Bollettino di Geofisica Teorica ed Applicata Vol. 59, n. 4, pp. 575-588; December 2018
DOI 10.4430/bgta0227

Elapsed time: 40 years. What young people of Friuli Venezia Giulia know about the 1976 earthquakes, natural hazard and seismic safety

L. Peruzza, A. Saraò, C. Barnaba and G. Massolino

Centro di Ricerche Sismologiche, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Udine and Trieste, Italy

(Received: 28 December 2017; accepted: 27 February 2018)

ABSTRACT The 40th anniversary of the 1976 Friuli earthquakes has been an opportunity to revitalise the memory and awareness of living in an earthquake prone country. Among several activities we organised, a placement test on past and actual natural hazards was proposed to the students visiting the Udine seismological laboratory. The test was compiled by 422 students and 35 teachers from middle-high schools of Friuli-Venezia Giulia in anonymous form and on a voluntary basis. The sample includes both municipalities heavily damaged in 1976, and localities with light or no damage. The answers clearly show that the knowledge about the facts of the 1976 earthquakes (where, how long) is inadequate, with 11-13% right answers: better known is the social impact (deaths, 35%). Young people have a vague perception about the major natural hazard they are exposed to, and the answers are often influenced by false beliefs. All interviewees underestimate the frequency for devastating events in Italy. The good news is that students have a realistic awareness of the vulnerability of their school, are conscious of the risks of non-structural elements, and well trained to react during an emergency. Conversely, the concept of seismic prevention by reinforcing and retrofitting buildings is overlooked. As the memory of earthquakes vanishes in one generation only, the efforts in seismic risk communication have to be strengthened.

Key words: Friuli 1976, facts about earthquakes, natural hazards preparedness, seismic risk perception, memory of catastrophe.

1. Introduction

In 1976, a devastating seismic sequence occurred in north-eastern Italy, with a M_L 6.4 event on 6 May that killed about 1,000 people in the rural area of central Friuli region. The major seismic activity nucleated eastwards of the most damaged villages of Gemona del Friuli, Osoppo and Venzone, then migrated in September towards WNW and lasted about a year (Slejko *et al.*, 1999; Aoudia *et al.*, 2000; Slejko, 2018). The remarkable post-earthquake recovery conducted in the following decades represents, beyond the tragedy, a turning point that deeply transformed that region. Nevertheless, after forty years, the memory of a community fades, tied to the survivors of the earthquake, and the new generations have little knowledge of the catastrophic event that has changed the history of the places where they live. Commemorations are, therefore, a good opportunity, especially for the youngs, to remember the seismic history and to raise the awareness of living in an earthquake prone area.

The Centro di Ricerche Sismologiche (CRS) of the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), established by the Italian government (Law n. 828/82) for monitoring the seismicity of north-eastern Italy (e.g. Priolo *et al.*, 2005; Bragato *et al.*, 2011), has also been engaged in educational campaigns on seismic risk issues, both at the local and national scale (e.g. Camassi *et al.*, 2005; Camassi and Peruzza, 2011; Saraò *et al.*, 2013, 2016b; Peruzza *et al.*, 2016b; Postiglione *et al.*, 2016; Barnaba *et al.*, 2017).

During previous Friuli earthquake anniversaries, we published informative materials (Fig. 1) about the 1976 earthquakes for various audiences (e.g. Peruzza, 2000; Peruzza and Slejko, 2001, 2006; Peruzza *et al.*, 2006); for the 40th anniversary, CRS has intensified the dissemination activities. Thus, we held numerous public lectures on the 1976 earthquake and seismic risk topics in different towns of the Friuli-Venezia Giulia (FVG) area, and we ensured a constant presence in the local media, i.e. newspaper articles, television interviews, talk shows, social media (Fig. 2a), with the aim of reaching a wide public, in terms of age and cultural level (Saraò *et al.*, 2016a). In April 2016, while hosting an international workshop on seismometric networks and seismic monitoring, we inaugurated the new building at the CRS headquarters in Udine, in the presence of the local authorities and with major coverage of these events in the local press (Fig. 2b).

In 2016, we increased the offer for the school visits, an activity we perform routinely to involve students as active participants in the seismic risk mitigation process; the motto chosen for the schools campaign was "Orcolat in our Net" (Fig. 3a), the *Orcolat* being a ugly ogre of a local popular legend

Fig. 1 - In 2001 and 2006 (25th and 30th anniversaries), about 10,000 CD-Roms (on the left) and 70,000 brochures (right) were distributed with local newspapers and during special events, to disseminate scientific and updated knowledge about Friuli earthquakes to different audiences.

