damage to artistic heritage, as well as to civil, industrial, and rural buildings. Additionally, 15,000 people were left homeless, historic centers and industrial areas suffered significant damage, and the economic toll was estimated at around 2 billion euros. The complexity of the ongoing sequence alarmed a vast, densely populated area, exacerbated by the "viral" spread of urban legends, gossip, rumors, and false information. This significantly challenged the ability of the affected population to adequately manage the emergency and hindered the effective handling of organizational and social issues. Drawing on the valuable lessons learned from the 2009 L'Aquila earthquake, a series of meetings were held with the population.

From the beginning of the fieldwork, it became evident that addressing and countering the rumours about the earthquake sequence, which were spreading rapidly and uncontrollably, was essential. Specific information regarding these rumours was considered fundamental in structuring the "Earthquake, let's talk about it together" campaign meetings.

Referring to previous research on rumor studies, particularly Allport and Postman [1947], a method similar to the rumor clinic experience was adopted to collect rumors circulating after the 2012 Po Valley Earthquake [Crescimbene et al., 2023]. To gather information on rumors that spread after the seismic events of 2012, an online collection was conducted through the websites of the promoting institutions (DPC, Emilia Romagna Region, and INGV). From 16 June to 12 October 2012, 239 rumors were collected. These were classified into six categories based on their content: explanatory, conspiracy, catastrophic, paranoid, positive, and other effects. Further processing enabled the calculation of the strength of the rumors by applying the Allport and Postman [1947] formula. The focus was on the degree of ambiguity of the theme, and three indicators were established to calculate the strength of the rumors: source, diffusion, and thrust. This approach facilitated the creation of a ranking of the collected rumors, with the strongest ones being prioritized for response. Actions to counter the rumors were designed to enhance the critical sensitivity of the affected population [Sunstein, 2010]. The objective of fostering critical sensitivity during the emergency phase was pursued through a series of actions coordinated with the other institutions involved in the meetings with the population. Before each meeting with the public, a session was held with the expert

group to critically analyze the most frequent rumors in that area. At the end of the session, experts defined the responses to be communicated to the population. In general, the agreed-upon responses aimed to promote healthy skepticism and the development of critical thinking.
The meetings titled "Earthquake, let's talk about it together" were structured to primarily provide psychosocial support, as outlined in the IASC [2007] guidelines (see section 1.3). During the 2012 seismic sequence, 44 public meetings were held between 4 June and 2 August 2012, with over 6,345 participants. In the following months, another 18 meetings took place between September 2012 and April 2013, attracting an additional 700 attendees. This initiative was further supported by 13 specialized meetings for schools, beginning with the start of the school year in September 2012, which involved 800 teachers as well as healthcare workers from local facilities (AUSL and hospitals). The duration of the meetings varied, typically lasting between 2 and 3 hours, depending on public engagement. Generally, two or three INGV researchers (both seismologists and psychologists) participated in each meeting [Crescimbene et al., 2023].
The experience of the meetings emphasized the strategic importance of establishing direct contact with the population and local institutions, rather than relying on a medium (which is generally less known and difficult to control) for communication during such a critical phase of the emergency. In many meetings, "direct" contact with the population played a significant role in building trust and fostering dialogue with citizens [La Longa et al., 2014].

4.3 Earthquakes in central Italy in 2016-2017

On 24 August 2016, at 3:36 local time, the Accumoli-Amatrice earthquake (Mw 6.0), marked the beginning of one of the most significant seismic sequences to affect the national territory in this century. The sequence, known as the "Amatrice-Visso-Norcia" earthquake due to the extent of the faults activated that night, was particularly devastating. It affected an area of approximately 8,000 square kilometers, encompassing 140 municipalities and around 600,000 people.
On 30 October 2016, the "Norcia" earthquake (Mw 6.5) became the strongest earthquake in Italy since 1980. Despite its high magnitude, the seismic event fortunately resulted in no fatalities, although it worsened the situation in several locations in central Italy that had already been severely affected by earlier earthquakes, especially the one on 24 August 2016.
The widespread impact of the various seismic events created significant challenges in managing the emergency, which also affected the coordination of support

activities for the affected populations. These organizational difficulties further limited the operations of the Emergency Information Group (IES) in carrying out psychosocial interventions targeted at various segments of the population. As a result, the support activities were primarily focused on the school sector (Table 3).

