Tsunami risk perception in Southern Italy: first evidence from a sample survey.

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Abstract

The Italian Tsunami Alert Center of the Istituto Nazionale di Geofisica e Vulcanologia (Centro Allerta Tsunami, hereinafter CAT-INGV) promoted a Computer Assisted Telephone Interview (CATI) survey to investigate tsunami's risk perception in two pilot regions of Southern Italy. The survey was carried out on a stratified sample of 1,021 interviewees representing about 3.2 million people living in 183 coastal municipalities of the two regions, namely Calabria and Apulia. The main goal of this research is to verify whether and how people's perception of tsunami hazard matches with what assessed by scientific data (TSUMAPS-NEAM Project, Basili et al., 2018). As shown by the results of this project, both investigated regions are characterized by high tsunami hazard. Nonetheless, the long return time of such events could lead people to consider the occurrence of a tsunami in the Mediterranean Sea as very unlikely.

The survey results reveal that people's risk perception is low: for almost half of the whole sample the occurrence of a tsunami in the Mediterranean Sea is considered quite unlikely, with a clear difference between Apulia and Calabria. In the latter region the risk perception is much higher than in the former, probably due to the shorter time elapsed since the last event. Also belonging to different coastal areas[1] appears to have a significant influence on the way tsunami hazard is conceived, having a stronger effect on risk characterization: the interviewees of Tyrrhenian Calabria are indeed more likely to associate tsunami risk to volcanoes with respect to the Ionian side citizens, coherently with the presence of active volcanoes and related tsunami precedents in the Tyrrhenian.

Television emerged as the most relevant source of knowledge for almost 90% of the sample, and the influence of media also results in the way tsunami risk is characterized. In particular, the survey showed that people's perception and understanding of tsunamis are affected by media accounts of large events, such as the 2004, Sumatra, and the 2011, Japan tsunamis. At the same time, it is evident that the risk posed by smaller events is underrated. Furthermore, the survey's results show that the word 'tsunami' occupies a different semantic space with respect to the Italian traditional headword 'maremoto", with differences among sample strata. In other words, the same physical phenomenon would be understood in two different ways by younger, educated people and elders with low education level. The results of this study, although limited to two regions, provide a first assessment of tsunami risk perception in Italy, also entailing important consequences for both risk communication practice and mitigation policies.

[1] For the purposes of this paper, the term "coastal area" refers to the part of the coastline defined by both seas and regions' limits, according to current geographical conventions. Tyrrhenian Calabria indicates the coastal region between the municipalities of Tortora and Scilla; Ionian Calabria spans from Reggio Calabria to Rocca Imperiale; Ionian Apulia from Ginosa to Castrignano del Capo, and Adriatic Apulia from Gagliano del Capo to Chieuti.

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1. Introduction

1.1 Relevance of tsunami risk in the Mediterranean and Italian coasts

Almost all countries surrounding the Mediterranean have faced the effects of historical tsunamis in the past four millennia, with more than 200 events documented for the area, as shown in the catalogue published by Maramai et al. (2014). According to this catalogue, most of the tsunamis in the area were generated by earthquakes (~83%), a fraction similar to that of other oceanic regions worldwide (Davies et al., 2018). Since 1700 AD, an average of 20 events every 50 years is reported in the catalogue (Maramai et al., 2014), i.e., one event every 2.5 years (including small tsunamis).

Besides large historical tsunamis, such as the big one occurred for an earthquake in Crete in 365 DC (Papadopulos et al., 2010), in the 20th century at least two important events did occur in the Mediterranean: the 1908 tsunami in southern Italy (that hit Messina, Reggio Calabria and the surrounding coasts) due to a magnitude 7 earthquake in the Messina Straits, with run-up as high as 13m in Pellaro (Tinti and Maramai, 1996) and a large number of fatalities; the 1956 tsunami in Greece, due to a magnitude 7.7 earthquake occurred close to the Cycladic island of Amorgos (Greece), that hit the coasts of Amorgos, Astypalaia and Folegandros with run-up values of 20, 10, and 14 m, respectively (Okal et al., 2009), or even up to 30m according to other sources (Ambraseys, 1960). More recently, in 2003 a relatively small tsunami caused by a magnitude 6.9 earthquake in Boumerdes (Algeria) hit the Western Mediterranean coasts causing damage to properties in at least eight harbours in Balearic Islands (Vela et al. 2011). Finally, two small tsunamis occurred in Dodecanese in 2017 (due to earthquakes with magnitude 6.4 and 6.6, respectively), along with the most recent one occurred in the Ionian Sea (Zakynthos) in October 2018 (magnitude 6.8). Other potential sources of tsunamis in the Mediterranean are volcanoes, such as those presently active in the Tyrrhenian Sea. Rosi et al. (2019) have investigated the occurrence of past tsunamis in this area through geological, archaeological and carbon datings along with historical sources. Their work allowed to identify three large tsunami deposits triggered by volcanic landslides which occurred at Stromboli volcano between the 14th and 16th centuries, possibly including the one observed in Naples in 1343 and described by the poet Petrarch. A database with all the observations related to the tsunamis known in the Italian region has been recently published by Maramai et al. (2019).

Based on these and other geological data, the first probabilistic hazard assessment for tsunamis (of seismic origin) (S-PTHA) in the NEAM region (North Eastern Atlantic, Mediterranean and connected seas) has been computed and published (TSUMAPS-NEAM Team, 2018). In an S-PTHA approach, the hazard in any specific point on the coast comes from the various tsunami sources affecting that point, including close and distant sources (Selva et al. 2016; Grezio et al, 2017; Davies et al., 2017; Volpe et al. 2019). For Italy, it is evident that the most hazardous areas are those exposed to both local earthquakes and distant ones. In particular, the most active region in the Mediterranean is the Hellenic arc, where strong tsunamigenic earthquakes have occurred in the past (Papadopulos et al., 2010; Maramai et al., 2014). Consequently, the coastal areas of Apulia, Calabria and Eastern Sicily facing the Ionian sea, have the highest hazard in Italy. However, a significant hazard exists for many other coastal areas throughout Italy, as the Ligurian Sea, the Adriatic Sea, and the Tyrrhenian Sea, due to both local earthquake sources and distant ones, as for instance the northern African fault system from Gibraltar to Tunisia.

Despite the high hazard of the Italian coasts, the memory of tsunamis is weak in Italy, mainly due to the long time elapsed since the last deadly event in 1908. In that circumstance, the tsunami significantly increased the already heavy death toll determined by the earthquake, also due to people's unawareness of the tsunami risk: many people escaped from the damaged and dangerous streets of Messina and other towns, looking for a safe place near the sea. After more than one century from this tragedy, we do not know if any memory is left in the region.

Another recent event that could have modified the perception of tsunami risk in Italy is the collapse of the unstable flank of the volcanic island of Stromboli in 2002 that generated a local tsunami with measured run-up of up to 10 m (Tinti et al., 2005).

1.2 The general tsunami context in the Mediterranean and the CAT-INGV

Coastal areas bordering the Mediterranean basin are subject to tsunami hazard. For this reason, in 2005 the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) established the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS), in response to the tragic 'Boxing Day' tsunami of December 26th 2004, in which over 230,000 lives were lost around the Indian Ocean region. Nowadays, the Mediterranean coasts are among the most densely populated areas of the world, with about 130 million people living along a 46,000 km coastline, 230 million tourists visiting the Mediterranean Sea every year, and 7 coastal cities with more than 2 million inhabitants (Marriner et al. 2017). The Mediterranean Sea also fosters a thriving maritime economy: according to the estimates of WWF-BCG report, economic activities related to the Mediterranean worth US$ 450 billion per year (Randone et al. 2017).

As far as Italy is concerned, according to the Italian National Institute of Statistics (ISTAT), in the fifteen Italian coastal regions there are 644 coastal municipalities, i.e., 8.0 % of the total number. These municipalities cover an area of 14.3% of the whole country surface area, hosting a population of 28.4% of the entire Italian population (more than 17 million inhabitants). Furthermore, coastal areas are the most densely populated, with 400 inhabitants per square kilometre, against an average of 168 for the internal areas, also showing a population growth rate which is more than twice that of the non-coastal population areas, i.e., +3.3% vs. +1.6% for the remaining areas (Istat, 2016). This means that tsunami risk exposure is relevant and constantly growing, suggesting the need for effective mitigation measures. Following the establishment of ICG/NEAMTWS, in 2013 Italy started to build a tsunami alert centre at the Istituto Nazionale di Geofisica e Vulcanologia (INGV). Although residents in coastal municipalities are not all located in the inundation areas which might be directly hit by a tsunami, they are likely to face non-direct consequences of a tsunami event. After a three-year testing phase, the CAT-INGV has become operational in 2016, after being formally accredited as a Tsunami Service Provider for the whole Mediterranean area by the ICG/NEAMTWS. Soon after that, the CAT-INGV became operational at national level within the framework of the SiAM (*Sistema d'Allertamento nazionale per i Maremoti di origine sismica*), coordinated by the Italian Department of Civil Protection (hereinafter DPC), and together with the Istituto Superiore per la Protezione dell'Ambiente (ISPRA), which manages the national sea level network.

