The impact of an exhibition on risk awareness of the general public in mountainous areas

Charrière, Marie K.M.; Junier, Sandra J.; Bogaard, Thom A.; Mostert, Erik; Malet, Jean Philippe; van de Giesen, Nick C.

DOI
10.1016/j.ijdrr.2017.07.011

Publication date
2017

Document Version
Final published version

Published in
International Journal of Disaster Risk Reduction

International Journal of Disaster Risk Reduction 25 (2017) 36–59

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

The impact of an exhibition on risk awareness of the general public in mountainous areas

Marie K.M. Charrière[a,*], Sandra J. Junier[a], Thom A. Bogaard[a], Erik Mostert[a], Jean-Philippe Malet[b], Nick C. van de Giesen[a]

[a] *Department of Water Management, Faculty of Civil Engineering and Geosciences, Delft University of Technology, South Holland, The Netherlands*
[b] *Institut de Physique du Globe de Strasbourg, CNRS UMR 7516, Université de Strasbourg, France*

ARTICLE INFO

Keywords:
Risk communication
Natural hazards
Awareness

ABSTRACT

This study investigates the impact of an exhibition on natural hazards on risk awareness of the inhabitants of the Ubaye Valley in southern France. Risk communication practices need to be effective to contribute to disaster reduction, but their impact is rarely evaluated. Using a pre-test/post-test research design as well as a longitudinal study, changes in awareness of adults, teenagers and children were measured. The responses to a questionnaire were analyzed using non-parametric tests. The questionnaire dealt with several factors determining or influencing awareness: attitudes to risk, previous experiences of emergencies, exposure to awareness raising, ability to mitigate/prepare/respond, worry level, self-reported awareness, hard knowledge and demographic characteristics. Generally, risk awareness was higher after visiting the exhibition. The exhibition had most impact on visitors that had experienced few natural hazards or that were little informed a priori. In contrast to teenagers and children, the awareness of adults increased only for risk in general and not for specific natural hazards. Moreover, the results show that the exhibition was more effective in raising awareness of the hazards that occur rarely. For more frequent and more locally occurring hazards, such as debris flows, other means of communication should be considered.

1. Introduction

Mountainous areas are typically affected by multiple natural hazards, such as floods, debris flows, landslides, avalanches and earthquakes that threaten society socially and economically [55]. Between 1982 and 2005, natural hazards induced economic losses added up to EUR 57 billion in the Alps alone [38]. Risk management can help to reduce losses.

Currently, there is a shift in risk management towards integrated approaches that focus on prevention and preparation [22]. This brings the importance of risk communication to the fore. The definition of risk communication itself has changed from a process of informing individuals about risks [40] to actions based on dialogue [21,29]. Risk communication favors the expansion of social capacities [22], such as the knowledge, skills and networks that are needed to successfully manage hazard occurrences [28]. However, as two-way communication is very demanding to put into practice and communities are not always inclined to participate, risk communication often remains one-directional. Applied research on one-directional risk communication therefore remains important [33].

One of the goals of risk communication on natural hazards is to raise public awareness of the hazards [27]. A well-known definition of public awareness is *"the extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards"* [50,51]. However, awareness is more than factual knowledge. It is a mental construct [54] that is multi-dimensional and is linked to personal attitudes [33]. Awareness raising efforts have to take the risk perception of the target audiences, i.e. their intuitive risk judgements [46], into account [15]. These are linked not only to the perception of the probabilities of occurrence and consequences of an event [6], but also to emotions e.g. [31,47,35]. In addition, personal experience with natural hazards and demographic factors such as age, gender and education have been found to play a role [26,49,54].

To contribute to risk management, risk communication must of course be effective, i.e. it must fulfill the goal for which it was designed. The effects depend on the source of the message, its content and the attributes of the target audiences [3]. Demographic characteristics of the public must be taken into account, but also their mental models [2], believes, concerns [20] and values [8]. Moreover, trust in the

* Corresponding author.
E-mail address: m.k.m.charriere@tudelft.nl (M.K.M. Charrière).

http://dx.doi.org/10.1016/j.ijdrr.2017.07.011
Received 2 June 2016; Received in revised form 23 July 2017; Accepted 24 July 2017
Available online 29 July 2017
2212-4209/

Table 1
Exhibits (content and used visuals) presented at the 'Alerte' exhibition.

Exhibits	Number	Content	Visuals
A0 Posters	15	Concept of risk, avalanches, landslides, torrential floods, debris flows, earthquakes, security guidelines, non-structural mitigation measures, structural mitigation measures, technical agency in charge of risk management.	Pictures, drawings, symbols, graphs, diagrams, color schemes, maps, scales.
Supporting information boards (30*30 cm)	12	Scientific definitions and explanations, additional information.	Pictures, drawings, symbols, maps.
120*400 cm Poster	1	Timeline of all reported events from the 19th century and important regulation changes, highlight of major events.	Pictures, old newspapers, histograms.
Numerical timeline (Ipad)	1	Web-based numerical timeline of all reported events from the 19th century and important regulation changes, highlight of major events.	Pictures, archives.
Flood scale model	1	330 × 80 cm model of Barcelonnette (DEM based) with manual system to simulate a flood.	–
Seismograph	1	–	Dynamic graph.
Videos (TV)	4	4 videos of local events (triggered avalanche, rockslide and debris flow) and earthquakes effects (Japanese compilation of videos from different countries)	Videos.
Videos (Ipad)	15	Testimonies of witnesses (local inhabitants) of events, technicians and scientists.	Videos.
Emergency kit	1	Emergency kit according to French ministry advices	Objects in showcase.
Google Earth map	1	Local area with descriptive pins at location of major events or important mitigation measures	Pictures, archives.

Table 2
Factors tested in the pre-test and/or post-tests with indicators' description. Items marked with a * were not asked in the children's questionnaire.

FACTOR	INDICATORS	TESTS
Dependent		
Worry	Worry about floods/landslides/debris flows/earthquakes/snow avalanches	Pre-test Post-tests
Self-reported awareness	Feeling of being aware of natural hazards occurring in the Ubaye valley	Pre-test Post-tests
Ability to mitigate/respond/prepare	Feeling of being vulnerable to natural hazards occurring in the Ubaye valley	Pre-test
	Feeling of having all the knowledge and information to respond to natural hazards occurring in the Ubaye valley,	
	Feeling of having all the material and financial resources to respond to natural hazards occurring in the Ubaye valley*	Post-tests
	Feeling of being prepared for natural hazards occurring in the Ubaye valley	
Attitude to risk	Likelihood of floods/landslides/debris flows/earthquakes/snow avalanches occurring in the next 5 years in the Ubaye valley	Pre-test
	Consequence of floods/landslides/debris flows/earthquakes/snow avalanches occurring in the Ubaye valley	Post-tests
Independent		
Previous experience	Direct experience	Pre-test
	- > Number of times floods/landslides/debris flows/earthquakes/snow avalanches were experienced	
	- > Impacts on health or belongings	
	Indirect experience:	
	- > Knowledge of persons impacted by natural hazards	
Demographics	Age, Gender, last obtained degree, whether work is related to natural hazards	Pre-test
Exposure to awareness raising	Time living in the valley	Pre-test
	Prior amount of information received on floods/landslides/debris flows/earthquakes/snow avalanches	
	Impact of prior information on awareness*	
	Impact of prior information on the motivation to become prepared*	
	Amount of new information on floods/landslides/debris flows/earthquakes/snow avalanches received by visiting the exhibition	Post-test
	Impact of the new information on awareness	
	Impact of the new information on the motivation to become prepared	
	Amount of new information on floods/landslides/debris flows/earthquakes/snow avalanches received between the two post-tests	Second post-test
	Whether the topic of natural hazards was discussed after the visit of the exhibition with the parents, the friends or at school.	
Hard knowledge	9 questions. See Fig. A6 in the Appendix	Post-tests

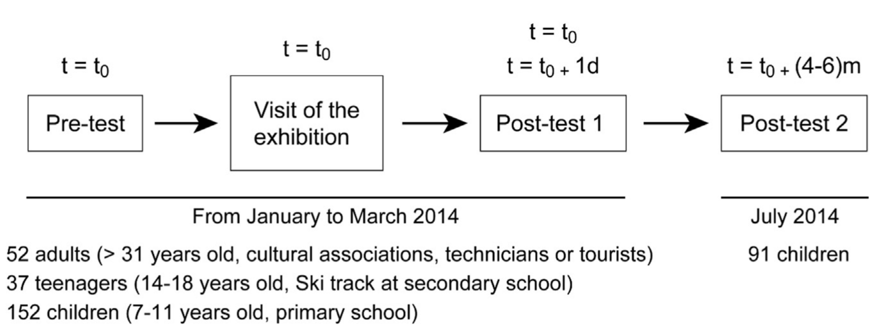

Fig. 1. Research design. t = time, d = day and m = month.