Project (period)	Project (period)	People engaged
"Ripartiamo Dalla Scuola – Terremoto 2016" (Let's Start Again from School – 2016 Earthquake) (2016-2017)	The initiative "Parlarne a scuola" (Talking About It at School) involved the multidisciplinary staff of the INGV-IES (Information in Seismic Emergency) Operations Group, formalized in 2015, activated in collaboration with the DPC and the MIUR (Ministry of Education, Universities, and Research). The information and training meetings were aimed at sharing knowledge on the seismicity of the territory, on its dangerous characteristics, on the sequence underway in central Italy and on what can be done immediately to reduce the risk also from a psychological and social point of view.	A total of 21 Comprehensive Institutes of Higher Education in the Ascoli, L'Aquila, Macerata, and Rieti areas were involved, with approximately 1,500 teachers, school staff, and, in some cases, parent representatives participating.
Amatrice One Year Later (29-30 October 2017)	One year after the earthquake in Amatrice on 24 August 2016, the INGV, in collaboration with the Municipality of Amatrice, organized a two-day event dedicated to citizens and students. On 29 October, INGV researchers shared with the population of Amatrice an informative presentation about the Institute's activities during the emergency. The day of 30 October was dedicated to the schools of Amatrice. In particular, the workshop "Invisible Cities" was held. The workshop was loosely based on the book *Le città invisibili* (Invisible Cities) by Italian writer Italo Calvino[17].	The population of Amatrice and over 70 students from the five classes (from I to IV) of the scientific and sports high school in Amatrice.
EDURISK Project for Rieti (2017-2019)	The EDURISK Project staff, as part of an agreement with the Lazio Region, developed a specific educational course on seismic risk for the Rieti province: "Earthquake: let's talk about it at school together." The goal of the course was to ensure that the earthquake becomes a shared and positive experience, ultimately helping to make communities stronger and safer.	10 Institutes in the municipalities of the Rieti province affected by the earthquake, with the participation of 164 teachers.

Table 3. *Projects and activities carried out after the 2016-2017 earthquakes in central Italy.*

[17] Italo Calvino, Le città invisibili, collana Collezioni "Supercoralli" e "Nuovi coralli" n. 182, 1ª ed., Einaudi, 1972.

5. Conclusion: A look to the future

The complexity of environmental issues, natural risks, and life on Earth cannot be addressed without adopting a holistic scientific approach that incorporates the philosophical, human, and social sciences. A new generation of scientists has emerged, trained to collaborate on these challenges, driven by the urgency of climate change and the need for decisions that can no longer be delayed or avoided—for the well-being of both humanity and the planet. It is hoped that the integration of various sciences and disciplines will continue and occur promptly to increasingly prioritize the Earth and its inhabitants. Research, both today and in the future, must recognize that human beings are an integral part of the Earth, and that its risks are human risks. The distinction between natural and anthropic risks no longer holds. There is a world in which all coexist with the Earth. In research institutes like INGV, dedicated to understanding the Earth, it is hoped that this knowledge is always accompanied by an understanding of human beings. Only in this way can the goal be achieved of raising awareness among women, men, scientists, and citizens about their lives, their choices, and their capacity to live in harmony with the environment.

References

Af WÅhlberg A.E., (2001). *The theoretical features of some current approaches to risk perception*. Journal of risk research, 4(3), 237-250. https://doi.org/10.1080/13669870152023791

Agazzi E., and Fortunati V. ed., (2007). *Memoria e Saperi: Percorsi transdisciplinari*. Booklet Milano.

Allport G.W., and Postman L., (1947). *The Psychology of Rumor*. New York: Henry Holt & Company. Available at https://archive.org/details/in.ernet.dli.2015.268464/page/n3/mode/2up (accessed 30 January 2025).

Braisby N., and Gellatly A. eds., (2012). *Cognitive Psychology*. Oxford University Press.