Fig. 2 - Snapshots of some activities performed by the CRS researchers in early 2016: a) a massive presence in the media (TV, radio, newspapers, social media) was ensured to commemorate the Friuli earthquake anniversary and to talk about the seismic hazard and risk of FVG. Videos are accessible on Facebook at https://www.facebook.com/ogscrs; b) some pictures of the international workshop and of the inauguration of the new CRS offices in Udine on 19 April, 2016.

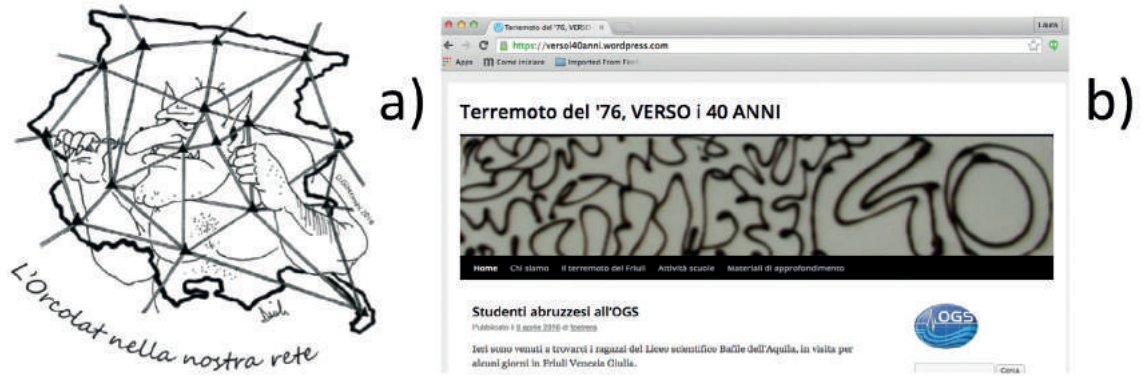

Fig. 3 - The CRS educational campaign of early 2016 was dedicated to schools: a) the logo of the campaign sketches the stations geometry of the CRS seismic network in FVG, imprisoning the *Orcolat*, the ogre of the popular tradition responsible for earthquakes; b) the online blog (https://versoi40anni.wordpress.com/) opened to collect materials and news about the anniversary activities.

who causes the earthquakes in Friuli; after 1976 *Orcolat* became the synonym of that devastating event, while the *Net* refers to the CRS seismometric network monitoring the *Orcolat*.

Our activities with students began early in May 2015, with a video-lesson ["Dialogo sul terremoto" available on Youtube https://www.youtube.com/watch?v=bTy60XuLdVA] during which a group of students interacted with CRS staff, in a kind of quiz game that started from some facts related to the 1976 earthquakes. This content, and other activities carried out during the campaign were published on a blog website (Fig. 3b, https://versoi40anni.wordpress.com). At the beginning of the 2015-2016 school-year, we opened the registrations - sold out in few days - for the school visits to the CRS labs; thus from February to May 2016, once a week, we welcomed more than 600 students to our headquarters in Udine (Fig. 4), and encountered about the same number of students in their own schools or at fairs. The visits were proposed *en liaison* with a tour to the "Tiere Motus"[1] museum in Venzone, the extraordinary historical town completely destroyed during the 1976 seismic sequence, then rebuilt as it was.

1 "Tiere Motus" is an exhibition collecting earthquake testimonies devoted to the victims, the emergency workers and to all those who supported Friuli reconstruction.

Fig. 4 - Some snapshots of the school visits at the CRS headquarters in Udine during the period February - May 2016.

The opportunity to meet so many students before the commemorations motivated us to check what young people really know about the earthquake that had shocked the lives of their grandparents and changed the history of their territory. So, we asked the teachers administering a survey as a placement test, before the class listened to the lectures given during the visit at our laboratory.

The analysis of the survey's answers is the topic of this work.

2. The survey

The questionnaire has been conceived with no requirements about students' background knowledge or specific earthquake lectures, and it has been proposed to the students through their teachers when booking the visit to our laboratory. The survey is organized into 10 questions, tackling the basic areas of knowledge, skills and abilities, as shown in Fig. 5; three questions concern the facts about the 1976 earthquake sequence, three are planned to scan the student's perception of natural hazards at the local and Italian scale, four items are related to their experience and abilities concerning earthquakes. All the questions have closed answers, except the last one. Some additional information about the interviewees was also collected, but the form compilation (online or printed) was anonymous.

The survey forms, in Italian and English (the second one is not yet used) and the related QR codes, are given as supplementary materials; they are still occasionally compiled online.

The main problems encountered when drafting the questions concern the lexicon and the usage of some specific terms whose understanding can be very dissimilar, depending on the students' ages and curricula. Therefore, we formulated the questions in the simplest possible way, trying to avoid technical jargon.