As a Tsunami Service Provider, CAT-INGV sends alert messages to about fifteen countries and Institutions of the Euro-Mediterranean region in case of potentially tsunamigenic earthquakes. At national level, CAT-INGV cooperates strictly with DPC and ISPRA for disseminating alert messages to the local authorities and the population. As well, CAT-INGV is involved in increasing knowledge and people's awareness on tsunami hazard and risk.

Although the Italian tsunami early warning system has been established in 2017, a comprehensive risk communication strategy is still under development. The main goal of this study is to contribute to identifying people's knowledge and perception and defining the best strategy.

2. Background: risk perception studies

The perception of risks involves the process of collecting, selecting and interpreting signals about uncertain impacts of events, activities or technologies. These signals can refer to direct observation or information from others (for example reading about

an earthquake in the newspaper). Perceptions may differ depending on the type of risk, the risk context, the personality of the individual, and the social context.

Within natural sciences the term 'risk' seems to be clearly defined and measured as the probability distribution of adverse effects. However, the everyday use of the word 'risk' has different connotations (Renn, 2008). For social sciences the terminology of 'risk perception' has become the conventional standard (Slovic, 1987). Current studies on risk perception, grounding on sensorial human perception research from the beginning of the XX century (Wagemans, et al. 2012), have shown that people's perception is affected by cognitive processes and past experience. The mental models and other psychological mechanisms that people use to judge risks (such as cognitive heuristics and risk images) are internalized through social and cultural learning and constantly moderated (reinforced, modified, amplified or attenuated) by media reports, peer influences and other communication processes (Morgan et al., 2001).

2.1 Theoretical references of studies on risk perception

In recent decades, many research studies have been carried out on psychological, social and cultural factors that influence the perception of risk. At present, the perception of risk is considered fundamental to understand what lay people think about risks and to adopt suitable political and communication strategies ~~to cope with it~~.

Renn and Rohrmann (2000) developed a structured framework that provides an integrative and systematic perspective on risk perception. Figure 1 illustrates this perspective by suggesting four distinct context levels (originally presented by Renn and Rohrmann, 2000: 221; adapted from Breakwell's, 1994 generic model).

The first level, from the bottom center in Fig. 1, includes the collective and individual heuristics that individuals apply during the process of forming judgements. These heuristics are independent of the specific risk nature, personal beliefs, emotions or other conscious perception patterns of the individual. Heuristics represent common-sense reasoning strategies that have evolved over the course of biological and cultural evolution (Ross 1977; Kahneman and Tversky, 1979; Breakwell, 2007), and may differ among cultures. However, ~~a number of evidence from~~ psychological research shows a surprising degree of convergence across different cultures (Renn and Rohrmann, 2000).

The second level refers to the cognitive (knowledge-based) and affective (emotion-based) factors that influence the perception of specific properties of the risk in question. Cognition about a risk source – what people believe to be true about a risk – governs the attribution of qualitative characteristics (psychometric variables) to specific risks (e.g. dread or personal control options) and determines the effectiveness of these qualitative risk characteristics on the perceived seriousness of risk and the judgement about its acceptability (Slovic, 1992). Recently, psychologists have discovered that emotions play an important role in people's decision processes (Loewenstein et al, 2001; Slovic et al, 2002). People's feelings about what is good or bad in terms of the causes and consequences of risks colour their beliefs about the risk and, in addition, influence their process of balancing potential benefits and risks.

The third level refers to the social and political institutions that individuals and groups associate to either the cause of the risk or the risk itself. Most studies on this level focus on trust in institutions, personal and social value commitments, organizational constraints, social and political structures, and socio-economic status. One important factor in evaluating risk is the perception of fairness and justice in allocating benefits and risks to different individuals and social groups (Linnerooth-Bayer and Fitzgerald, 1996).

Other studies have placed political and social organizations, and their strategies to communicate with other organizations and society at large, as the prime focus of their attention (Clarke, 1989; Shubik, 1991). Press coverage appears to contribute substantially to a person's perception of risk, particularly if the person lacks personal experience with ~~that~~ risk and is unable to verify claims of risks or benefits from their own experience. In contrast to popular belief, however, there is no evidence that

the media can create opinions about risks or even determine risk perceptions. In fact, studies on media reception suggest that people select elements from media reports and use their own frame of reference to form their opinions. Most people reconfirm existing attitudes when reading or viewing media reports (Peters, 1991; Dunwoody & Peters, 1992; Breakwell 2007).

The last level (the external frame in Fig. 1) refers to cultural factors that govern or co-determine many of the lower levels of influence. The most specific explanation for cultural differences about risk perceptions comes from the so-called 'cultural theory of risk' (Douglas and Wildavsky, 1983).

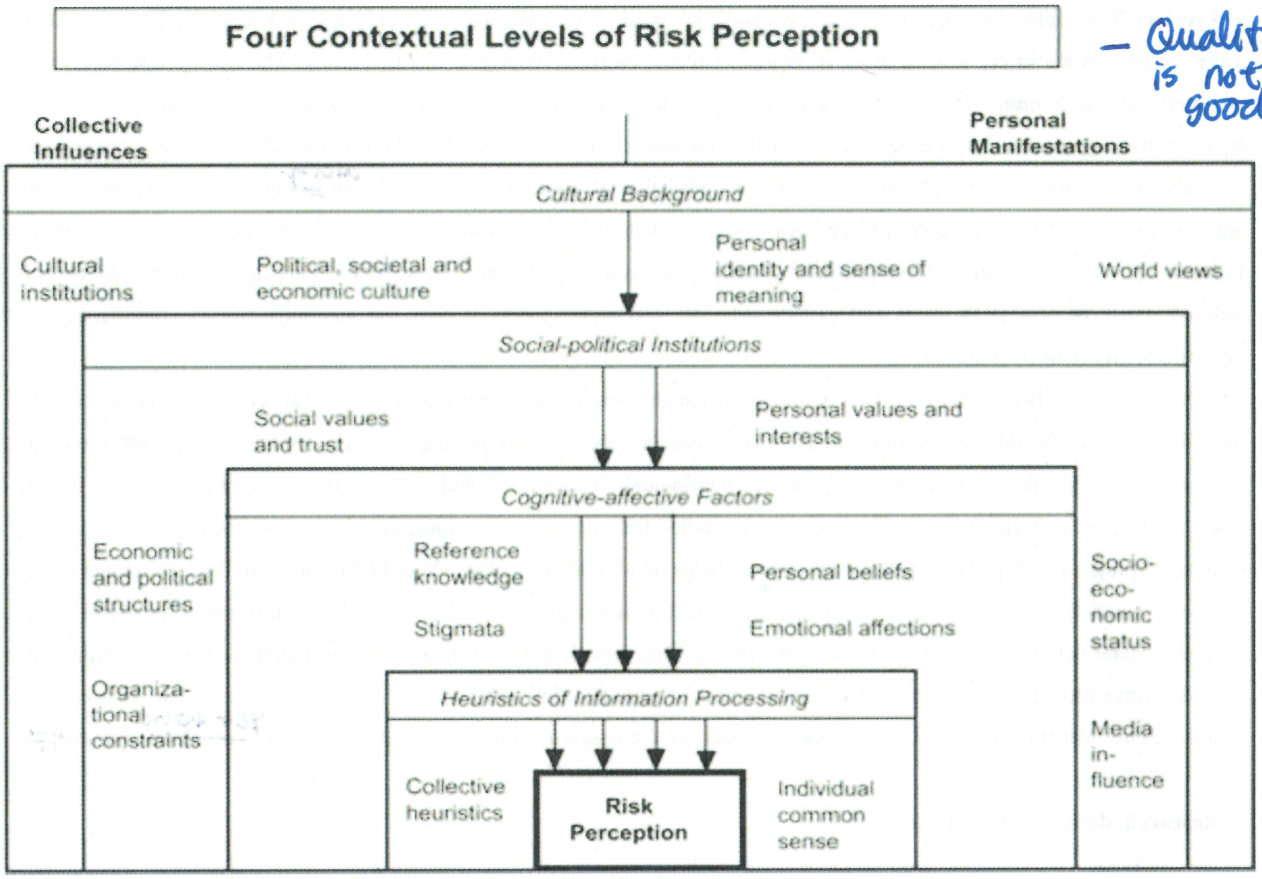

Fig. 1. Levels of Risk Perception (Renn, 2008)

All four levels of influence are relevant in order to gain a more accurate understanding of risk perception. In spite of many questions and ambiguities in risk perception research, one conclusion is beyond any doubt: abstracting the risk concept to a rigid formula, and reducing it to the two components' 'probability and consequences', does not match people's intuitive thinking of what is important when making judgements about the acceptability of risks (Slovic, 1992). The framework of social amplification may assist researchers and risk managers to forge such an integrative perspective on risk perception. Yet, a theory of risk perception that offers an integrative, as well as empirically valid, approach to understanding and explaining risk perception is still missing (Wachinger & Renn, 2010).