Brondi S., Benedetti L., Tanga R.C., and Bertoldo R., (2021). *Between oblivion and drastic evidence: How local communities cope with seismic risk by forgetting and remembering*. International Journal of Disaster Risk Reduction, 56. https://doi.org/10.1016/j.ijdrr.2021.102132

Camassi R., Crescimbene M., La Longa F., and Nostro C., (2009). *EmerFOR - Attività di Formazione e Informazione in Emergenza*. Workshop Saperi e valori nella partecipazione al dibattito scientifico 15 maggio 2009, Città dell'Altra Economia, Roma. Retrieved from: http://hdl.handle.net/2122/5867 (accessed 30 January 2025).

Cancian T., (2016). *Uno psicologo nel terremoto del Friuli*. Rivista di Psicologia dell'Emergenza e dell'Assistenza Umanitaria, 16, 26-33.

Ceccarelli G., (2016). *Psicologia e psichiatria di fronte alle emergenze: primi contributi italiani.* Rivista di Psicologia dell'Emergenza e dell'Assistenza Umanitaria, 16, 6-25. https://hdl.handle.net/11576/2642110 (accessed 30 January 2025).

Cerase A., Crescimbene M., La Longa F., and Amato A., (2019). *Tsunami risk perception in southern Italy: first evidence from a sample survey*. Natural Hazards and Earth System Sciences, 19(12), 2887-2904. https://doi.org/10.5194/nhess-19-2887-2019

Chally P.S., (1992). *Empowerment Through Teaching.* Journal of Nursing Education, 31(3), 117-120. https://doi.org/10.3928/0148-4834-19920301-07

Cinti F.R., Faenza L., Marzocchi W., and Montone P., (2004). *Probability map of the next M≥ 5.5 earthquakes in Italy*. Geochemistry, Geophysics, Geosystems, 5(11). https://doi.org/10.1029/2004GC000724

Cocco M., Cultrera G., Amato A., Braun T., Cerase A. et al., (2015). *The L'Aquila trial*. In Peppoloni, S. and Di Capua, G. (eds.), Geoethics: the Role and Responsibility of Geoscientists, Geological Society, London, Special Publications, 419, pp. 43-55. https://doi.org/10.1144/SP419.13

Connerton P., (1989). *How Societies Remember*. Cambridge University Press.

Crescimbene M., La Longa F., Camassi R., Nostro C., Bernardini F. et al., (2010). *L'Aquila earthquake of April 6, 2009: a turning point in the educational strategies for seismic risk reduction*. 32nd ESC General Assembly, Montpellier (France), September 6-10, 2010. Retrieved from: https://www.earth-prints.org/server/api/core/bitstreams/5f176b19-f3f5-4bcd-b72b-1b1f01524b01/content (accessed 30 January 2025).

Crescimbene M., and La Longa F., (2012). *Emozioni, sentimenti, percezione del mondo.* In Pessina, V. and Camassi, R. (eds.), Sintesi dei lavori del Workshop EDURISK 2002 – 2011: 10 anni di progetti di educazione al rischio - Roma, 30 Novembre 2011, Miscellanea INGV, 13, pp. 40-42. https://doi.org/10.13127/misc/13

Crescimbene M., La Longa F., Camassi R., Pino N.A., and Peruzza L., (2014). *What's the Seismic Risk Perception in Italy?* In Lollino, G., Arattano, M., Giardino, M., Oliveira, R. and Peppoloni, S. (eds.), Engineering Geology for Society and Territory - Volume 7, Springer, Cham, pp. 69-75. https://doi.org/10.1007/978-3-319-09303-1_13

Crescimbene M., La Longa F., Camassi R., and Pino N.A., (2015). *The seismic risk perception questionnaire*. In Peppoloni, S. and Di Capua, G. (eds.), Geoethics: the Role and Responsibility of Geoscientists, Geological Society, London, Special Publications, 419, pp. 69-77, https://doi.org/10.1144/SP419.4

Crescimbene M., Todesco M., La Longa F., Ercolani E., and Camassi R., (2023). *The whole story: Rumors and science communication in the aftermath of 2012 Emilia seismic sequence.* Frontiers in Earth Science, 10.

https://doi.org/10.3389/feart.2022.1002648

Cugliari L., Crescimbene M., La Longa F., Cerase A., Amato A. et al., (2022). *Tsunami risk perception in central and southern Italy*. Natural Hazards and Earth System Sciences, 22(12), 4119-4138, https://doi.org/10.5194/nhess-22-4119-2022

Douglas M., and Wildavsky A., (1983). *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers*. University of California Press.