The form, optimized for mid-high school students (aged 13-19 years), has been proposed by some teachers to young pupils (e.g. last year of primary school, 10 years old), but we consider it as acceptable for adults with an average education too.

Sometimes the question formulation does not refer explicitly to the concepts in which we are interested in. For example, in question no. 1, we do not mention the term "hypocentre" (that implies prerequisite knowledge of what an epicentre/hypocentre is), but the "location" proposed in the answers refers to well-known towns, associated with a depth value. This artefact drives the compiler towards some reasoning about the plausible depth of earthquakes in Friuli region. Similarly, in questions no. 5 and no. 6 we skipped quantifying the earthquake size in terms of magnitude or intensity; even if these are very basic concepts in seismology, most people do not handle properly the differences between the measure of the energy released by an earthquake, and the classification of damages or effects observed at the Earth's surface; by allowing this ambiguity

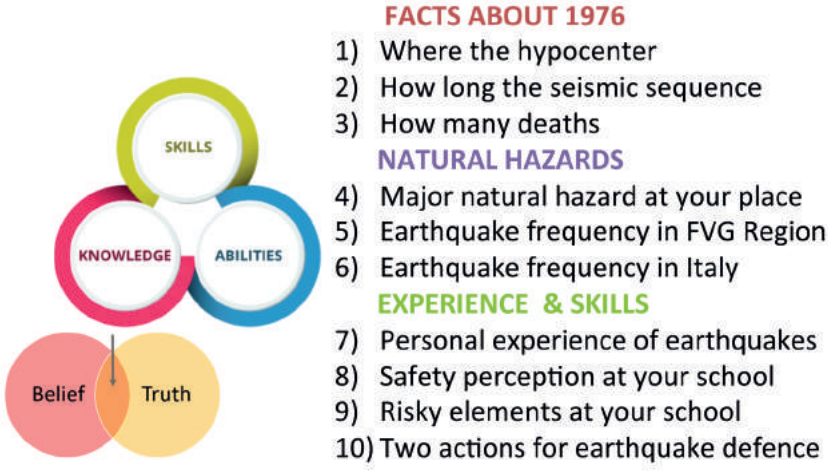

Fig. 5 - Schematization of the 10-question survey prepared for the educational campaign in the 40th Friuli earthquake anniversary. The full list of questions is given in Italian and in English as supplementary materials.

in the question, we believe the answers may sample different cognitive skills of the interviewees, or reflect a wide area of personal interpretation of beliefs and truths.

Last but not least:

1. the quantification of casualties is not given by absolute numbers, but in relationship with other recent events in Italy and abroad (data as in mid-2015 when the educational campaign started, updated in 2017 for the online form);
2. the answer "I do not know" is necessary to avoid a selection by chance.

The surveys were filled by the students before visiting our labs, between February and May 2016, i.e. before the major commemorations of the Friuli earthquake anniversary, culminated during the week of 6 May, to limit the contaminations due to the media pressure. Out of about 600 visiting students, the test was compiled on a voluntary basis by 422 students and 35 teachers from middle and high schools. The distribution of the answers for age and for school locations in FVG is given in Fig. 6; about ¼ of the 457 forms was compiled on paper, as Internet facilities are partially available at school.

3. Results: the long and winding road of Science

The results of the survey show that the *Generation Z*, i.e. people born between the mid-1990s and the mid-2000s, has vague or distorted scientific notions about the 1976 earthquakes, while the social impact is slightly better known. In Fig. 7 the histograms represent the distribution of the