2.2 Recent research on tsunami risk perception

In many countries where the tsunami hazard is high, such as those in the Pacific and Indian Oceans, several studies have been carried out on risk perception and people's understanding and preparedness (Raine, 1995; Bird and Dominey-Howes, 2006; Kurita et al., 2007; Paton et al., 2008 and 2017; Oki and Nakayachi, 2012; Goeldner-Gianella et al., 2017; Arias et al., 2017, etc.). Unfortunately, research on tsunami risk perception in the Mediterranean are neither numerous nor homogeneous. Nevertheless, one of the oft-cited figures in research is a tendency of coastal populations to underestimate tsunami risk. Recent research has been carried out in the NEAM area (North Eastern Atlantic, Mediterranean and connected seas) by the EU project ASTARTE, that has investigated tsunami risk perception and community preparedness, through the collection of 1159 questionnaires in six coastal areas of France, Greece, Norway, Portugal, Spain, Turkey. The survey was based on a standardized questionnaire (about 50 questions), and random face-to-face interviews being administered on main beaches, boats, ports, city centers (Papageorgiou et al., 2015; Goeldner-Gianella et al., 2017; Liotard et al., 2017). Despite the precious insights coming from this investigation, such as the perception of negligible tsunami hazard along European shores, the method was based on interviews of a convenience sample (also known as accidental sampling). Such a non-probabilistic approach is based on the availability of participants, their geographical proximity or their willingness to participate rather than on well-defined statistical criteria to select and include subjects, and unfortunately it does not guarantee results' significance and generalizability (Etikan et al., 2016).

The 2004, Sumatra, Boxing Day tsunami and its global scale consequences revealed how cultural and societal resources have actually resulted into different abilities to cope with tsunami risk, thus triggering a fresh new interest for risk perception research in its broadest sense, also including psychological, sociological and anthropological approaches. The lack of information or of cultural memory of past events, including their negative outcomes, may jeopardize the effectiveness of any mitigation program, while the improvement of knowledge and emergency plans should be prioritized. Such programs should not be dropped from the top, but must always be placed within a given social context. The communities involved should indeed mediate between agencies' proposals and pre-existing knowledge through a variety of patterns of relationship, which should always include and properly consider the value of participation, self-efficacy, empowerment and trust (Paton et al., 2008). In Italy, despite a long tradition of tsunami research, the issues of tsunami risk perception have yet to be deepened.

3. Research, design and methods

3.1 Goals and research hypotheses

Our pilot study, conducted in Apulia and Calabria regions (Fig. 2), has the main strategic goal of providing empirical data on citizens' understanding and risk perception in a tsunami risk-prone area, also allowing future comparisons with different areas of the NEAM Region. Moreover, the results will contribute to identify key messages, channels and techniques to effectively communicate tsunami risk in the Mediterranean area.

The results of our survey will provide both CAT-INGV and DPC with data on people's perception and preparedness in Italy, contributing to an improved communication strategy on tsunami risk. A comprehensive and sound risk communication strategy will hopefully improve people's ability to understand phenomena and to enforce both individuals' and communities' response capabilities.

Our research lies on a general assumption: the lack of awareness and the misconceptions about tsunami dynamics and impact may considerably hamper the effectiveness of any mitigation measures. Furthermore, more in detail, the scope of this study is to provide a general description of what people know about tsunamis, and how they perceive this risk. In particular, we move from the following two hypotheses:

RH1: Does the tsunami risk perception of Apulia and Calabria match with the hazard assessed by scientific data?

RH2: Does people's perception in Italy about tsunamis rely upon media representations of catastrophic events such as the ones occurred in Sumatra and Japan? └ Apulia + Calabria ?

3.2. Methods and techniques

Following the ~~According to~~ a well-established standard in social science and risk perception research, a questionnaire survey was deemed to be the most suitable method of investigation. This method allows us to obtain valid, accurate and robust data in a reasonably short time, as well as to check data quality and validity of empirical evidence as it emerge from the survey.

The tsunami risk perception survey was based on a semi-structured questionnaire, consisting of ~~in~~ 27 items, ~~also~~ including closed questions, open questions, and Likert scales ~~as~~ to measure respondents' attitudes with respect to the topics under investigation (see Attachment A). The number of questions was optimized for being administered by telephone, taking duly into account the need for brief and comprehensible questions. To date, despite some problematic elements such as the increasing undercoverage rate (De Vitiis & Righi, 2011), Computer Assisted Telephone Interview (CATI) is still considered the most suitable technique in order to reach all ~~the~~ population strata (i.e., the oldest and the youngest, the most and the least educated, etc.), thus obtaining a statistically representative sample. It is no coincidence that the *Italian National Institute* of *Statistics (ISTAT)* along with similar organisations across the world, make a massive usage of CATI interviews for their research.

The questionnaire is structured in six areas of interest: 1) socio-demographic data and characteristics of the territory; 2) level of knowledge of the phenomenon and sources used for the collection of information; 3) perception of the tsunami risk in the geographic and social context of the interviewees; 4) social representations of the tsunamis; 5) cultural attitude towards the risk and 6) messages and channels suitable for early warning messages (see SM1).

The questionnaire was developed in the light of pre-existing research literature (Lindell and Perry, 2012) on tsunami risk perception (e.g., Bird and Dominey-Howes, 20076) also considering the need to encompass the different ways in which scientists and lay people are used to understand tsunami risk. A number of papers ~~has~~ have been considered to formulate, include or re-adjust questions to be included in the questionnaire. Questionnaire structure and contents were formulated according to both cited risk perception research and tsunami risk perception studies. As an example, the idea of including some questions about familiarity, understanding and the occurrence of events in the local area came from Raine (1995) and Alam (2016); beliefs about possible regions of tsunamis' ~~origins~~ sources are from Bird and Dominey-Howes (2007); the effectiveness of tsunami knowledge and optimal channels of information from Kurita et al. (2007); risk evaluation of tsunami heights were readapted by Oki and Nakayachi (2012), and so on.

The questionnaire was drafted in a simple and non-technical language so as to be easily understood by lay people without any knowledge of seismology, geology, physics and related fields. Furthermore, questions were intended to ensure maximum adherence between physical concepts (e.g. maximum inundation height, run-up, ~~ingression~~ and distance and so on) and ~~the way they were turned into~~ common language. For these reasons, the questionnaire ~~has been~~ was drafted and reviewed in the light of results of two focus groups with 1) scientists and 2) lay people, respectively. The first one involved INGV tsunami scientists for a first review and an elicitation of scientific content of the questions. Then, the questionnaire was tested on forty people with low and medium level of education and different ages to assess questions' readability, identifying possible biases in the way questions were formulated. Their feedback was used to adjust and rephrase some questions ~~as~~ to make them easier to understand.

3.3 Study area and sample characteristics

The research covered two regions of Southern Italy, Calabria and Apulia, representing over three million inhabitants living in some of the most tsunami prone areas of the Italian peninsula (Table 1), as it appears from historical catalogues of the Italian tsunamis (Tinti et al, 2004; Maramai et al., 2014) and S-PTHA studies (Lorito et al. 2008; Basili et al., 2013) (Fig. 2).

The research was carried out on a proportional stratified sample of 1,021 respondents, including 474 men and 547 women aged between 18 and 95 years across 138 different coastal municipalities of Apulia and Calabria. These two regions have shorelines extending for 865 and 780 km, respectively, covering 22% of the Italian coasts and 16% of the whole Italian coastal population. The interviews have been collected following research team directions about a) reference universe, b) sampling strategy, c) stratification variables, d) number of interviews to be implemented and administered. Interviews have been carried out using Computer Aided Telephonic Interview (CATI) methodology. The sampling plan was aimed at ensuring the best possible representativeness in accordance with the available resources, in order to provide scientists, end-users and Civil Protection with robust and reliable data to ground mitigation actions, also improving scientific debate on these topics. Sampling operations followed these steps: (a) defining the population; (b) choosing sample size; (c) sorting the population; (d) assigning numbers to cases for each class; (e) calculating the sampling fraction; (f) selecting the sample (Table 2). Interviewees were selected by using three stratification variables: age, gender and coastal areas, as to guarantee the best possible correspondence between subpopulations in the sample and in the reference universe. 833 questionnaires were administered to landlines users and other 188 to mobile phone users, for a total of 1,021 questionnaires. The decision to contact mobile phone users was due to the need of including a larger number of young people, who are less likely to use landlines. Data collection was completed between April and May 2018 by a team of over twenty trained interviewers, supervised by highly trained research experts of Questlab S.r.l., a specialized research company based in Venice.