Fanta V., Šálek M., and Sklenicka P., (2019). *How long do floods throughout the millennium remain in the collective memory?* Nature Communications, 10. https://doi.org/10.1038/s41467-019-09102-3

Friedman W.J., (1987). *A follow-up to "Scale Effects in Memory for the Time of Events": The earthquake study*. Memory & Cognition, 15, 518-520. https://doi.org/10.3758/BF03198386

Hirsch M., (2008). *The Generation of Postmemory*. Poetics Today, 29(1), 103-128. https://doi.org/10.1215/03335372-2007-019

IASC, (2007). Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Inter-Agency Standing Committee, https://interagencystandingcommittee.org/sites/default/files/migrated/2020-11/IASC%20Guidelines%20on%20Mental%20Health%20and%20Psychosocial%20Support%20in%20Emergency%20Settings%20%28English%29.pdf (accessed 30 January 2025).

JSME, (2014). *Lessons Learned from the Great East Japan Earthquake Disaster: Report of the JSME Research Committee on the Great East Japan Earthquake Disaster*. The Japan Society of Mechanical Engineers, https://www.jsme.or.jp/jsme/uploads/2016/08/ChapterTitle.pdf (accessed 30 January 2025).

Kahneman D., and Tversky A., (1979). *Prospect Theory: An Analysis of Decision under Risk*. Econometrica, 47(2), 263-292. https://www.jstor.org/stable/1914185

Kasperson R.E., Renn O., Slovic P., Brown H.S., Emel J. et al., (1988). *The Social Amplification of Risk: A Conceptual Framework*. Risk Analysis, 8(2), 177-187. https://doi.org/10.1111/j.1539-6924.1988.tb01168.x

La Longa F., and Crescimbene M., (2010). *La dimensione psicologica del terremoto che ha colpito l'Abruzzo.* Retrieved from: https://www.earth-prints.org/server/api/core/bitstreams/e9ff82e5-4835-41be-8eb2-cb3b60ed70a9/content (accessed 30 January 2025).

La Longa F., Camassi R., and Crescimbene M., (2012). *Educational strategies to reduce risk: a choice of social responsibility*. Annals of Geophysics, 55(3), 445-451. https://doi.org/10.4401/ag-5525

La Longa F., Crescimbene M., and Camassi R., (2014). *Il contrasto di voci e dicerie sui terremoti del 20 e 29 Maggio 2012 in Pianura Padana*. GNGTS Proceedings, pp. 401-

409, https://gngts.ogs.it/archivio/files/2014/S23/Riassunti/LaLonga.pdf (accessed 30 January 2025).

Lorenz D.F., (2013). *The diversity of resilience: contributions from a social science perspective*. Natural Hazards, 67, 7-24. https://doi.org/10.1007/s11069-010-9654-y

Maslow A., (1962). *Toward a psychology of being*. D Van Nostrand. https://doi.org/10.1037/10793-000

Moretti M., Nostro C., Govoni A., Pignone M., La Longa F. et al., (2011). *L'intervento del Centro Operativo Emergenza Sismica in occasione del terremoto del 2009 a L'Aquila.* (The operation of the Centro Operativo Emergenza Sismica during the 2009 L'Aquila earthquake sequence). Quad. Geofis., 92: 1-32, https://editoria.ingv.it/archivio_pdf/qdg/92/pdf/qdg_92.pdf (accessed 30 January 2025).

Morgan M.G., Fischhoff B., Bostrom A., and Atman C.J., (2002). *Risk Communication: A Mental Models Approach*. Cambridge, UK: Cambridge University Press.