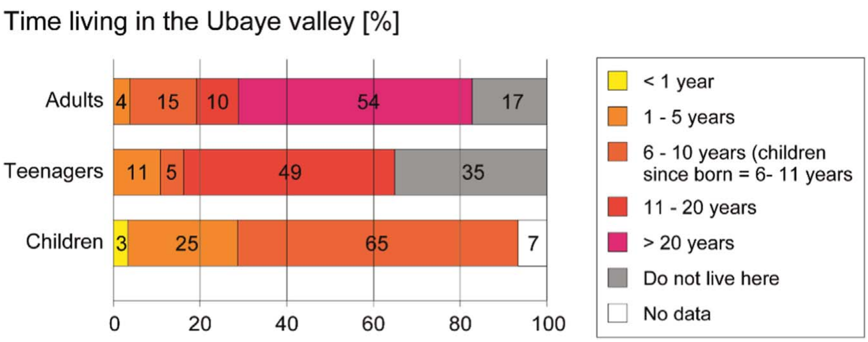

Fig. 2. Exposure to awareness raising in terms of time living in the Ubaye valley.

communicators [14] and the use of suitable formats [5] must be ensured. However, even if those preconditions are met, one cannot take for granted that risk communication is effective without having conducted an evaluation.

In the last decades, the need for evaluating risk communication has been stressed in the literature (e.g. [39,13,34,32]). Rorhrmann [41,42], for instance, acknowledged the importance of empirical evaluation in order to assess whether a specific effort was successful or needed to be ameliorated or replaced by something else. He remarked, like others [e.g. [13,37]], that effectiveness depends on the goal set for the given communication effort. Several types of evaluations can be performed: content, process, or outcome (i.e. summative) evaluations. One possible outcome or impact of public communication is the change that it produces to those that were involved in it, in terms of knowledge, beliefs, attitudes and behavior [18,37].

Evaluations of communication outcomes in relation to natural hazards are not common [49]. Scientific research focusses more on the content evaluation in laboratory research settings [9]. In general, practice and research on risk communication concentrates on floods [22,9]. This also applies to the few studies focusing on outcome evaluation of risk communication. In his research from the Netherlands, [49] measured only small effects of risk communication through workshops on the flood risk perception, but he also found that a lack of updated and relevant information may reinforce inappropriate beliefs. Concerning Zürich, [33] found that a once only dissemination of written information concerning flood risks only slightly increased risk awareness and risk preparedness of their targeted audience.

This observed lack of studies on the effects of risk communication on awareness calls for more research. Therefore, the goal of this study is to measure the effectiveness of an exhibition on risk, the "Alerte"

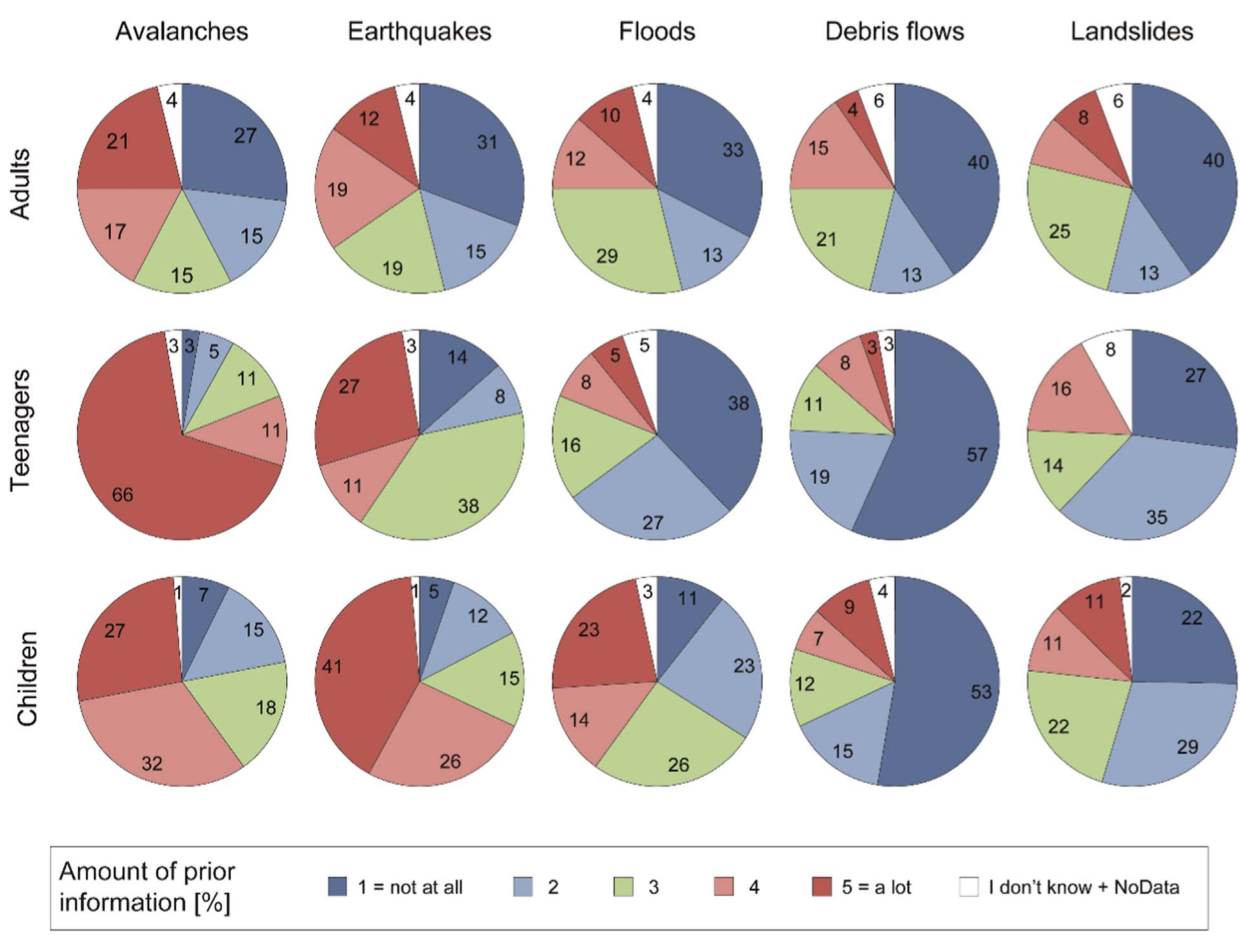

Fig. 3. Amount of information (factor *Exposure to awareness raising*) received on each natural hazard by age group prior to the visit of the exhibition. Question: "How much information have you received on avalanches/earthquakes/floods/debris/landslides?" 5-points Likert scale: 1 = not at all to 5 = a lot.

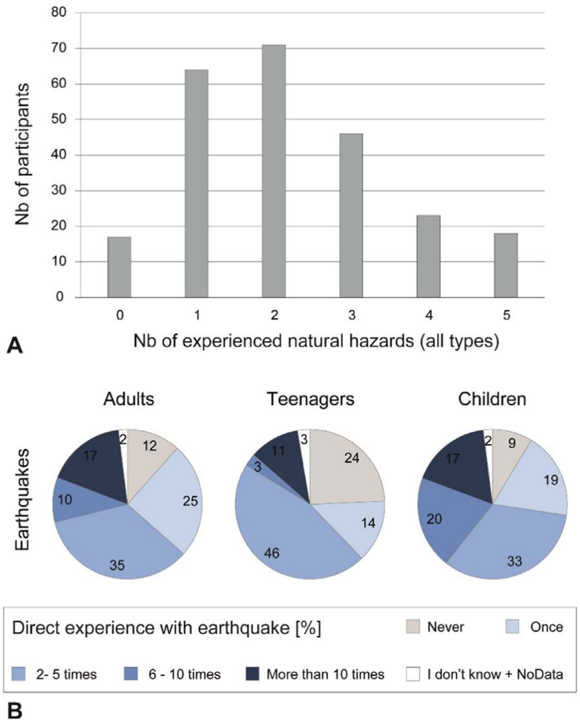

Fig. 4. Number of hazards experienced by the participants (A) and direct experience with earthquakes (B). Results derived from the question "How often have you experienced the following natural hazards (avalanche/earthquakes/floods/debris/landslides?".

Table 3
Changes in awareness factors for the whole sample. All tests are based on negative ranks meaning that there are increases in scores between the two-tests. Significant changes are highlighted in light green for the small effects and in darker green for the medium effects. Complete test statistics in the appendix (Table A1).

General indicators			Effect size (*r*)
Ability to mitigate/respond/prepare		Self-reported awareness	-0.14
		Self-reported vulnerability	-0.19
		Self-reported amount of know. and info.	-0.22
		Self-reported amount of resources	-
		Self-reported preparedness	-0.35
Worry level		Floods	-0.17
		Landslides	-
		Debris flows	-
		Earthquakes	-
		Avalanches	-
Specific indicators			Effect size (*r*)
Attitude to risks	Perceived likelihood	Floods	-0.23
		Landslides	-
		Debris flows	-
		Earthquakes	-
		Avalanches	-0.19
	Perceived consequences	Floods	-0.36
		Landslides	-
		Debris flows	-0.15
		Earthquakes	-
		Avalanches	-0.18

exhibition. This exhibition, held in the Ubaye Valley, a small mountain community in the southern French Alps, aimed at increasing risk awareness of the general public. Different types of audiences were targeted and different hazards were addressed, reflecting the reality in many small mountainous communities, where funds are usually too limited to have separate communication efforts for different audiences and hazards. Moreover, it aimed to measure factors that constitute or influence risk awareness, specifically knowledge, attitudes to risk, previous experience, exposure to awareness raising, ability to mitigate, worry and demographic characteristics. In addition, the goal is to measure the persistence of risk communication on risk awareness of children by using a longitudinal approach with two post-tests separated by several months. Assessing the long-term effects is as necessary for understanding risk awareness as for understanding risk perception [45]. Most of the published research focusses on the personal characteristics of individuals that play a role in risk awareness in order to provide guidelines for risk communication practices. In our case, we also tested to what extent and how a risk communication effort can change the attitudes and perceptions that constitute risk awareness.