Table 1 - Total population per country, region and coastal area

Country	Residents	Coastal Municipalities
Italy	17,689,240	668
Region		
Apulia	1,716,797	67
Calabria	1,120,698	116
Total	2,837,495	183
Coastal area		
Calabria Tyrrhenian Coast	561,908	45
Calabria Ionian Coast	558,790	71
Apulia Ionian Coast	469,044	21
Apulia Adriatic Coast	1,247,753	46
Total	2,837,495	183

Table 2 - Sample of the survey for age, gender, coastal area and educational level

Coastal area / Education level / Age	Ionian Calabria			Tyrrhenian Calabria			Adriatic Apulia			Ionian Apulia			Total
	L	I	H	L	I	H	L	I	H	L	I	H	
18-49	1	44	49	1	31	22	3	96	64	0	31	17	359
50-64	5	58	33	2	29	10	4	106	28	2	41	13	331
over 64	13	46	23	6	20	11	23	83	41	7	46	12	331
Total	19	148	105	9	80	43	30	285	133	9	118	42	1021

L = Low level of education or no instruction; I = Intermediate, secondary school and high school; H = graduate and post-graduate

Table 3a – Response rate for age and telephone connection

	Landline	Mobile	Total
18-34 yrs.	11,0%	29,8%	14,5%
35-49 yes	14,0%	50,0%	20,7%
50-64 yes	35,7%	18,1%	32,4%
65 and over	39,3%	2,1%	32,4%
Total	100,0%	100,0%	100,0%

Table 3b – Response rate for gender and telephone connection

	Landline	Mobile	Total
Men	42,9%	62,2%	46,4%
Women	57,1%	37,8%	53,6%
Total	100,0%	100,0%	100,0%

In order to get 1,021 complete and valid interviews, a total of 20,248 units were contacted. Among these, 15,564 call attempts were unsuccessful (unanswered phone calls) and 3,663 units explicitly refused the interview. The response rate is 21.8%, calculated as the ratio of the number of positive responses to the total number of responses. The Tables 3a and 3b show the response rate by age and gender, and also indicate whether the contact was made through a landline or mobile phone.

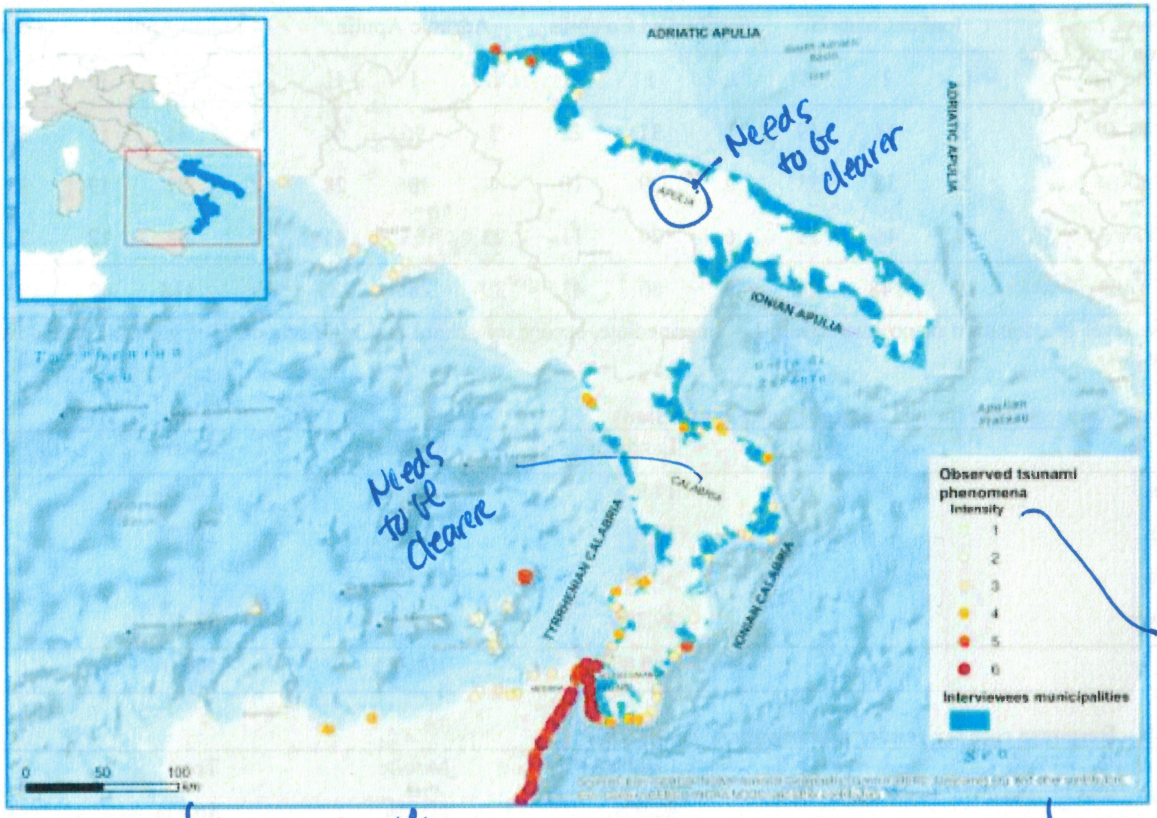

Fig. 2. Geographical distribution of interviewees' municipalities (light blue areas), with points of tsunami observations (circles). The circles' color is proportional to the tsunami intensity (see legend). Data are from Maramai et al. (2019).

4. Results and discussion

The results of our research are discussed in two separate ~~paragraphs~~ sections. The first part is dedicated to the tsunami risk perception, in the strict sense. The second part illustrates and discusses the data on the characteristics of the tsunami phenomenon and examines the data on tsunami knowledge sources.

4.1 Tsunami risk perception

Considering the whole sample, the majority of people (49.5%) consider tsunamis to be rather unlikely in the Mediterranean area. Specifically, 41% of the interviewees believe that the occurrence of such an event is "unlikely" and the 8.5% consider it "not at all likely". By contrast, the overall percentage of those who think that a tsunami in the Mediterranean is a likely event is 42,5%. Of these, most consider it 'quite likely' (33% of the total), and 9.5% holds it even to be 'very likely'. The leftover 7,9% consider the occurrence of a tsunami an event 'neither likely nor unlikely' (see Fig. 3). It may be useful to recall here that the Likert Scale ("not at all unlikely; unlikely; neither likely nor unlikely; quite likely; very likely") is to be considered as a generally accepted standard in social research (see Likert, 1932).

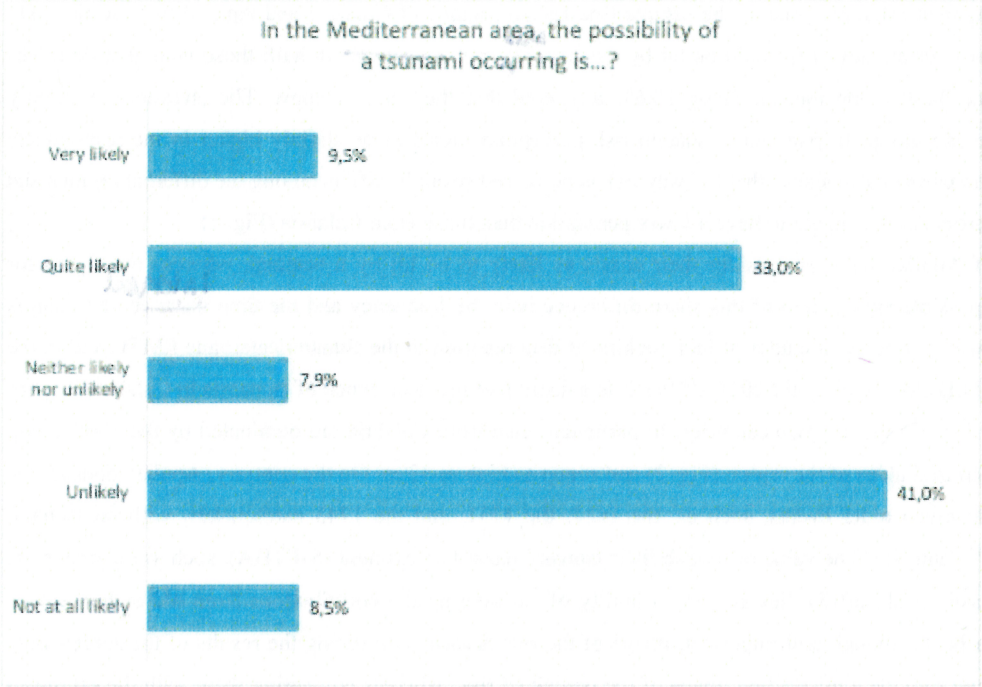

Fig. 3. Perception of tsunami occurrence in the Mediterranean area

Fig. 4 shows in detail which Mediterranean areas are deemed to be subjected to tsunami hazard: 35.6% of the sample indicates their region of residence and nearby ones (Calabria and Puglia coasts) as the most prone area, 17.1% suggests the Western Mediterranean, 10.9% the Eastern Mediterranean, 11.2% the Central Mediterranean, and 25.3% declare they do not know.