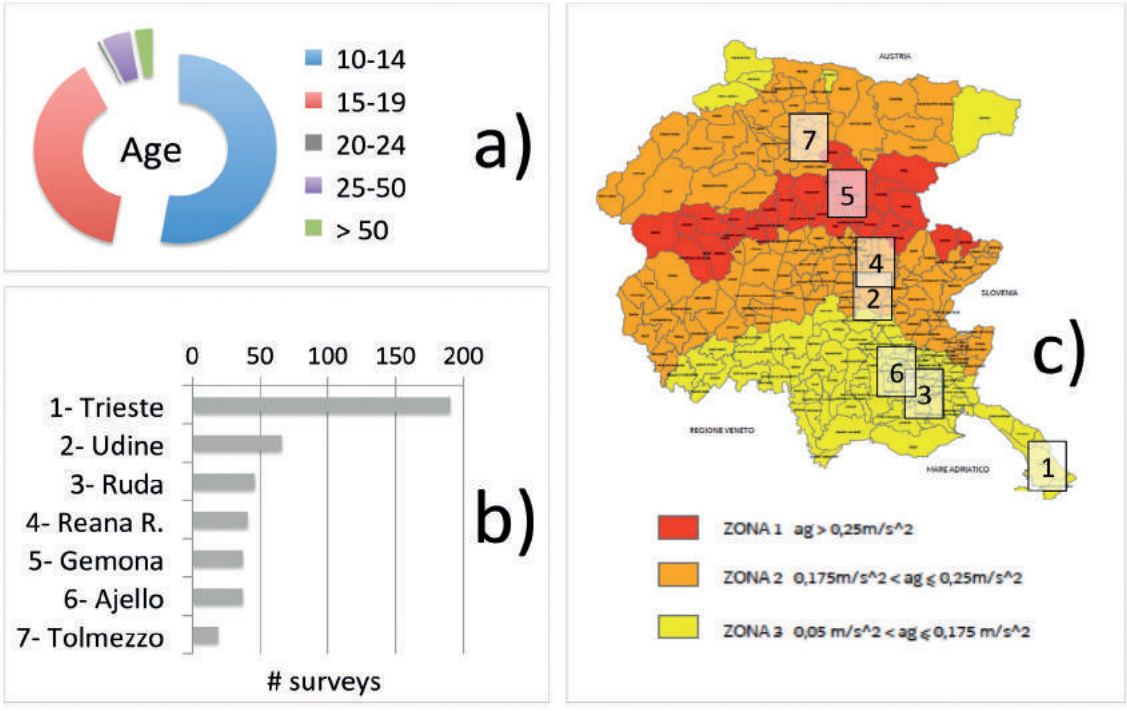

Fig. 6 - The survey took place from February to May 2016: a) distribution of the 457 answers by ages; b) number of the student surveys by localities: Trieste (TS) and Udine (UD) are the most represented towns for the school visits at CRS lab; c) location map of the towns listed in b). They represent different levels of seismic hazard, as shown by the regional seismic zonation adopted in 2010 (see also Peruzza and Pessina, 2016).

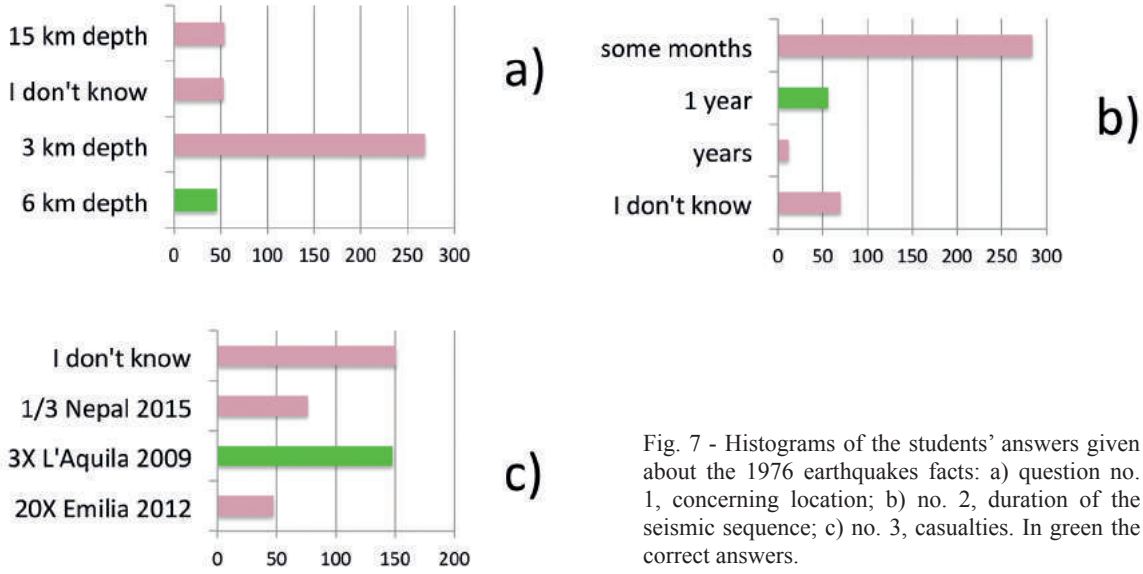

Fig. 7 - Histograms of the students' answers given about the 1976 earthquakes facts: a) question no. 1, concerning location; b) no. 2, duration of the seismic sequence; c) no. 3, casualties. In green the correct answers.

students' answers for the facts about the 1976 earthquakes; the right answers are plotted in green. "Where" (question no. 1) and "How long" (question no. 2) was the Friuli sequence is correctly answered by 11% (Fig. 7a) and 13% (Fig. 7b) of the interviewees only; "Deaths" (question no. 3) by 35% (Fig. 7c); slightly worse performances for age below 16, and better ones in epicentral area for all but the "Where" question. The "I do not know" answers have similar percentages to the right ones; the logic skills seem to help the eldest students (e.g. the shallow depth, in question no. 1), but many students, during the visit, declared they discarded some options not by following a logical thinking, but on the basis of the emotional impact of the answers (e.g. 20 times the Emilia's deaths sounds the highest number among the available choices, whilst it is the smallest one).