The paper is organized as follows: Section 2 presents the development and the content of the intervention, i.e. the "Alerte" exhibition, and the methodology used to assess the effectiveness of this intervention. Sections 3 and 4 present the characteristics of the participants and the observed changes in risk awareness. Section 5 discusses these changes. Section 6 contains the conclusion.

2. Intervention development and methodology for measuring changes in public awareness

2.1. The development of the "ALERTE" exhibition

In order to be able to test the effectiveness of risk communication on public awareness, a real-life communication effort was developed using an action research approach [11,48]. A two years' consultation and collaboration process with the local authorities and risk managers of the Ubaye Valley (Southern French Alps) as well as with scientific experts of the area lead to the exhibition "Alerte – 'ALEas Risques et proTEction': Connaître les risques en montagne, c′est y être mieux préparé "(English translation: "Alert – 'Hazards, risks and protection': Knowing the risks in mountains to be better prepared") at the public multimedia library of Barcelonnette.

The Ubaye Valley is highly exposed to several natural hazards. In the last 100 years, at least 72 earthquakes, 119 landslides, 144 snow avalanches, as well as 414 floods and debris flows were reported (database of local technical risk managers, i.e. Restauration des terrains en

Table 4
Changes in awareness factors by age group. All tests are based on negative ranks meaning that there are increases in scores between the two-tests. Significant changes are highlighted in light green for the small effects and in darker green for the medium effects. Complete test statistics in the appendix (Table A2).

General indicators			Effect size (*r*)		
			Adults (pre-test/post-test1)	Teenagers (pre-test/post-test1)	Children (pre-test/post-test1)
Ability to mitigate/respond/prepare		Self-reported awareness	-.22	-.27	-
		Self-reported vulnerability	-	-.25	-
		Self-reported preparedness	-.31	-	-.24
		Self-reported amount of know. and info.	-.31	-	-
Worry Level		Floods	-	-.23	-.13
Specific indicators					
Attitude to risks	Perceived likelihood	Floods	-	-.30	-.12
		Avalanches	-	-	-.19
	Perceived consequences	Floods	-.30	-.34	-.2
		Debris flows	-	-.45	-
		Avalanches	-	-.28	-

montagne – Office National des Forêts). These events frequently caused damage to infrastructure and buildings but did not cause a large number of victims.

Results of a prior survey on hazard information needs in the Ubaye Valley [1] had shown that the population perceived a broad range of aspects of natural hazards as important topics of information. Because of the expressed needs of the target audience, the exhibition was created around two general topics: the physical phenomena and the risk management. This research had also concluded that the population in the Valley has great trust in the risk information provided by scientists, so this precondition for effective risk communication was met in our case.

The exhibition focused on all natural hazards occurring in the Ubaye Valley, i.e. landslides, debris flows and floods, earthquakes, and snow avalanches. This was requested by local stakeholders, in particular the technical risk managers. Another reason behind this choice was to

Table 5
Changes in awareness factors for the adults. All tests are based on negative ranks meaning that there are increases in scores between the two-tests. Significant changes are highlighted in light, medium and dark green, corresponding to small, medium and large effect size. Complete test statistics in the appendix (Table A3).

ADULTS - *Effect size (r)*	**Self-reported awareness**	**Self-reported preparedness**	**Self-reported amount of know. and info.**	**Perceived severity of the consequences of floods**
Gender	Men: -.35	Women: -.41	Women: -.42	Women: -.31
Age	-	51-70 years old: -.35	-	>70 years old: -.35
Work related to natural hazards	-	No: -.41	No: -.32	No: -.31
Time living in the valley	-	Not: -.65	-	More than 20 years: -.33 Not: -.65
Last obtained degree	-	Unknown: -.42	-	Level II: -.58 Level V: .61 Unknown: -.51
Number of experienced natural hazards*	2: -.52	1: -.52 2: -.52	2: -.53	Yes: -.44
Suffered damages from the given number of natural hazards*	0: -.28	0: -.43	0: -.32	No: -.32
Knows people that suffered damages from the given number of natural hazards*	-	0: -.45	0: -.37	Yes: -.35
Prior total information**	2: -.44	1: -.6 2: -.6	1: -.55 2: -.46	1: -.68

* These variables are used differently depending if general or specific indicators are analyzed. In the first case, they become "Number of hazard types, among the 5 possible, experienced", "Number of hazard types, among the 5 possible, that impacted health and properties" and "Number of hazard types, among the 5 possible, for which they know somebody that was impacted". In the second case, i.e. in relation to floods' consequences perception, they were transformed in dichotomous yes/no variables: "floods experienced or not", "Impacted by floods or not" and "Know somebody impacted by floods".

** This variable is modified when used to analyzed general indicators. Likert scales scores 1–5) for each of the natural hazards are summed and subsequently categorized in 5 prior information levels 1–5 - > 1, 6–10 - > 2, 11–15 - > 3, 16–20 - > 4 and 21–25 - > 5). This variable is raw, i.e. "prior amount of information received on floods" when used for analyzing the specific indicator.

Table 6
Changes in awareness factors for the teenagers All tests are based on negative ranks meaning that there are increases in scores between the two-tests. Significant changes are highlighted in light, medium and dark green, corresponding to small, medium and large effect size. Complete test statistics in the appendix (Table A4).

TEENAGERS *Effect size (r)*	Self-reported awareness	Self-reported vulnerability	Worry level related to floods	Perceived likelihood of floods	Perceived severity of the consequences of floods	Perceived severity of the consequences of debris flows	Perceived severity of the consequences of avalanches
Gender	Girls: -.35	-	-	-	Boys: -.41 Girls: -.49	Boys: -.36	Boys: -.35
Work related to natural hazards	No: -.32	-	-	-	No: -.46	No: -.27	No: -.34
Time living in the valley	Not: -.45	-	-	-	11-20 years: -.40 Not: =-.54	11-20 years: -.40	-
Number of experienced natural hazards *	1: -.56	-	-	No: -.32	No: -.45	No: -.29	No: -.37
Knows people that suffered damages from the given number of natural hazards*	-	-	No: -.36	No: -.48	No: -.51 Yes: -.42	No: -.25	-
Prior total information*	-	-	-	-	1: -.48	-	5: -.41

The “age” variable was not considered as all teenagers fall in the same category (< 18 years old). Similarly, “Suffered damages from the given number of natural hazards” is not considered as only one teenager had been impacted. Moreover, for obvious reasons, the “diploma” variable is not considered as well. Please refer to footnotes of Table 5 for the explanation on how some variable were modified (*).

accommodate scientific perspectives such as multi-hazard risk assessments. This approach has been advocated for mountainous regions to avoid misjudgment of the general risks [4] and can form the basis for multi-hazard risk management and, consecutively, multi-hazard risk communication.

The topics of the exhibition were all illustrated by local examples, except for one picture and one video. Local authorities, risk managers and cultural partners as well as inhabitants and scientists familiar with the area provided most of the information and data. Visual tools were prioritized to present the information, with only some supporting text (Table 1). The reading level of the latter was chosen to be suitable for 10–15 years old children as the Library requested that the exhibition should target both children and adults, and as it was assumed that younger children would not spend much time on reading. More in-depth information was included on A3 posters located next to A0 posters in order to target a potentially more expert audience. The exhibition was held at the Library between 04.12.2013 and 19.02.2014 in two rooms of 80 m^2 in total. It could be visited free of charge 18 h a week.

2.2. Research instrument, design and participants

The impacts of the exhibition were measured using a pre-test/post-

Table 7
Changes in awareness factors for the children. All tests are based on negative ranks meaning that there are increases in scores between the two-tests. Significant changes are highlighted with three hues from light to dark corresponding to small medium and large effect size. Complete test statistics in the appendix (Table A5).

CHILDREN *Effect size (r)*	Self-reported preparedness	Worry level related to floods	Perceived likelihood of floods	Perceived severity of the consequences of floods	Perceived likelihood of avalanches
Gender	Boys: -.23 Girls: -.25	-	Girls: -.21	Boys: -.18 Girls: -.21	Boys: -.20 Girls: .18
Age	8 years old: -.40	10 years old: -.22	-	7 years old: -.45 8 years old: -.31	7 years old: -.45 9 years old: -.26
Time living in the valley	Since born: -.18 1-5 years: -.33	-	1-5 years: -.27	Since born: -.28	Since born: -.18
Number of experienced natural hazards *	No: -.52 1: -.31	No: -.15	No: -.15	Yes: -.38	No: -.27
Suffered damages from the given number of natural hazards*	0: -.31 2: -.53	No: -.16	No: -.16	Yes: -.51	No: -.20
Knows people that suffered damages from the given number of natural hazards*	0: -.27	No: -.20	No: -.16	No: -.14 Yes: -.30	No: -.21
Prior total information*	3: -.25 5: -.44	-	2: -.26	2: -.36	5: -.30

For obvious reasons, the “diploma” and “work related to natural hazards” variables are not considered. Please refer to footnotes of Table 5 for the explanation on how some variable were modified (*).