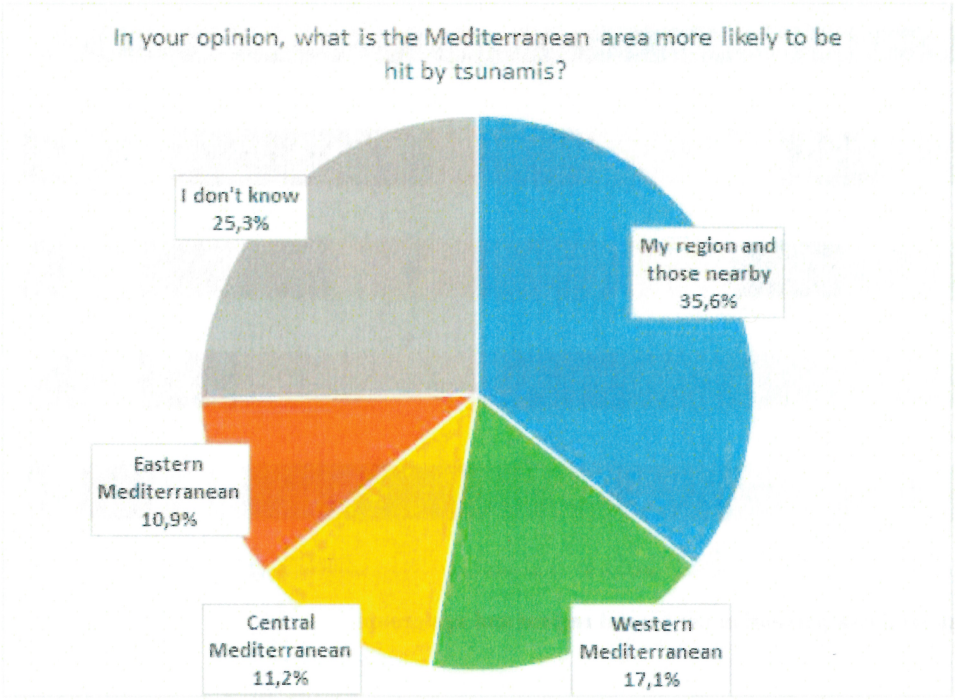

Fig. 4. Mediterranean areas perceived as the most prone to be hit by a tsunami

With respect to the geographical reference area of the sample (the Italian regions of Calabria and Apulia) the question 'Do you think that the coasts of your municipality could be hit by a tsunami?' split the sample in half: those who answered Yes were 44.7%, whilst No had 44.8%, and the remaining 10.6% answered that they do not know. The answers are slightly different depending on the age group. In particular, tsunami risk perception seems to be slightly higher in the respondents aged 50-64 (Fig. 5). The comparison also shows that the way risk is perceived strongly differs among the different regions and coastal areas: respondents from Apulia appear to have a lower perception than those from Calabria (Fig. 5).

In particular, only 30% of Apulian citizens consider their coasts as likely to be hit by a tsunami, whereas the figure for Calabria exceeds 60%. A possible explanation of this sharp difference is in the frequency and the time distance of tsunamis that have occurred in the two regions. As a matter of fact, looking at data reported in the tsunami catalogue EMTC and in the database of observations ITED (Maramai et al.; 2014, 2019), it is evident that the occurrence of tsunamis in Calabria is more frequent than in Apulia, at least in the last two centuries. In particular, data from Calabria are dominated by the 1908 event, with observations on both coastal areas of the region (Fig. 2) and runup as high as 13 m. On the contrary, Apulian data are far less numerous and refer to much older events, such as, the 1627, the 1731, and the 1743 earthquakes, with no tsunami reported in the 20th and 21th centuries. The value of probabilistic tsunami hazard assessment (S-PTHA), such as the one made by TSUMAPS-NEAM (Basili et al., 2018), lies also in its ability of considering the contributions from old and/or hidden events; this allows to get a better, though still imperfect, image of the real hazard. Comparing the results of the survey only with the historical data could provide a misleading image of the perceived risk, whereas comparing them with the estimated hazard gives a more realistic view of perception, confirming that tsunami risk in Apulia this is particularly underrated.

Furthermore, the results of our survey also show that Tyrrhenian Calabria's residents have a higher perception of tsunami risk than all other coastal regions, but this point will be discussed in detail later in the text.

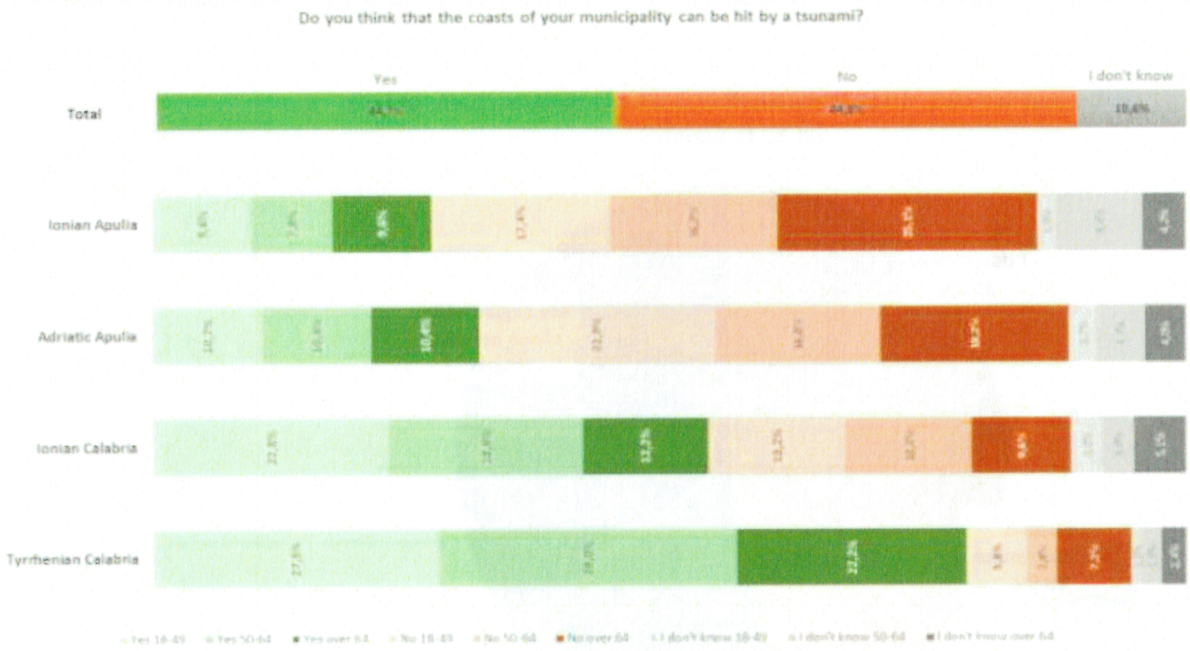

Fig. 5 - Comparison of the tsunami risk perception per coastal regions and age groups

We also compared the perception of tsunami risk with the education level of respondents. The data show that the perception of risk increases with the level of education, in particular graduates and postgraduates show a perception of risk higher than the others (Fig. 6).

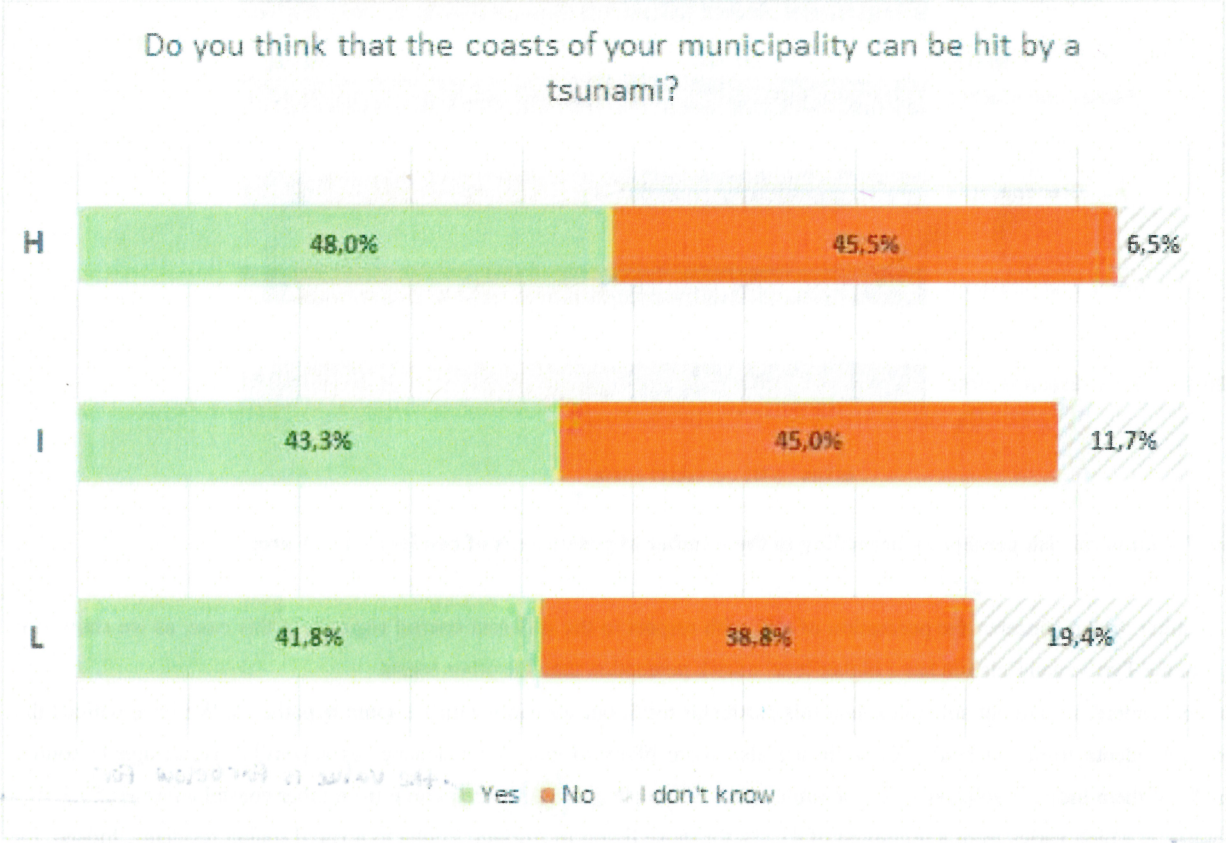

Fig. 6 - Tsunami risk perception by education (L = Low level of education or no instruction; I = Intermediate, secondary school and high school; H = graduate and post-graduate)