Question no. 1 (where) is a typical example of the difficulties in disseminating new scientific findings out of a specialised audience. The days after the earthquake of 6 May, newspapers reported Mt. San Simeone as being the epicentre of the main shock. Maps and images published immediately after the event (Finetti *et al.*, 1976) were, and still are recursively used by the newspapers. Then new, more accurate, seismological findings about the 1976 earthquakes became available (e.g. Slejko *et al.*, 1999; Aoudia *et al.*, 2000); the epicentre of the main shock was moved eastwards with respect to Mt. San Simeone, the very first epicentral location mentioned by the press, and approximately the barycentre of the most severely damaged area. Nevertheless, despite many articles in magazines and newspapers, the CDs and special brochures published in 2001 and 2006 (as mentioned in Fig. 1), several public conferences and activities with school, the survey has demonstrated the persistence of the first information: subsequent updates, carrying more precise scientific information than before do not reach the wide public and the most quoted location of the 6 May 1976 earthquake is still at Mt. San Simeone [see more details in Santulin *et al.* (2018)].

As regards the second group of questions on natural hazards, the answers revealed that, in general, young people in FVG are not properly aware of the natural danger they are exposed to. Students were asked (question no. 4) to select the most relevant hazard in the municipality of their

school: earthquakes, landslides, and floods are on average the most represented phenomena (see Table 1), and this is right for FVG [for an overview of the natural risks in FVG see the report of Regione Autonoma Friuli Venezia Giulia (2015)]. However, if we disaggregate the mean values in percentages for sites, we argue that sometimes there is a rationale, but also some answers not supported by a realistic vision of the environment: for example there are different and unjustified perceptions of earthquake risk for nearby locations (see sites 3 and 6, or 2 and 4 with a scatter of 25%). Trieste, site 1, has the highest value for landslide hazard (twice that of site 7, Tolmezzo, a town surrounded by mountains with numerous landslides), maybe because of the presence of hills in Trieste or for some occasional news in the local media about road interruptions caused by retaining wall collapses or rock falls, ascribed by students to landslide phenomena; tsunami is the main natural hazard for 8% of the students, although there are no reliable testimonies of past tsunamis along the coast of FVG. Note also that tsunami is selected by some students in localities that are 20-50 km far away from the coastline. With the cautions needed for statistics on small samples, these data suggest that sometimes students lack basic concepts of hazard and risk about the place where they live, and ignorance or concepts by image association (e.g. sea = tsunami, hills = landslide) prevail.

The beliefs about the frequency of earthquakes occurrence (question no. 5 and no. 6) span decennials, centuries, thousands of years: the age of the interviewees, or their location with respect to the 1976 epicentral area do not matter. Trying to avoid the quicksand of magnitude/intensity scales definition, we asked about the occurrence of "events like the 1976 earthquake". We know that this was a trick question, mainly for two reasons: 1) the seismic energy release and the related damages do not always correspond; 2) the earthquake statistics - basically, the ones provided on earthquakes catalogues - have to deal with uncertainties (in size and location of earthquakes), incompleteness of records, representativeness of the time window with respect to clustering/quiescence phenomena, and so on. We are aware that all these matters are not handled with ease by scientists, and therefore are quite difficult to understand by the generic public. Thus, the following considerations on earthquakes statistics are just orientational. The Parametric Catalogue of Italian Earthquakes (CPTI15) by Rovida *et al.* (2016) assigns to the 6 May 1976

	%	1 TS	3	6	2 UD	4	5	(7)
Earthquake	52	29	41	68	83	56	92	74
Landslide	22	43	2	8	3	2	8	21
Flood	16	7	57	22	4	32		
Tsunamis	4	8		3	3			
Wind		4						
Snow		3			3			

Table 1 - Major natural hazard statistics in the municipality of the schools: total percentages of answers (column %), and percentages disaggregated for sites (see their location in Fig. 6).

event a $M = 6.45$, and epicentral intensity Io = IX-X MCS; with reference to about 700 year long seismic history (the completeness, even for major earthquakes, is not guaranteed before the XIV century), CTPI15 reports 40 events occurring in Italy with $M \geq 6.45$ and 53 earthquakes with $Io \geq$ IX-X MCS; for the FVG, there are 2 similar sized earthquakes (in 1348 and 1976), or 4 (1511, 1873) if we account for uncertainties in the magnitude and the geographical assignment. Thus, this trivial counting suggests a frequency of 1 event in 13-17 years for Italy and one in 175-350 years for FVG.