Table 8
Longitudinal survey - Changes in awareness factors for the children. Green color = analysis based on negative ranks, i.e. it shows an increase between the two considered tests; orange color = analysis based on positive ranks, i.e. it shows a decrease between the two considered tests. Small effect size in light hues and for the medium effects in darker hues. Complete test statistics in the appendix (Table A6).

CHILDREN	Self-reported preparedness (pre-test/2nd post-test)	Perceived likelihood of floods (pre-test/2nd post-test)	Perceived likelihood of floods (1st post-test/2nd post-test)
Gender	Boys: -.29 Girls: -.24	Boys: -.25	Boys: -.32
Age	10 years old: -.29	11 years old: -.63	8 years old: -.35
Time living in the valley	Since born: -.25	-	Since born: =-.28 1-5 year: -.33
Number of experienced natural hazards *	3: -.40	-	No: -.30
Suffered damages from the given number of natural hazards*	0: -.32 2: -.55	No: -.23	No: -.28
Knows people that suffered damages from the given number of natural hazards*	0: -.34	No: -.20	No: -.23 Yes: -.42
Prior total information*	3: -.25 5: -.42	-	2: -.30 4: -.49 5: -.44
Post total information*	2: -.33	3: -.48	3: -.37
Number of settings where natural hazard topic was discussed after the exhibition	1: -.35 2: -.36	-	2: -.39 3: -.25

* Please refer to footnotes of Table 7 for the explanation on how some variable were modified (*). "Post total information" is modified according to the same logic.

test research design with a panel sample using questionnaires, and following the holistic data collection framework proposed by [16]. This framework for measuring emergency awareness and preparedness is based, among others, on [42] risk communication model, which stipulates that the output of communication is influenced as much by economic, societal and individual factors as by the concrete communication effort. Enders proposed six factors, as well as questions for each factor, that should be taken into account: *hard knowledge*, *attitudes to risk*, *previous experiences of emergencies*, *exposure to awareness raising*, *ability to mitigate/ prepare/ respond* and *demographic characteristics*. The items of the questionnaires were inspired by the list proposed by [16] and adapted to our specific case. We added two factors, i.e. the *worry level*, as there is a consensus in literature that emotions also have an impact on risk perception, and the *level of self-reported awareness*, as we are aiming at measuring awareness. The questions either used a 5-points Likert scale or were close-ended. The changes, i.e. impacts of the exhibition, were analyzed using four dependent factors, i.e. *attitudes to risk*, *ability to mitigate/prepare/respond*, *worry level* and *self-reported awareness*. These factors were included in both the pre-test and the post-tests (Table 2).

In this paper, the term "awareness" is used to cover the concept defined by all these factors. The questions related to the factors that could not be impacted by the visit to the exhibition, i.e. the independent ones, were asked either in the pre-test or in the post-tests. Changes in *hard knowledge* were not measured because asking questions on hard knowledge in the pre-test would trigger visitors to look for the answers during their visit to the exhibition and would therefore bias results. Therefore, these questions were asked in the post-tests only.

A total of 52 adults participated in this study after having been invited by the library, who contacted local associations and touristic resorts. Moreover, secondary and primary schools classes were asked though the same channel to join the activity, resulting in 37 teenagers and 152 children participating in the study.

The procedures of taking the test were as follows. All groups took the pre-test immediately before visiting the exhibition (Fig. 1). The test was first introduced to the groups of adults and teenagers to verify whether they knew the natural hazards addressed by the exhibition and avoid that they did not understand or did not answer the questions. They generally knew the differences between the different hazards and all proceeded to do the tests on their own. If more explanation on the questions was requested, it was given. More extensive explanation was needed for the children. They usually did not know what a debris flow is and mixed up landslides and earthquakes. This is due to similar terms for these two phenomena in French, i.e. respectively “mouvements de terrain” et “tremblements de terre”. For the children, each question of the test was read out loud, one at a time.

Adults and teenagers completed the post-test individually immediately after the visit. Due to time constraints, children took it later on the same day when they were back at the school or the following day. Four to six months later, some of the primary school classes agreed to participate to a second post-test. For all groups, the tests were completed using hard copies.

Following the advice of the Library's employee in charge of children activities, the tests for this group were slightly modified. Questions on material and financial resources (*ability to mitigate/prepare/respond*) as well as diploma and work (*demographics*) were removed as they are not applicable to this group. Moreover, questions on the impacts of prior/new information on motivation to become prepared and of prior information on awareness were not asked of the children in order to reduce the length of the questionnaire. Finally, the use of the term “awareness” was replaced by “knowledge” as the first term was believed to be too complex for the children. In the second post-test that the children took, several questions were added. They addressed additional information about natural hazards or discussions that could have taken place in-between the two post-tests. Therefore, potential changes can be analyzed in the light of these facts. The children's parents were informed beforehand that their children would participate in a scientific experiment and that they could oppose to it. None did.

2.3. Description of the statistical test and analyses

In social sciences research, Likert scale data are often statistically analyzed as if they are interval scale data, and measures of changes are most often conducted using paired *t*-tests. Statisticians, however, oppose the use of such tests for Likert scale data [12], as Likert scales are in fact ordinal and data is usually not normally distributed [10]. An alternative non-parametric test, i.e. one that does not assume normal distribution, is the Wilcoxon signed-rank test [17,52]. This test was performed using the Statistical Package for Social Sciences, version 20 (SPSS, IBM Corp., Armonk, NY). It assumes that participants perceive the Likert scale steps as having the same size.

Effect size (ES), or the “*standardized measure of the magnitude of observed changes*” [17] is computed as follows:

$$r = \frac{Z}{\sqrt{N}}$$

where r is effect size, Z is the test result and N the total number of observations, i.e. twice the number of participants that took both the pre- and post-tests. The number of observations varies for each tested indicator as not all participants answered all questions. If an individual did not answer a question in either the pre or the post test, that individual is not taken into account in the overall analysis concerning that indicator.

Since effective risk communication should take into account the characteristics of its target audiences, the dataset was split into age groups (adults, teenagers and children). To explain observed changes, the Wilcoxon signed-rank test was first applied to each age group for those indicators for which changes were measured for the whole sample. Further testing was conducted within each age group using the indicators that constitute the independent factors (Table 2).

In order to measure whether the observed effects of the exhibition remained after a few months, a second post-test was conducted with part of the group of children. Changes were determined both between the second and first post-tests and between the second post-test and the pre-test in order to assess whether there was a return to the initial level of awareness. Furthermore, the standard McNemar nonparametric statistical test for nominal data (here 1 = correct answer and 2 = wrong answer) in the context of a pre-test/post-test research design [44] was used to assess if there were significant changes in children's hard knowledge between the first and second post-tests.

3. Characteristics of the participants

3.1. Demographics

The sample as a whole accounts for around 9% of the population of the town of Barcelonnette [23]. For teenagers and children, the sample is representative in terms of gender and age. The sample of adults is not representative in terms of age [24]. This is due to the fact that the exhibition venue was only opened during working hours, preventing many employed adults to visit it and participate in the research activity. The adult sample is probably also not representative in terms of level of education because of the high proportion of participants that have a lower education level than the lowest level included in the questionnaire or who did not provide this information. Detailed demographics are presented in the Fig. A1 of the appendix.

3.2. Prior exposure to awareness raising

In Enders’ framework, the length of time living in an area is an indicator of the factor *Exposure to awareness raising.* More than 60% of the participants have been living in the Ubaye valley for more than 10 years or, for the children, since they were born (Fig. 2). More than half of the adults have been living there for more than 20 years, therefore most participants were presumably exposed to prior awareness campaigns in the valley. Adults that do not live in the Ubaye valley are tourists mainly coming from the south of France. Seven teenagers come from the surrounding area (< 60 km) and five from further away (max 160 km radial distance) (one did not specify). They spend at least the weekdays in the Ubaye valley as they were enrolled in a high school ski specialization.

The second indicator of *Exposure to awareness raising* is the amount of information received regarding a particular hazard before the visit to the exhibition (Fig. 3). Generally, participants had been informed most about avalanches and earthquakes and least on debris flows. There is no major difference between age groups, except the significant amount of information on avalanches received by the teenagers.

In general, in pre-test results the participants did not clearly express a link between prior information and awareness or motivation to become prepared (Fig. A2 in the Appendix). However, it appears that for adults there is a connection between receiving prior information on avalanches and earthquakes, and awareness or motivation to become prepared for these hazards. For teenagers, the results suggest this connection for avalanches.

After the visit to the exhibition, participants were asked whether the exhibition provided them with new information about the concerned natural hazards; whether this new information made them more aware; and whether it motivated them to take action (asked of adults and teenagers only). The results show no clear tendency (Fig. A3 in the Appendix).