Fig. 7 shows the results of tsunami perception for number of generations of residence in the considered coastal municipality. It can be noted that, contrary to what happens for the age, the number of generations of residence has a small effect on tsunami risk perception. This may indicate that considering the whole sample there is a low transfer of information and experiences related to the tsunami risk from ~~a~~ generation to ~~the following ones~~, while recent local events may trigger other patterns of information gathering and seeking.

Collective memory of natural disasters is a relevant issue to keep into consideration: although a single definition is still missing, some authors highlight it as a dynamic process of functional adaptation to a changing world (Assmann, 1997). Oral communication could play a key role, because it would allow memories to circulate, also connecting historically separate generations that otherwise could not have mnemonic access to each other. This mnemonic transitivity would allow people to preserve memories in the form of oral traditions, passed on from one generation to the next ~~one~~ by means of elders and families (Nora, 1982, 1986, 1992).

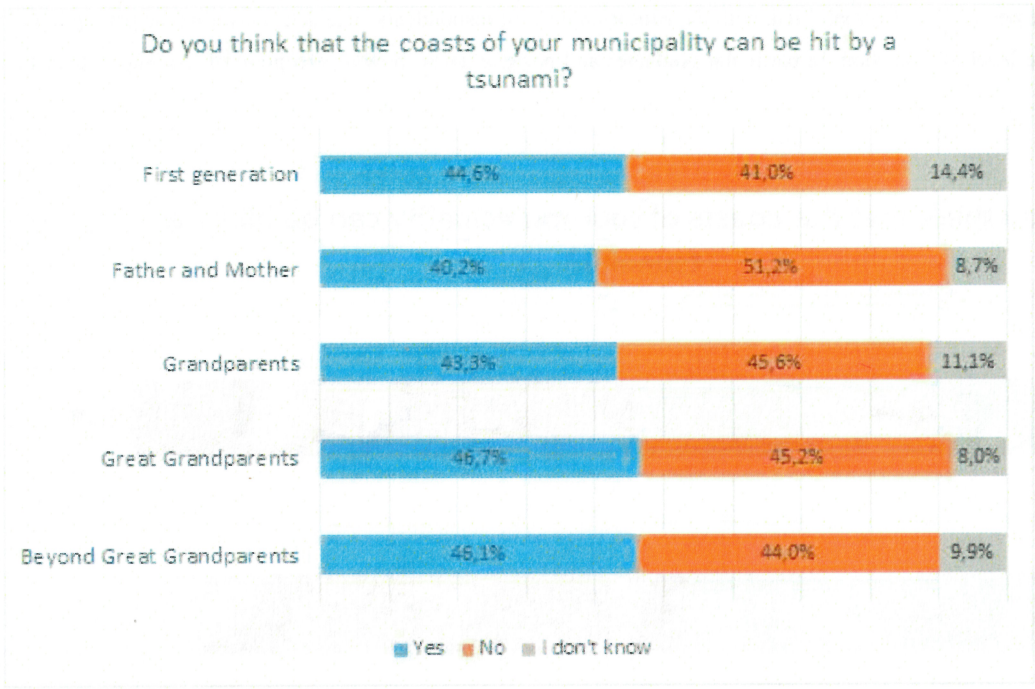

Fig. 7 - Tsunami risk perception according to the number of generations of residence in the area

A peculiar aspect concerns the perception of risk with respect to the different coastal regions. In this case, as we showed in Fig. 6, the Tyrrhenian Calabria has a higher level of risk perception than the other coasts.

At the moment, we are not able to explain this particular result but we can formulate some hypotheses. We have noticed that the respondents from Tyrrhenian Calabria are also more likely to consider volcanoes as a possible tsunamigenic source: 66.2% of them indicate volcanoes as a possible cause of the phenomena, while people from other coastal areas are far below this value, which varies from a minimum of 41.4% for those living in Adriatic Puglia to 45% of Ionian residents. Indeed, the southern Tyrrhenian sea hosts several active and quiescent volcanoes, including the Aeolian Islands (Stromboli, Vulcano, Salina, Lipari and others), and submerged volcanoes like the Marsili, Palinuro and other sea mounts (Figure 2). Therefore, the results outlined above could reflect both people's knowledge of this presence (in bright days people living on the coasts of Tyrrhenian Calabria can see the volcanoes offshore), and the fear of submarine eruptions and tsunamis, particularly from Mt. Marsili, to which a strong devastating power is attributed often by media. Moreover, it must be considered that a 'volcanic' tsunami did actually occur in 2002 triggered by a collapse of the Sciara del Fuoco flank, on Stromboli island, with run-up as high as 10 m on the island and notable effects even in Calabria (Bonaccorso et al., 2003: Maramai et al., 2005; Tinti et al., 2005; Chiocci et al., 2008). The fear for volcanic tsunami risk on Tyrrhenian shores is confirmed by a recent research on tsunami risk perception in relation to a hypothetical volcanogenic tsunami event, conducted on a sample of 888 interviewees from three Tyrrhenian coastal regions of Southern Italy, namely Campania, Calabria and Sicily (Gravina et al. 2019). Albeit the lack of counter-evidence for other coastal areas, this paper has shown that people from Tyrrhenian coasts are very concerned by the occurrence of tsunamis generated by volcanic eruptions, but they are also unable to indicate or recall proper actions and behaviour to be held in case of an event. It is worth noting that two small tsunamis (with maximum wave heights of about +/-30 cm recorded by tide gauges in the Eolian islands, in Sicily and Calabria) have occurred in June and August 2019 after two strong explosions of Stromboli volcano and subsequent landslides or pyroclastic flows on the Sciara del Fuoco.

In conclusion, the results on Tyrrhenian Calabria need to be better assessed in the light of multivariate analysis and possibly deepened through a specific research project on this coastal area.

Regarding the perceived size of tsunami waves, one should keep in mind that tsunamis can occur in many ways, and even a small event can cause serious damage and loss of life (like dragging children and even adults into the sea). Only 16% of the sample believe that a wave size of 50-100 cm would be dangerous for an adult who is near the shore, and those who think that even smaller waves of the tsunami can be a serious threat are even less: only 3.2% (Table 4).

Table 4: How high should the water level rise to be dangerous for people near the shore?

	N	%
Less than 50 centimetres	33	3.2
Between 50 centimetres and 1 meter	163	16.0
Between 1 and 3 meters	357	35.0
Over 3 meters	402	39.4
Don't know	66	6.5
Total	1021	100

Despite the greater probability of occurrence of small tsunamis and the remarkable danger represented by waves of less than a meter (with speeds up to 10 m/s), it is still probable that people refer to the tsunami being influenced by the strong and persistent images of great events displayed on television.

waves and flooding

4.2 Tsunami: sources of knowledge and phenomenon characterization

According to hypothesis 2 (see paragraph 3.1), the way tsunamis and related risk are understood and perceived may be affected by the sources of knowledge which have been actually used by the interviewees, first and foremost the media.

In our survey, we first considered the difference between the Japanese word 'tsunami' which dominates the tsunami risk governance field in many languages, and the word 'maremoto' (literally sea-quake), that is more common in spoken Italian. Survey results have shown that these two words are associated with two different mental models, in which some given features of the phenomenon are differently recalled and combined together, although with some degree of overlapping. Putting aside minor differences, the idea of 'big wave' is strongly associated with the word 'tsunami' (60.8 %) rather than with 'maremoto' (39.5%). Moreover, the word earthquake ('terremoto' in Italian) is mentioned as a feature of 'maremoto' (50%) more frequently than with 'tsunami' (35.4%). Other differences are found for the association of 'maremoto' with sea-storms (23.7% vs. 17.9% for 'tsunami"), while sea withdrawal is slightly more associated to tsunami (15.9%) than to 'maremoto' (10.9%). In general terms, the majority of the interviewees ~~considers~~ was more familiar the Italian word 'maremoto' (53.3%) than 'tsunami' (46.7%). Such a difference is more pronounced for elders, for women, and for people with low level of education, and of course has relevant implications for future risk communication strategies. It would be interesting to verify whether similar differences are present in other languages, where 'autochthonous' words such as the Italian 'maremoto' do exist, as for instance in Spanish in which the same word is used.