In the survey's results (Fig. 8), the frequency of occurrence for earthquakes like the 6 May 1976 event are peaked on a lifetime period (1 in 50 years) in both the histograms referring to FVG, and to the whole country. About the same percentage of students assigned rare events (1 in 500 years) to FVG, and frequent events (1 in 5 years) to Italy. Comparing these numbers with the earthquake reported in CPTI15, there is some overestimation of devastating earthquake frequency for FVG, and a clear underestimation of earthquake occurrence for Italy. Beyond the proper quantification of earthquakes frequency, the comparative trend of the two answers is the most significant result: about 53% of the students gave the same class of frequency - no matter which one - to earthquakes in the whole of Italy and in FVG region, thus demonstrating they are not familiar with the concept that an earthquake is more likely to occur, the larger the area is to take into account. However, the underestimation of Italian earthquake frequency affects the teachers' sample too.

Concerning experience and skills (question no. 7), the students in FVG have not experienced earthquakes at all (48%, see Fig. 9a), or they have experienced very weak motions such that they did not realise immediately it was an earthquake (27%). The perception of safety at their school (question no. 8, total answers given on a 5-steps Likert scale in Fig. 9b) spans all the available choices (56 and 30 samples, respectively, for the extremes, totally unsafe and fully safe), but it is well correlated with intuitive vulnerability considerations based on the age/maintenance

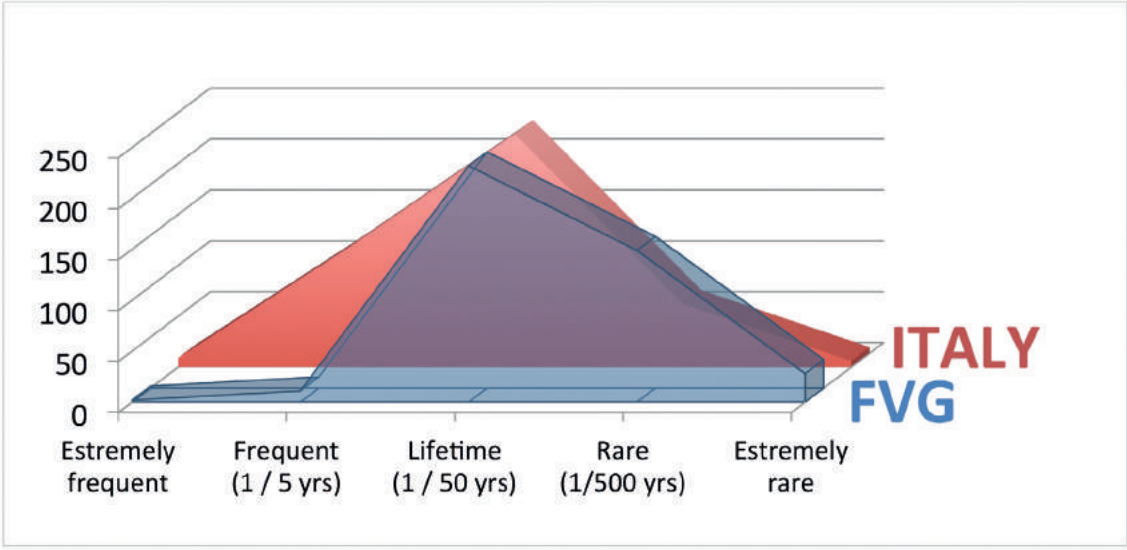

Fig. 8 - Histograms of the students' answers about the earthquake frequency in the FVG region and in the whole Italian territory: about 53% of interviewees selected the same value (no matter which one) for both cases.

Fig. 9 - Students direct experience with earthquakes (question no. 7, on the left) and their perception about safety in the school buildings (no. 8 on the right).

conditions of the school buildings, that we are able to track by the additional information we collected from the compilers.

The students have a realistic awareness of the risky elements of their school (question no. 9): they are conscious that both human reactions and non-structural elements may be the main danger in case of earthquakes at school; "Panic attack, crowd" is at the top in the risky elements addressed, followed by "False ceilings, lamps, windows" and "Staircases, elevators".

Question no. 10, the last, is an open one, and students were asked to list two actions for a "defence" against earthquake. The answers are summarised through a word cloud in Fig. 10. They all answered with actions to take during an earthquake emergency, and some wrong or fatalistic attitudes (e.g. run) emerge. Only one student, nicknamed by us "the wannabe engineer", noted preventive actions, such as strengthening of buildings.

We summarised the main results of our survey in an info-graphic chart (Fig. 11), that has been distributed at the conference where this work was originally presented (Peruzza *et al.*, 2016a), and in other public meetings.

Fig. 10 - Word clouds of the actions to be taken for a defence against earthquakes. a) original answers, in Italian; b) translated into English.