3.3. Previous experience with natural hazards

The factor *previous experience* with natural hazards is constituted by direct and indirect experience indicators. In the first case, the *number of times a given hazard was experienced* and the *personal impact (physical and resource wise)* those hazard events had on the participant were measured. Most participants have experienced several natural hazards. But the hazard most often experienced by all groups is earthquakes (Fig. 4). Concerning the other natural hazards considered, adults usually report most experience and teenagers least (Fig. A4 in the Appendix). The personal impacts of disasters, i.e. physical, damages to belongings, is usually low (Fig. A5 in the Appendix). The greatest personal impact was reported by adults in relation to earthquakes (10%) and by children in relation to earthquakes (30%), floods (13%) and landslides (13%). Overall, debris flows had the smallest personal impact on the participants.

Results for the indirect experience (Fig. A5 in the Appendix) show that only 6–8% of the adults, teenagers and children know people that have been impacted by debris flows. Fifteen to 17% of the participants know someone impacted by landslides. The indirect experience of earthquakes, floods, and avalanches is higher but never reaches more than 50%, with exception of indirect experience of teenagers with avalanches, which reaches 94%. This can be explained by the fact that they practice skiing intensively as part of their curriculum and are therefore in contact with the skiing community.

3.4. Hard knowledge

Hard knowledge questions were asked in the post-tests only. All the answers could be found in the exhibition. As we did not measure the a priori knowledge, it is impossible to determine whether correct answers were due to the visit to the exhibition, prior knowledge or simply chance. All questions were multiple-choice, with 4 choices.

Adults and teenagers had about half of the answers right (Fig. A6 in the Appendix). Adults answered best to questions related to physical phenomena and risk management. Teenagers answered best (> 80%) to the question related to avalanche risk scale, which again could be related to their ski sport specialization. Moreover, more than half of them answered the question on security guidelines correctly. Generally, children did not answer the knowledge questions very well in both the first post-test, conducted after the exhibition, and the second post-test, which was held 4–6 months later (< 50% of correct answers). Only the question about the security guidelines shows a high percentage of correct answers for both tests. Between the two post-tests, the percentage of correct answers for four questions increased by 10%. This increase was not statistically significant according to the McNemar tests performed.

3.5. Information on natural hazard between the two post-tests

Generally, children that participated in the second post-test received little or no new information on the natural hazards between the two post-tests, except for earthquakes (Fig. A7 in the appendix). The main sources of new information as reported by the children are the family, television and school. However, most children did discuss natural hazards after the visit, in particular with their parents and at school.

4. Changes in awareness

This section presents the results of the statistical analysis performed using the Wilcoxon signed-rank test for the total sample and by age group, as well as the effects of the explanatory factors.

4.1. Overall measured changes

Table 3 shows that significant changes occurred in the awareness of the participants due to the visit to the exhibition for ten out of the twenty indicators. Four out of five of the general indicators, those relating to hazards in general, present significant score' increases while this is only the case for six out of fifteen of the specific indicators, i.e. related to specific hazards. The observed effect of the exhibition's visit (i.e. effect size), given by r is small (< .3) for most of these increases except for the *feeling of being prepared* and *the perception of the severity of consequences linked to floods* for which it is medium ($.3 < r < .5$).

4.2. Observed changes by age group

Table 4 shows that these ten changes are not observed equally in all three age groups: only the *perception of the severity of consequences linked to floods* shows a significant increase for all age groups. Four indicators show a significant increase for two of the age groups (one for adults and teenagers, one for adults and children, and two for teenagers and children). The remaining five indicators show a significant increase for one age group only. Out of this total of sixteen significant increases, six have a medium and ten a small effect size.

4.3. Effect of explanatory factors

The observed significant changes for each age group were analyzed with respect to the independent or explanatory factors (Tables 5–7). Most of these changes have a medium effect size except for the children where lower effect sizes are more present.

4.3.1. Factor 'demographics'

Gender proved to be a significant explaining variable for all four significant scores' increases in the adults group, for three of the seven significant score' increases among the teenagers, and only one of five significant score' increases for children. In five cases, the score' increases were significant for females and in three cases for males. Moreover, older adults' scores were significantly higher for self-reported preparedness and perception of the severity of floods in the post-test. Also among the children, age is significant for some changes. Furthermore, adults and teenagers that do not work or study in a field related to natural hazards scored significantly higher on seven of the eleven indicators than those who do. Finally, adults' level of education seems to have some influence on two of the assessed changes.

4.3.2. Factor 'previous experience'

Generally, adults, teenagers and children who had not experienced any natural hazards, or only a few, scored significantly higher. The exception was children who had experienced floods. Their perception of related consequences' severity still increased significantly. Moreover, the adults and children who had not suffered any damage due to natural hazards, increased their scores between the two tests. Nothing can be said concerning teenagers as only two had been personally impacted.

Results related to the indirect experience with natural hazards are mostly similar, i.e. low experienced people scoring significantly higher in the post-test. However, adults that had knowledge of people affected by floods still increased their *perception of the severity of the consequences* linked to this hazard. The increase in this indicator were both significant for children and teenagers independently of whether they had indirect experience with this hazard or not.

4.3.3. Factor 'exposure to awareness raising'

In the few cases for which the *time living in the valley* produces changes in the dependent indicators, contrary effect appears. For both adults and teenagers, significant score' increases between the tests were observed only for long-term residents in the valley and non-residents. Small increases were observed in the indicators for children born in the Ubaye valley or who have lived there for 1–5 years.

Overall, adults who reported low prior information levels on natural hazards (1 or 2 on 5) increased their scores significantly between the two tests. For teenagers, two situations occur. Concerning the consequences of floods, those whose level of prior information is low answered significantly higher in the post-test. Concerning the consequences of avalanches, the scores increased significantly for those with the highest level of prior information. Note that those constitute most of the surveyed teenagers. The same can be observed for the children (medium ES). For the other indicators, children with different levels of prior information (low, medium and high) increased their scores in the post-test.

4.4. Longitudinal study – observed changes for the children

Generally, there was no significant change between the two post-tests that the children took (Table A2 in the appendix). A significant decrease was only measured for the *perceived likelihood of floods*. This change was also observed between the pre-test and the second post-test. We can clearly observe variations in this change in terms of the gender (boys) and prior experience (none) (Table 8). Additionally, the *self-reported preparedness* significantly increased between the pre-test and both post-tests, but not between the two post-tests (Table A2 in the Appendix), although this was not uniform among participants (Table 8).

5. Discussion

5.1. Overall changes in awareness

It appears that the visit to the exhibition triggered several changes in the immediate awareness of the participants and thus fulfilled its aim. When directly asked, participants reported only slightly increased awareness. However, the positive impact of the exhibition was revealed by the changes that were shown in the tests. This is particularly true for the factors that are not specific to particular natural hazards. Indeed, increases in the scores for *feeling of being prepared* and *having all the knowledge and information to respond to natural hazards* are signs that the exhibition had an effect. However, the *feeling of having all the necessary resources to respond to natural hazards* did not increase. This indicates that the *feeling of being prepared* depends largely on information and knowledge rather than on personal resources. Preparedness also depends on the concrete protective actions that are undertaken before a disaster occurs. Yet, as previous research suggests, being aware does not always induce such type of actions [43]. Risk managers should therefore not rely only on the feeling of being prepared, but should also inform their audience that knowing about hazards is not enough and provide suggestions on what their audience can do to cope with a disaster. Although the *feeling of being prepared* increased, the *feeling of being vulnerable* increased as well. This can be interpreted positively as a realization of living in a risky area where disasters can take place and may lead to more protective behavior [25].

It is known that perceptions about risks vary according to personal characteristics [43], but the evaluation of the "Alerte" exhibition showed that risk communication's effects also depend on the type of natural hazard. Most significant score' increases were measured for indicators related to emotions and attitudes towards floods (*worry level*, *perceived likelihood of occurrence* and *perceived severity of consequences*). Floods occur infrequently in the Ubaye valley (the last major flood occurred in 1957), and it is therefore not surprising that those indicators increased due to the visit. Moreover, direct observation and monitoring methods of the attractiveness of exhibits that complemented this study showed that the visitors found the flood scale model very attractive. The enhanced engagement with this exhibit may have led to an increased awareness of the risk of flood.

For the more frequently occurring (database of technical risk managers, i.e. Restauration des terrains en montagne – Office National des Forêts, confirmed by [19]) but also more localized hazards that are avalanches and debris flows, *attitude to risk* indicators, especially *perceived severity of consequences*, also showed significant scores' increases. Indicators related to natural hazards that are neither rare nor very frequent in the Ubaye valley, i.e. landslides and earthquakes, did not change. These results suggest that awareness raising programs, such as the exhibition, affect the *attitude to risks* related to hazards differently depending on likelihood and potential extent of consequences. Although some studies indicate that likelihood and magnitude have little effect on people's risk perception [53], it shows that risk communication should be tailored according to those aspects.