Interviewees were also asked to respond about the possible causes of tsunamis: earthquakes are correctly recalled by 75% of respondents, while volcanic eruptions were indicated by 46,1%, meteorological phenomena by 12,2%, meteorites befalling in the sea by 10,1%, landslides by 9.0%, and finally 6% proposed other possible causes[2]. Bivariate analysis has shown that

[2] Multiple responses question, percentages are based on cases. The overall total can exceed 100%.

causes listed above are first influenced by coastal area, then by level of education, age and gender: further analyses are required to better explain these differences. Such percentages reflect in some way the relative distributions of tsunamis' ~~causes~~ sources worldwide. Although the interviewees had the possibility to select more than one choice (and therefore they could have selected all of them), it is possible that they decided to pick only a few of them, i.e., those that were considered as more likely. The answers to the question about the possible effects of a tsunami on the coasts of one's own region suggest that people are more likely to recall some aspects of the physical phenomenon instead of others, which appear to be less familiar. Data distribution shows that the first five items, arranged in decreasing number of 'correct' answers, are consistent with the catastrophic visual imagery of the great tsunamis of Sumatra and Tohoku, as most of the interviewees were able to address physical damages to houses, buildings and infrastructures (92.2%), negative impacts on economy and occupation (91.6%), environment (90.4%), casualties and injured people (89.4%). An interesting result emerging from the survey is that people are well aware that fleeing to the beach after a strong shaking is not the right choice (85.1%).

The greatest difficulties to understand tsunamis are concerned with some relatively unfamiliar effects, such as the possibility to have great tsunamis (> 20m) even in the Mediterranean (38.6% think this is a real possibility); that tsunamis may trigger strong sea currents (37.8%) and that a tsunami wave of only 50cm can be actually dangerous for people staying near the shorelines (only 19.2% of the sample consider this a real danger). Evidence from this survey are consistent with what happened in the aftermath of recent events occurred in the Mediterranean. On July 21, 2017, a small tsunami ~~originated~~ generated by a magnitude 6.6 crustal earthquake, hit the island of Kos (Greece) and the nearby coastal city of Bodrum (Turkey) with run-up elevation up as high as 2m (Yalçiner et al., 2017). On that occasion, surveillance cameras on the Kos waterfront captured the way people were reacting to sea level anomalies: they were seemingly calm and utterly curious to see the water inundating quaysides. They were shooting pictures and videos with their smartphones instead of fleeing away, thus emphasizing that the risk posed by small tsunamis was almost completely ignored.

In order to get a concise and comprehensive picture of knowledge about the phenomenon, a rough but effective knowledge index has been developed, simply calculated as the unweighted sum of the number of correct answers to all the above listed questions about the 'physical reality' of the event, divided by the number of items considered. Given the average value for the whole sample (0.6952), gender, level of education, age and coastal area differently affect the level of knowledge. It is evident that a higher level of education implies a higher index of knowledge, as expected. Index values appear to be higher (> average value) for women, for middle-aged people (35-49), for residents of Tyrrhenian Calabria and Ionian Apulia coastal areas. On the contrary, elder people (65 and over), less educated people, males in general, together with inhabitants of Ionian Calabria and Adriatic Apulia, are placed below the average value.

These data could be more usefully scrutinized by considering the main sources of knowledge which have been used by people. Social images of the tsunami and in turn, risk characterizations rely on a variety of sources, combined in different patterns according to age, education, gender and coastal areas. We assumed that broadcast media, printed media, the Internet and other sources, including word of mouth through interpersonal networks (relatives, neighbours and friends) would have different impacts on people's understanding of tsunamis, thus resulting in different mental models. We asked people to list the sources of information they actually used from a list of 12 items (multiple response questions), thus analysing both the relative relevance of any single source and of their possible combinations. It is evident that television has a fundamental importance as first source of information for almost all the respondents, in line with general statistics on cultural consumption in Italy (Istat, 2018).

Figure 8 shows the results obtained by grouping the channels into homogeneous categories, the overwhelming role of television emerges even more clearly, since it is able to reach almost 90% of the sample (89.4%), followed at a considerable distance by traditional media (newspapers, books, movies, radio), which weighs just over half (50.8%) and then from the

What is aired on TV doesn't it include institutionall t Science sources as well as other sources of information. How do you distinguish the source of what is on TV.

Internet (17.5%). This suggests that any effective risk communications campaign must face with the overwhelming role of television. Social networks, which include all the interpersonal channel such as friends, parents and other relatives, together with neighbours and personal acquaintances were found to be a relevant source for 13,4%, while institutional and scientific sources together with other sources are placed at the lower steps of this ranking (9.9%). It is therefore important for research Institutions and Civil Protection agencies to work in this field, trying to reach more people and giving the correct information about this risk. Unfortunately, the results of our survey highlights the minimal impact that institutional and scientific sources on the understanding of tsunami people have had so far (cumulative percentage: 5.6%). In Italy, the efforts of DPC, along with INGV and other scientific institutions, to raise people's awareness on tsunami risk and inform about best practices of civil protection, dates back to 2013, through the campaign "Io Non Rischio" ("I don't take risks"), started in 2011 for earthquake risk (see Postiglione et al., 2016). However, only a very limited percentage of municipalities have included the tsunami risk among the activities. In 2018, only in 5% of the squares where "Io Non Rischio" took place (a total of 502) the tsunami risk was included. In particular, in the two regions where we launched the survey (Apulia, Calabria), no activity on tsunami risk was carried out during the 2018 campaign in any of the towns and villages involved (source: http://iononrischio.protezionecivile.it/io-non-rischio/dove-si-svolge/). The results of our survey seem to indicate that the previous awareness-raising initiatives have proved neither numerous nor effective. The number of respondents who recalled communication campaigns of civil protection/risk is 34 out of 1021 people interviewed, a number too low to draw any significant statistical inference (N = 34/1021, that is about 3.3% of the sample). Furthermore, "Io Non Rischio" is a campaign that takes place at the municipal level, and our research has not collected enough answers to draw conclusions at this level. Rather, in the future, it would be desirable that the same "Io Non Rischio" campaign, ten years after its launch, provides itself with tools to assess its impact and effectiveness.

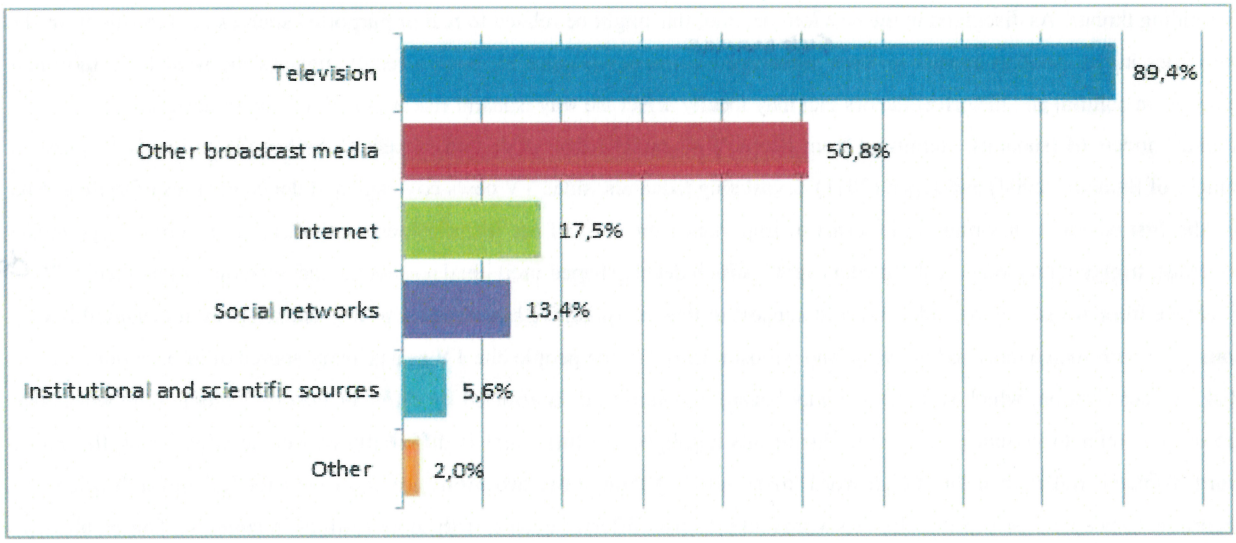

Fig. 8. Sources of knowledge on tsunamis: channels and penetration rates

impact

Our results seem to indicate that the enormous media coverage of the events of 2004 and 2011 in the Indian Ocean and in Japan has left a profound sign in Italy in the social images of the tsunami. Compared to the past, some of the best-known images of these events came from accounts of digital eyewitnesses, transmitted through multiple Internet channels, so that the contents generated by amateur users quickly became the most important source of transmission news from the most affected areas (Allan & Peters, 2015). Images like those of the big waves approaching the beach of Khao Lak (Thailand) after the

withdrawal of the sea, as well as the flood wave that overcomes the shores and crashes on the Miyako seafront, in Iwate prefecture (Northern Japan) have travelled the world, providing a vivid account of the event, contributing to shape people's understanding and tsunami mental models globally (Yamori, 2013; Couling, 2014; Goeldner-Gianella et al. 2017).