4. Conclusions and perspectives

The 1976 Friuli earthquakes have been commemorated recurrently and with important efforts, by institutions and common people; the survey on students that we performed in the frame of the 40th anniversary was a check on the persistence of the cultural traces of earthquakes in a region that experienced a catastrophic event, followed by an exemplary recovery after the devastation. The 457 answers collected in early 2016 tell us that the generation born in this millennium is losing the knowledge about the earthquakes that affected their parents or grandparents, and the memory of the facts is dominated by the most repeated, familiar but sometimes incorrect beliefs.

On average, the earthquakes are considered the major natural hazard in FVG for all municipalities except Trieste, mainly affected by landslides, in students' opinions, with large fluctuations in nearby localities. The frequency of devastating earthquakes at the Italian scale is underestimated by students and teachers. We acknowledge the difficulty in formulating good questions about the frequency of earthquakes, without introducing more complex concepts that involve the scales for measuring earthquakes, the uncertainties associated with the measurement, the basic comprehension of the differences between energy release and damages, natural hazard and risk. Some other shortcomings in lexicon or basic logic also emerged from the answers.

Even if the students have no direct experience of earthquakes, they addressed correctly the risky elements at schools. Sadly, the defence against earthquake for the students in FVG is linked only to the emergency phases; some fatalism survives, and no prevention strategies are addressed.

The commemoration of the 1976 Friuli anniversary has been dramatically interrupted by the occurrence, since 24 August 2016, of a new devastating seismic crisis in central Italy. The priorities have thus changed: the need to assist, recover and rebuild has driven the actions of Civil Defence Department volunteers, scientific personnel, side by side to the hit population.

In the subsequent school year 2016-2017, the questionnaire was proposed during other activities with schools (e.g. while promoting the earthquake drill known as "The Great SHAKE OUT", https://www.shakeout.org), collecting about 250 more answers, mainly from Trieste. The post-anniversary compilations show negligible changes with respect to the data set collected in early 2016, except for an increase in the "I do not know" answers about the casualties of the Friuli earthquake (question no. 3), and the pole-position gained by "frequent" devastating events in Italy (question no. 6). We believe that these answers were driven by the emotional impact of the 2016 central Italy sequence; the improvement in knowledge about the Friuli earthquake, as a consequence of the 1976 Friuli 40th anniversary cannot be detected by this additional sample. As observed for other recent earthquakes (Crescimbene *et al.*, 2012), such a consideration confirms once more the difficulties of the scientific community to draw the attention of people to earthquake related facts in the absence of that emotive involvement raised soon after the events that resulted in casualties and destruction.

The conclusions we draw from this work are similar to those we reached during past experiences involving students as active participants of the seismic risk mitigation process (e.g. Camassi and Peruzza, 2011; Peruzza *et al.*, 2016b; Barnaba *et al.*, 2017). Particularly, we remark that:

1) authoritative sources of information about natural hazard and risk must be available for educational advancement of the whole community; in a fast changing society teachers and schools are the main resource to drive the changes and preserve the earthquake memory. Therefore, easily understandable maps of the natural hazard at different scales should be provided to the public, together with basic concepts of the risk components to facilitate prevention strategies. In FVG,