5.2. Seniors vs juniors

The above-mentioned effects of the exhibition on the *attitude to risks* related to floods, debris flows and avalanches are mostly valid for teenagers and children and not for the group of adults, consisting mainly of senior citizens. This could be explained by the fact that adults have globally more experience with these hazards. Yet, the exhibition did have a more generic impact unrelated to specific hazards for the adults. The question is whether the lack of a more specific impact is due to the multi-hazard character of the exhibition. If yes, and if more specific impact is aimed for, risk communicators should complement multi-hazards risk communication practices by separate efforts specifically dedicated to a given hazard when they target this segment of the population.

Nonetheless, the generic effect of the exhibition was also observed for the younger participants. For example, particularly for the teenagers, increased self-reported awareness is associated with a realization of being vulnerable to natural hazards. It shows that risk communication efforts, such as this exhibition, can have considerable impacts on teenagers.

5.3. Changes related to demographics, experience and awareness raising

The influence of demographics factors *gender*, *age* (within an age group) and *education* on the measured changes is ambiguous and difficult to explain. However, the analysis did show that the visit to the exhibition had a bigger impact on lay people than on specialists. This is neither surprising nor problematic since the aim of the exhibition was to raise the awareness of the general public.

The analysis shows that the exhibition was most effective for people with little experience, direct and indirect. This confirms that risk communication acts as a proxy of experience [30,33]. In the light of those results, when selecting target audiences for awareness campaigns similar to the exhibition, priority should be given to people with little experience with natural hazards.

Most participants appear to have received a fair amount of information on natural hazards prior to the visit to the exhibition, especially on avalanches and earthquakes, but the impact of this information on prior *Awareness and motivation to become prepared* is not clear. This is also true for the impact of the information provided by the exhibition. However, *Self-reported awareness and preparedness* of the whole sample increased significantly between the pre- and the first post-test, but the detailed analysis shows these positive effects mainly for adults and teenagers who do not live in the Ubaye valley and who had little prior information on the considered natural hazards. Although it confirms that experience is one of the main factors of awareness [43], it is interesting to observe that visitors that had lived in this area for a long time also had increased scores concerning the perceived severity of consequences of floods, debris flows or avalanches, as if the exhibition acted as a reminder or “booster shot”. Significant changes were also observed for children who had previously received relatively much information. Hence, also for these groups an exposition may make sense.

5.4. Hard knowledge

Due to potential bias, hard knowledge questions were asked only in the post-tests, and it was therefore not possible to assess the effect of the exhibition on this factor. However, some interesting age dependent observations can be made. Adults’ hard knowledge is historical, on specific events, and related to preparedness (security guidelines). Teenagers hard knowledge is more technical, such as seismic waves and avalanche risk indexes, and most probably linked to the education they received. They are enrolled in a ski specialization and earthquakes is a topic that is taught in the 8th grade French curricula [36]. Prior knowledge can also explain the good score of children related to security guidelines. They had participated in an emergency exercise in their school during the year that preceded the visit to the exhibition.

More importantly, measuring the hard knowledge of the participants after the visit to the exhibition where they could find the answers to all questions, highlighted two very important misconceptions in the risk perception of the participants. The first is the idea, especially among teenagers and children, that avalanches and earthquakes are the most common natural hazards in the valley, while in fact this is debris flows. Secondly, debris flows are not well understood. They usually occur in summer, but most participants think they occur mainly in spring. Consequently, protective actions may not be taken at the right time. Since debris flows have a high-risk potential because they can occur suddenly at many places [43], future risk communication efforts should give priority to this hazard.

The idea of teenagers and children that avalanches and earthquakes are the most common natural hazards, can be explained by their experience with earthquakes and the ski specialization that the teenagers follow. The importance of direct experience and education is reinforced by the results provided by the comparison between children's hard knowledge answers of the two post-tests. The only questions for which the number of correct answers increased between the two tests are linked to natural hazards that took place or were discussed during this time. In the period between the two tests, an important earthquake occurred (7th of April 2014, magnitude 5.2, [7]). Moreover, children reported that they received more information on this hazard between the tests. In addition, two classes that took part in the study also participated in a national challenge (Ma ville se prépare,) for which they had to work on risk perception. Discussions with the teachers showed that they worked on the 1957 flood event, that they interviewed a witness chosen because the person had already been interviewed for the exhibition, and that almost every class that visited the exhibition was included in the activities related to the challenge.

5.5. Persistence of the effect

The persistence of the effect of the exhibition was addressed by the longitudinal part of the study that involved the children (N = 91). Three types of effects are visible. A long-term positive effect on *self-reported preparedness* as it remained at a higher level than before the visit to the exhibition. A short-time effect with negative effect is observed for *perceived likelihood of floods*. It first increased but in the second post-test dropped to below the initial level of the pre-test. Finally, the operationalization of a second post-test allowed to moderate the effects that have been measured for *floods’ worry*, the *perceived severity of consequences* due to this hazard and *the perceived likelihood of avalanches*. The significant increases between the pre-test and the first post-test as well as the scores’ stability between the two post-tests, indicate a long-term effect. However, the fact that there is no significant change between the pre-test and the second post-test suggests that the effect was only of short duration. Nevertheless, as the children who did not participate in the second post-test might have biased this stability analysis, caution is needed.

6. Conclusion

This study has shown that a one-way risk communication effort, i.e. an exhibition in a small mountainous town in the French Alps, can increase risk awareness of the general public. The research detected changes in factors that constitute awareness, which can help to prioritize risk communication efforts and risk communication research.

Changes were observed for general indicators of risk awareness, not related to any specific natural hazards and linked to preparedness. The *feeling of being prepared* and *feeling of having all the knowledge and information to respond* increased due to the visit to the exhibition. The *feeling of being vulnerable* increased as well, particularly for the teenage group, indicating a realization of the dangerous character of the place and a perception of higher risk. With respect to specific natural hazards, awareness of teenagers and children increased more than that of adults, mainly the *perception of consequences*. These results point out that while multi-hazard risk communication efforts are suitable for the younger age groups to increase their awareness of numerous natural hazards, more focused efforts might be appropriate for older people if the goal is to raise awareness of a given hazard. This indicates that a single awareness raising campaign, designed to meet the requirements of different groups in a community, is only advisable when resources are limited. In other cases, it is better to design various communication efforts. For example, in the context of this case study, a complementary effort targeting working population would have been valuable as the opening hours of the exhibition's venue were not suitable for this segment of the population.

This study also showed that the exhibition did not change the awareness regarding the different natural hazards to the same extent. More changes occurred for indicators related to the rare but potentially very destructive phenomenon of floods. The effects were lower or non-existent for more frequent or more localized hazards. These empirical observations indicate that when prioritization in developing risk communication efforts is required, preference should be given to extreme hazards events. Prioritization of target audiences can be conducted according to experience and education as this study confirmed that risk awareness is strongly influenced by those factors but that risk communication can act as a substitute for them. However, the results also showed that experienced and aware people benefited as well from this effort to raise awareness and therefore repeated campaigns are important.

Although the persistence of the effects of the exhibition for children is not obvious, direct observations and informal discussion with the children showed that the effect may have been more sustainable than could be measured by our research design. In addition, the latter did not allow measuring potential variations in hard knowledge, an important dimension of risk awareness, although the way it was taken into account unveiled some incorrect risk assessments of the participants. This calls for further research on methodological improvement, including the analysis of biases related to how the survey is conceived and assumptions behind the use of appropriate statistical tests. Further research in similar and different settings and on different natural hazards is needed to increase the knowledge of how to operationalize the measurement of changes in the mental construct of risk awareness in its full complexity. Moreover, additional efforts are required to allow the systematic conduct of longitudinal studies to measure long term effects of awareness raising campaigns related to natural hazards risks. In the context of multi-hazard risk communication related to natural hazards, the link between awareness and taking preparatory actions should also be addressed. As confirmed by this study, multi-hazard risk communication can increase the feeling to be prepared in general. Further studies should assess if risk communication can also result in behavioral change.

This study should be seen as a contribution towards the highly important task of science to analyze the effectiveness of multi-hazard risk communication efforts targeting a community as a whole. Moreover, it is an example of how scientists not only took on the role of communicators, but also conducted research regarding their own actions. From the perspective of the inclusion of stakeholders in the process, the project was highly successful and calls for more practices where both real communication campaigns and research are carried out simultaneously.

Acknowledgements

The authors are extremely grateful to all stakeholders that were involved in this research. They particularly thank the employees of the Médiathèque de Barcelonnette and of the Restauration des Terrains en Montagne, the Association Seolane, the schools and cultural association of the Ubaye valley, the scientists of the Bureau Central Sismologique Français of the Réseau National de Surveillance Sismique, without which this work could not have been completed. This research was developed within the Marie Curie Initial Training Network "Changes: Changing Hydro- meteorological Risks as Analyzed by a New Generation of European Scientists", funded by the European Community's 7th Framework Programme. FP7/2007–2013 under Grant Agreement No. 263953. Further financial and logistical support was provided to develop the exhibition by the Municipality of Barcelonnette, the Région Provence-Alpes Côte d'Azur, The EUR-OPA Major Hazards Agreement, the Council of Europe and the Research Project FP7-Kulturisk.