Conclusions

We carried out a CATI survey in order to retrieve empirical data on tsunami knowledge and risk perception in Italy. The results of the survey show that the tsunami risk is generally underrated, despite the high hazard of the regions under investigation. The level of risk perception seems to be quite low for the whole sample, and it appears to be influenced by education level and gender, as well as by the possibility to access reliable sources of information. On the contrary, the interviewees' age and their time of ~~stay~~ residence in the same coastal area (considering number of generations) do not result in significant differences on risk perception.

The general underrating may be due to the infrequency of damaging tsunami events in the last decades in Italy, and amplified by the lack of available information on this risk, and by the limited number of tsunami drills and campaigns ~~focused on it.~~

An interesting result emerging from this study is that the inhabitants of Calabria and Apulia have a very different level of tsunami risk perception, although the hazard assessed from scientific data show similar levels of occurrence probability in the two regions. More than 60% of the Calabrians consider quite likely the occurrence of a tsunami in their region, whereas only 30% of the Apulians do. We interpret this difference as due to the lower frequency of tsunami observations in Apulia compared to Calabria (Fig. 2), and to the larger time elapsed from the most recent event in the former region. This result confirms the need for raising awareness in areas where the memory of events is loose and the perception of risk is even less pronounced.

Moreover, we find that residents in the Tyrrhenian Calabria coastal area are more likely to consider tsunamis as actual and impending threats. As discussed in the previous section, this might be related to real or purported sources of tsunamis from the volcanoes in the Aeolian Islands or from submerged (submarine) volcanoes (Figure 2). Such a result suggests the need for a thorough analysis on cultural and historical factors that may locally affect the way tsunami risk is perceived and understood.

Mental models of tsunamis, stemming from people's characterization of hazard, appear to be heavily influenced by media images of Sumatra (2004) and Japan (2011) devastating tsunamis, since TV news coverage and documentaries of these events are the first source of information in terms of importance for most of our interviewees. Both disasters received huge media coverage, triggering a global-scale 'media event", which deeply shaped individual and social understanding of tsunami. Evidence from our survey provides a robust support to this interpretative hypothesis: the way tsunamis are understood is very consistent with such a televised imagery, and almost nine out of ten people cite TV as a primary source of information.

– does this not contradict what is stated in lines 153 – 15 ??

Risk characterization, which resumes the way hazard is understood, is affected by different factors, including the words that are used to refer to certain phenomena. Our results highlight that this event is differently conceived when using the exotic word 'tsunami' rather than the Italian word 'maremoto". Although the two terms are equivalent for Italian Earth scientists, according to people's perception, the two words refer to two different events, with some features in common. Our results also show that people appear to be conscious that earthquakes are the most frequent cause of tsunamis. Also, they tend to overestimate volcanoes as a possible cause of tsunamis, while underrating other causes such as landslides. Moreover, there is a poor awareness of some aspects of this hazard: previous tsunami disasters in Italy are in any case part of a distant past, whose details are doomed to fade away. In general, the respondents appear to totally neglect the possible impacts of small tsunamis, as also evidenced in other countries, thus fostering a false sense of subjective immunity. Our research underlines another critical point: people are likely to match information on tsunamis with their personal experience about sea-storm

waves to understand and characterize this risk, thus resulting into misleading assumptions about the real hazard posed by tsunamis (Oki & Nakayachi, 2012; Santos et al. 2016; Sutton & Woods, 2016; Wood et al., 2018).

This research is the first of its kind conducted in Italy, and its findings appear to be promising. Future analyses on this data set will probably allow us to better identify the main factors affecting tsunami risk perception in Italy, as well as to better understand the reasons behind the differences between regions and coastal areas. Future steps of this research will include the extension to other contiguous coastal regions which are most exposed to tsunami hazard together with Calabria and Apulia.

This research aims at integrating and enriching tsunami-related literature from social sciences fields, also providing new data and insights on the Mediterranean area. Currently, most of the available contributions regard only a few coastal areas in Pacific and Indian Ocean, such as Japan, Indonesia, Chile, Cascadia and Pacific Islands, where tsunamis are considered both as a matter of fact and a historical reality, and the risk posed by tsunamis is fairly known by local populations. To date, research papers on this topic are noticeably scarce for the NEAM area, with a few local exceptions, for example some Norwegian fjords (Lacasse and Nadim, 2011, Rød et al., 2012; Goeldner-Gianella et al., 2017). Lacking directions on people's perception and understanding of what is a tsunami and its related ~~damages~~ impact may lead to significant difficulties in setting-up sound risk communication strategies. Furthermore, the lack of data from social science could result in serious difficulties in fostering people's engagement and participation in the implementation of effective mitigation measures. In general terms, the development of tsunami warning systems should ~~not~~ focus not only on managing an ongoing event through crisis communication, but it should improve individuals' and communities' awareness and preparedness in a long term perspective (Lundgren and McMakin, 2011). This implies a better understanding of targets, messages and channels to be arranged both for informing people about the hazard posed by tsunamis, and to effectively shape an alerting strategy, to make people conscious about what it is happening and what they should do in case of an event.

The research is first intended to provide viable knowledge about people's perception and attitudes toward tsunami related risks, in order to improve communication strategies of both CAT - INGV and Civil Protection Department (DPC); it also aims to provide useful cues and suggestion to the overall Tsunami community in Mediterranean Region and beyond. This is the first extensive study on tsunami risk perception in Italy, and the first of this kind (with large stratified sample and CATI interviews) being completed in the NEAM region.

Any effective, sound risk communication strategy should lie on the integration of theory, empirical research, best practices and careful assessment of outcomes, within an open-ended cycle of research and action. Research results may indeed foster an open discussion on risk and crisis communication strategies to be held, to improve both individual awareness and communities' involvement and participation to risk reduction programs at national and regional level.

Risk communication should be integrated with other initiatives of community engagement rather than being conceptualized as a stand-alone process. The relevance and the meaning of the information about tsunamis arise from the way they are interpreted and prioritized within given social contexts, hence to facilitate preparedness any successful communication strategy must consider if and how information is known and whether it is used, (Paton et al. 2008). In particular, it would be important to challenge clichés about tsunami, and to consider actual knowledge and education level of people living in tsunami prone areas, also bearing in mind which channels are more suitable to reach as many people as possible.

The validity of the data collected and analysed in this paper is limited by definition to the coastal populations of Calabria and Apulia, and cannot be generalized to the entire Italian coastal population. As shown by research data, tsunami risk perception may be affected by a number of factors acting at global and local level such as events' history, risk characterization and presence of known tsunamigenic sources (volcanoes), along with socio-demographic features of the considered population.

In order to improve knowledge and clarify conundrums, in future investigations one may consider the following alternatives:

of

a) using the same sample methodology ~~used in~~ this first survey (stratified population sample) to investigate tsunami risk perception in other Italian regions and coastal areas (Basilicata, Molise, Sicily, etc.);

b) extending the survey to the entire Italian population, considering that many Italians who also live in inland areas spend their holidays in coastal areas.

c) conducting interviews addressed to specific groups of people representing the coastal population in a specific season of the year, using the same survey questionnaire. However, in order to have a good representative statistical base of the population, this method requires having data on the tourist population and the non-resident population of the coastal municipalities.

The general structure of the questionnaire, the type and number of questions, as well as the duration of the interviews are strictly designed to be administered by telephone, but the questionnaire could be adapted to be suitable for direct interviews or self-administration.

Survey methodology entails an assumption: data about individuals are used to make inferences about social attitudes and beliefs, thus underestimating the influence of both local culture and 'group thinking' when facing complex problems. For these reasons the survey should be ideally seen as a first step in a wider research strategy, aimed at providing further developments within a mixed-method approach, 'to bring in more robust evidence than either qualitative or quantitative approaches provide when they are used separately' [...] and 'to gain a deeper understanding of hazard perception and preparedness' (Alam, 2016). In this way, qualitative research methods (focus groups, interviews, etc.) could be used to implement and explain the results of the survey, contributing to clarify the role of both culture and individual motivations in shaping social response and risk awareness.

The research is indeed conceived as a set of integrated modules, to fit different needs and social context, and it is suitable to be replicated as a whole or in part in other geographical contexts, both in Italy and in the countries of the North East Atlantic, Mediterranean and connected seas region (NEAM). Data comparison and multivariate analysis may reveal underlying cross-cutting factors of tsunami risk perception predictors, thereby focusing on similarities and differences among coastal areas and countries.

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Data availability.

Research data can be accessed by contacting Massimo Crescimbene at his e-mail address: massimo.crescimbene@ingv.it

Author contributions.

AC, MC, FLL and AA provided theoretical background, analyzed data and wrote the paper. AC and AA revised it and supervised the research.