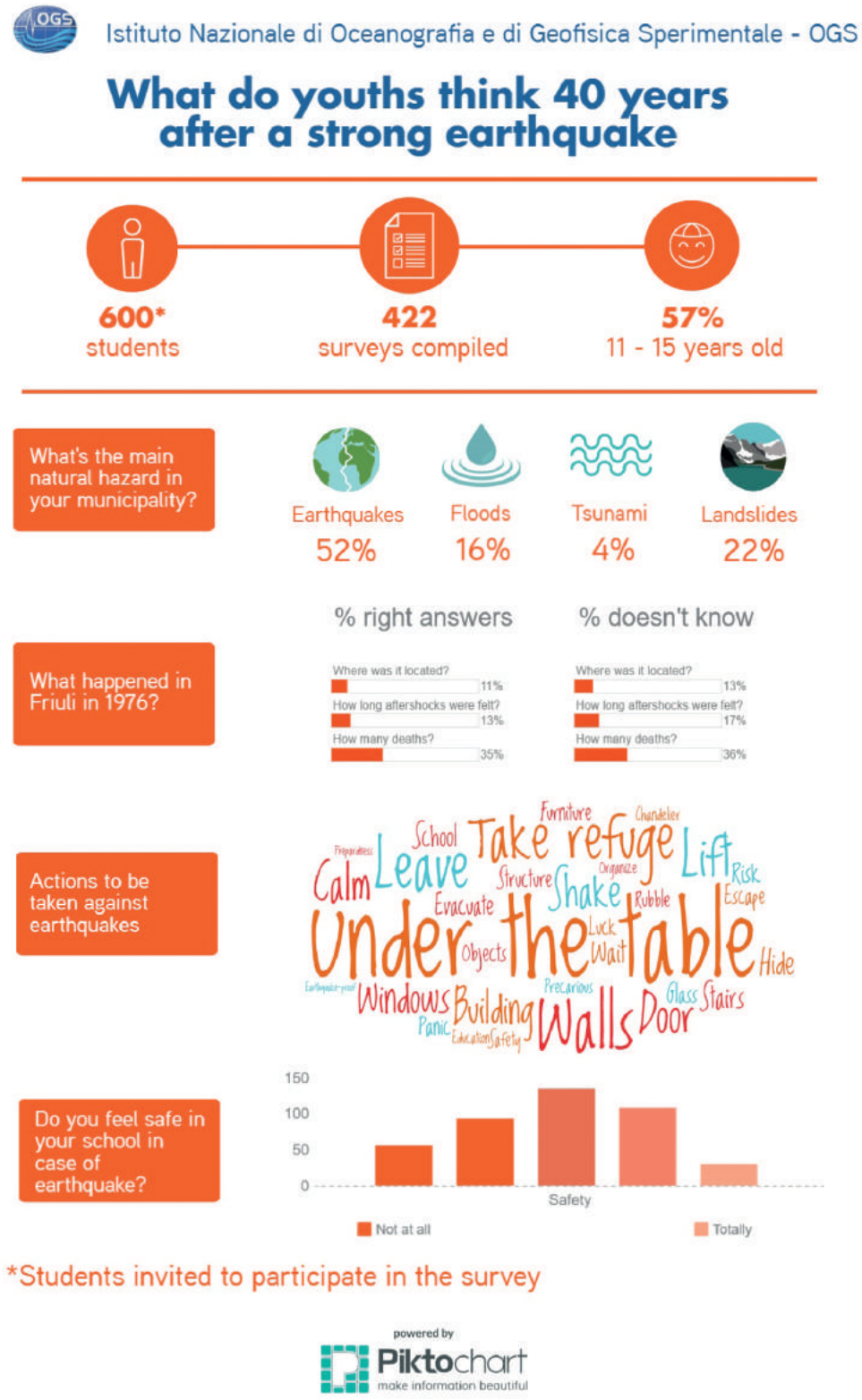

Fig. 11 - Info-graphic summarizing the results, distributed at scientific and public meetings.

the last release of the seismic zonation map (updated in 2010) is a good proxy for representing the seismic hazard, but the situation in other Italian regions is different (see for example Peruzza and Pessina, 2016). However, such a map is poorly known by the community;

2) student activities that require efforts lasting more than a few hours' visit are very effective. This was the case, for example, of some students that carried out a geophysical survey, collecting seismic noise measurements for microzonation studies (Barnaba *et al.*, 2017), and some others that created a seismograph with Arduino board (Saraò *et al.*, 2016b); both the groups were later involved in disseminating the seismic risk notions acquired to younger companions;
3) additional efforts are needed to dismantle rumours and fake news, or for disseminating updated scientific results and knowledge about earthquakes in the communities, if they are not living the heavy consequences of seismic events. The interest in earthquakes decays fast, and one generation is sufficient to cancel the cultural traces of catastrophic seismic events, in the epicentral area too.

For all the above reasons, we still pursue our efforts in educational initiatives such as the IONONRISCHIO campaign (www.iononrischio.it); the TemaRISK FVG project (https://temarisk.wordpress.com) involving different stakeholders, in accordance with the perspectives and duties assigned to the OGS-CRS department, that leads research on earthquake hazards, closely rooted in the FVG region, and keeps on maintaining the north-eastern Italy seismic network and the commitment to disseminate the culture of seismic risk prevention.

We hope that our work may be of benefit to all the earthquake-stricken communities by maintaining the memory of earthquake facts for the future generations.

Supplementary material related to this article is available online at the BGTA website www3.inogs.it/bgta.

Acknowledgments. We thank our colleagues D. Zuliani, P. Fabris, P.L. Bragato, A. Peresan, A. Snidarcig, A. Romano, P. Comelli, P. Di Bartolomeo and C. Ponton for their help in assisting the school visits at the CRS laboratories. This work is dedicated to our unforgettable colleague M. Mucciarelli, Director of CRS from 2012 to 2016, who inspired and supported our disseminative initiatives. All of the websites cited in the paper were last accessed on 22 February, 2018.

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Corresponding author: Laura Peruzza
OGS – Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Centro di Ricerche Sismologiche
Borgo Grotta Gigante 42c, 34010 Sgonico (TS), Italy
Phone: +39 040 2140244; e-mail:lperuzza@inogs.it