Appendix A

See Figs. A1–A7
See Tables A1–A6

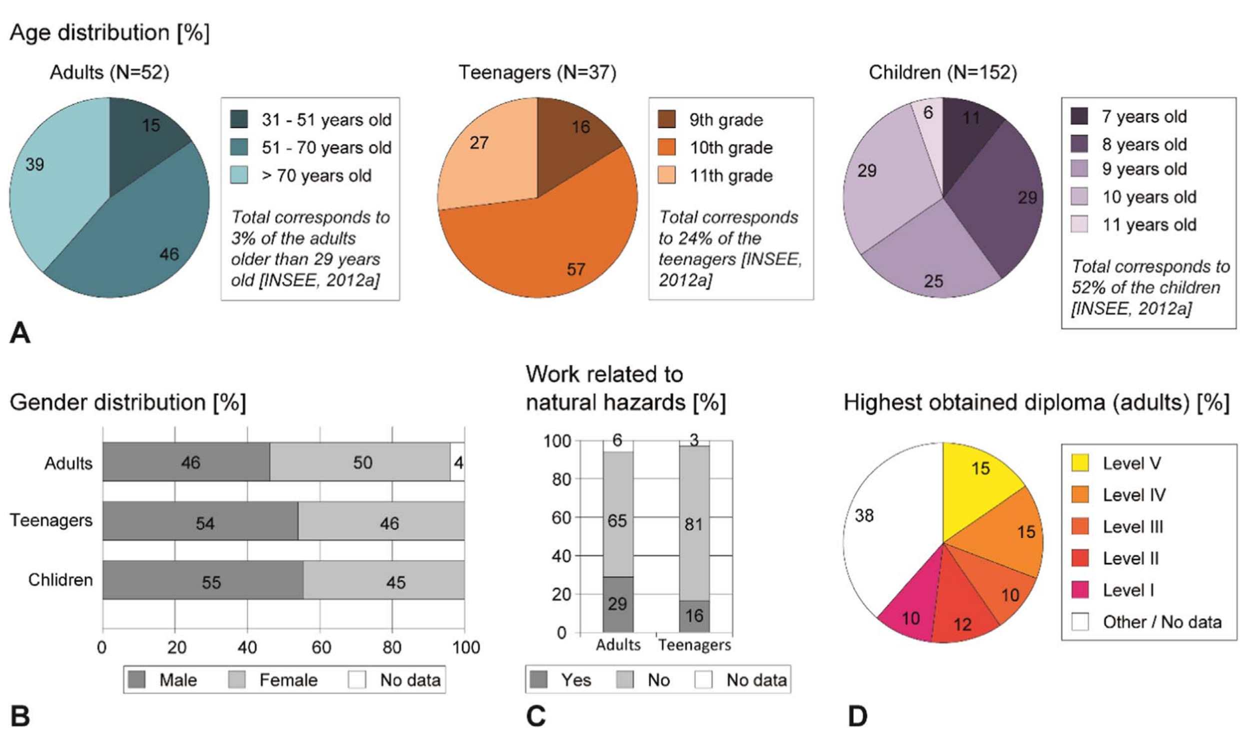

Fig. A1. Demographic characteristics of the sample. Concerning "diploma", Level V refers to lower secondary education, Level IV to upper secondary education, Level III to 2 years of education after high school, Level II to a Bachelor degree, and Level I to a Master's degree or doctorate.

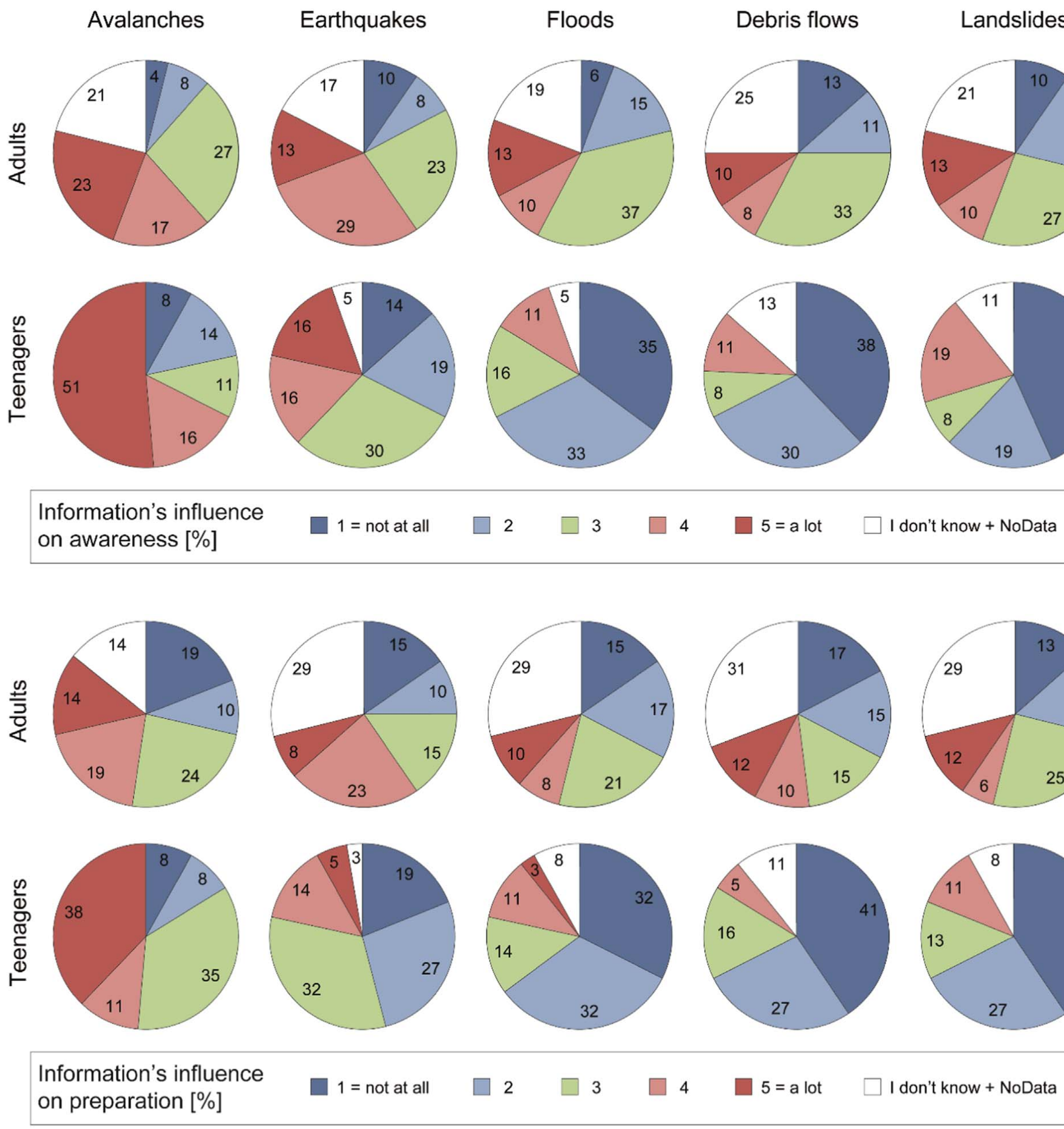

Fig. A2. Influence of received prior information on the awareness and motivation to become prepared. 1 = not at all, 5 = a lot. Questions: "Has this information helped you to be more aware of avalanche/earthquakes/floods/debris flows/landslides?" and "Has this information motivated you to take actions/change your behavior to be more prepare for avalanche/earthquakes/floods/debris flows/landslides?".