Olick J.K., (1999). *Collective Memory: The Two Cultures*. Sociological Theory, 17(3), 333-348. https://doi.org/10.1111/0735-2751.00083

Paton D., and Johnston D., (2001). *Disasters and communities: vulnerability, resilience and preparedness*. Disaster Prevention and Management, 10(4), 270-277. https://doi.org/10.1108/EUM0000000005930

Pidgeon N., Kasperson R.E., and Slovic P. eds., (2003). *The Social Amplification of Risk.* Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9780511550461

Pietrantoni L., and Prati G., (2009). *Psicologia dell'emergenza*. Il Mulino, Bologna.

Pisa P.F., (2024). *Understanding memory transmission in disaster risk reduction practices: A case study from Japan.* International Journal of Disaster Risk Reduction, 100. https://doi.org/10.1016/j.ijdrr.2023.104112

Ranzato L., (2018). *Il lungo passato e la storia breve della psicologia dell'emergenza*. Rivista di Psicologia dell'Emergenza e dell'Assistenza Umanitaria, 19, 30-41, https://imagecdn.spazioweb.it/29/50/29504224-eabe-439c-ab9b-edbeab713f40.pdf (accessed 30 January 2025).

Reivich K., and Shatté A., (2003). *The Resilience Factor: 7 Keys to Finding Your Inner Strengths and Overcoming Life's Hurdles*. Random House USA Inc.

Renn O., (2008). *Risk Governance: Coping with Uncertainty in a Complex World.* Routledge, Taylor & Francis.

Rohrmann B., and Renn O., (2000). *Risk Perception Research*. In Renn, O. and Rohrmann, B. (eds.), Cross-Cultural Risk Perception, Technology, Risk, and Society, 13, Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-4891-8_1

Sbattella F,. (2009). *Manuale di psicologia dell'emergenza.* FrancoAngeli, Milano.

Shenk D., Ramos B., Joyce Kalaw K., and Tufan I., (2009). *History, Memory, and Disasters Among Older Adults: A Life Course Perspective*. Traumatology, 15(4), 35-

43. https://doi.org/10.1177/1534765609359729

Slovic P., (1987). *Perception of Risk.* Science, 236(4799), 280-285. https://doi.org/10.1126/science.3563507

Sunstein C., (2010). *Voci, gossip e false dicerie. Come si diffondono, perché ci crediamo come possiamo difenderci*. Feltrinelli, Milano.

Tierney K., and Waugh W., (2007). *Emergency Management: Principles and Practice for Local Government.* Washington DC: International City and County Management Association.

Triantafyllou I., Papadopoulos G.A., and Kijko A., (2023). *Probabilistic Tsunami Risk Assessment from Incomplete and Uncertain Historical Impact Records: Mediterranean and Connected Seas.* Pure and Applied Geophysics, 180, 1785-1809. https://doi.org/10.1007/s00024-023-03262-6

Tversky A., and Kahneman D., (1992). *Advances in prospect theory: Cumulative representation of uncertainty*. Journal of Risk and Uncertainty, 5, 297-323. https://doi.org/10.1007/BF00122574

Van der Kolk B.A., (1998). *Trauma and memory*. Psychiatry and Clinical Neurosciences, 52(S1), S52-S64. https://doi.org/10.1046/j.1440-1819.1998.0520s5S97.x

Villone Betocchi G. ed., (1982). *Il Contributo della psicologia in situazioni di emergenza*. Palladio, Salerno.

Wachinger G., and Renn O., (2010). *Risk Perception and Natural Hazards*. CapHaz-Net WP3Report, DIALOGIK Non-Profit Institute for Communication and Cooperative Research, Stuttgart, http://caphaz-net.org/outcomes-results/CapHaz-Net_WP3_Risk-Perception.pdf (accessed 30 January 2025).

Wallace D.P., (2007). *Knowledge Management: Historical and Cross-Disciplinary Themes.* Bloomsbury Publishing.

Wenger E., McDermott R., and Snyder W.M., (2002). *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Harvard Business Press.

Wisner B., (2006). *Let our children teach us! A Review of the Role of Education and Knowledge in Disaster Risk Reduction*. ISDR System Thematic Cluster/Platform on Knowledge and Education, http://www.unisdr.org/2005/task-force/working%20groups/knowledge-education/docs/Let-our-Children-Teach-Us.pdf (accessed 30 January 2025).

*Corresponding author: **Massimo Crescimbene**

e-mail: massimo.crescimbene@ingv.it