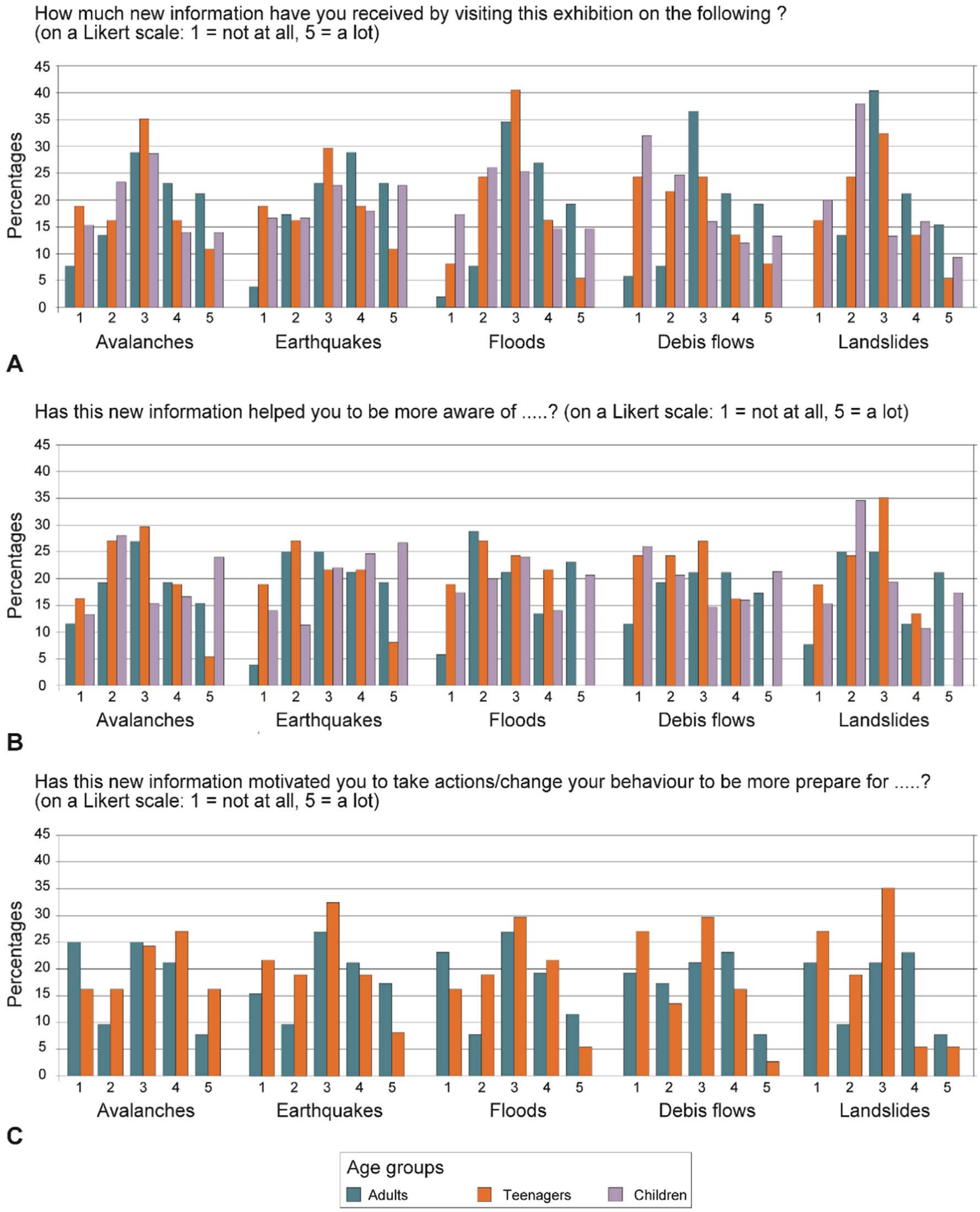

Fig. A3. New Information received by visiting the exhibition and its reported impact on awareness and motivation to become prepared. Percentage for each score.

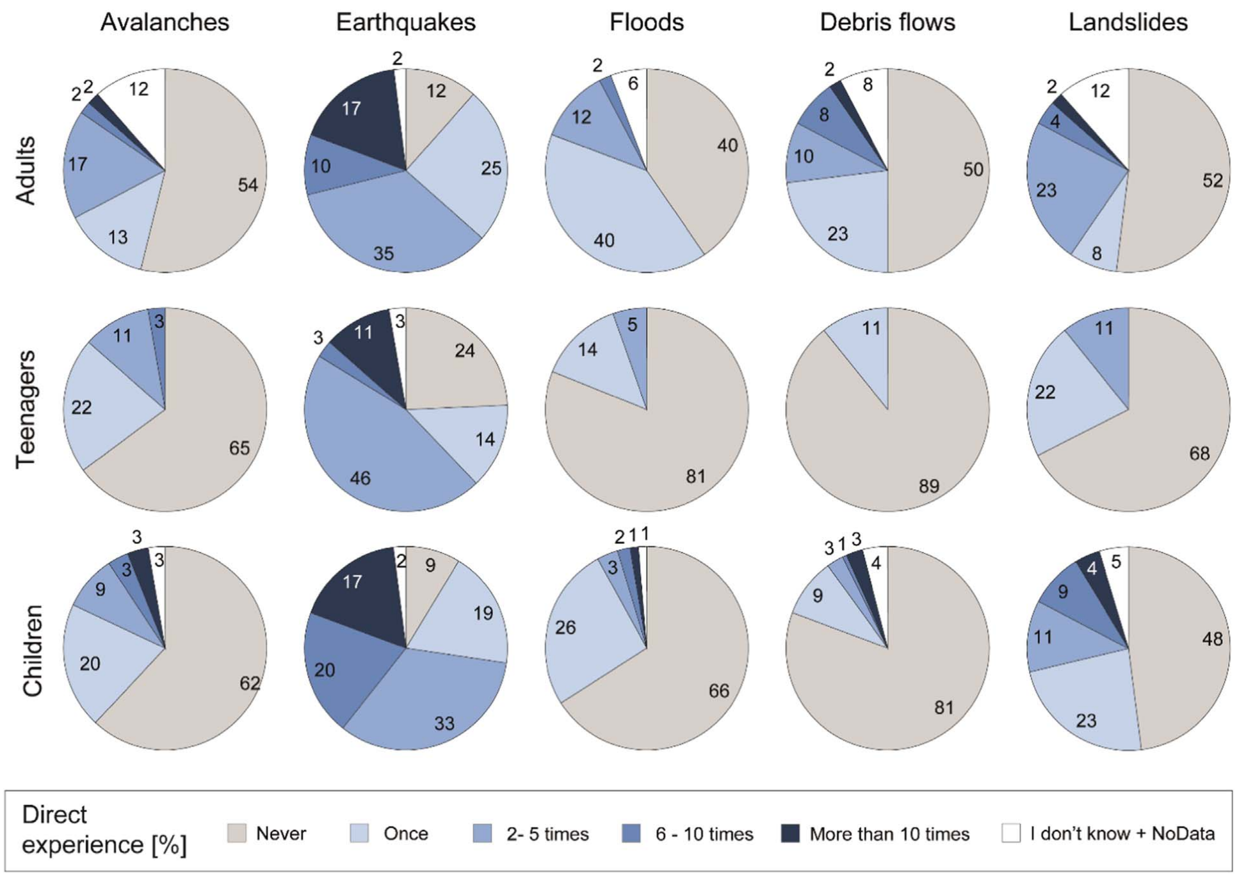

Fig. A4. Direct experience with the specific natural hazards in percentages. Question: "How often have you experienced the following natural hazards (avalanche/earthquakes/floods/debris/landslides?".

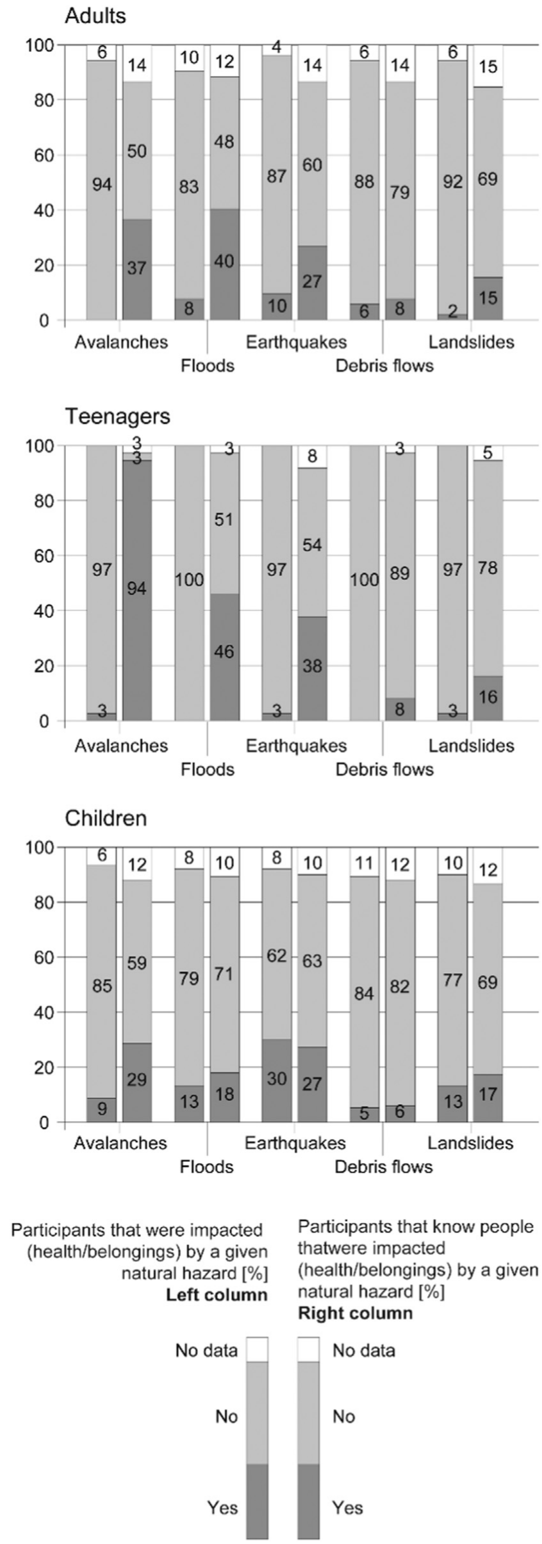

Fig. A5. Own damage (physical/to belongings) and damages of acquaintances (physical/to belongings). Percentages by natural hazard. Questions: "Have you ever experienced health problems or suffered damages as a result of the occurrence of any of these natural hazards (avalanches/floods/earthquakes/debris flows/landslides)?" and "Do you know somebody that has experienced health problems or suffered damage of the occurrence of these natural hazards (avalanches/floods/earthquakes/debris flows/landslides)?".

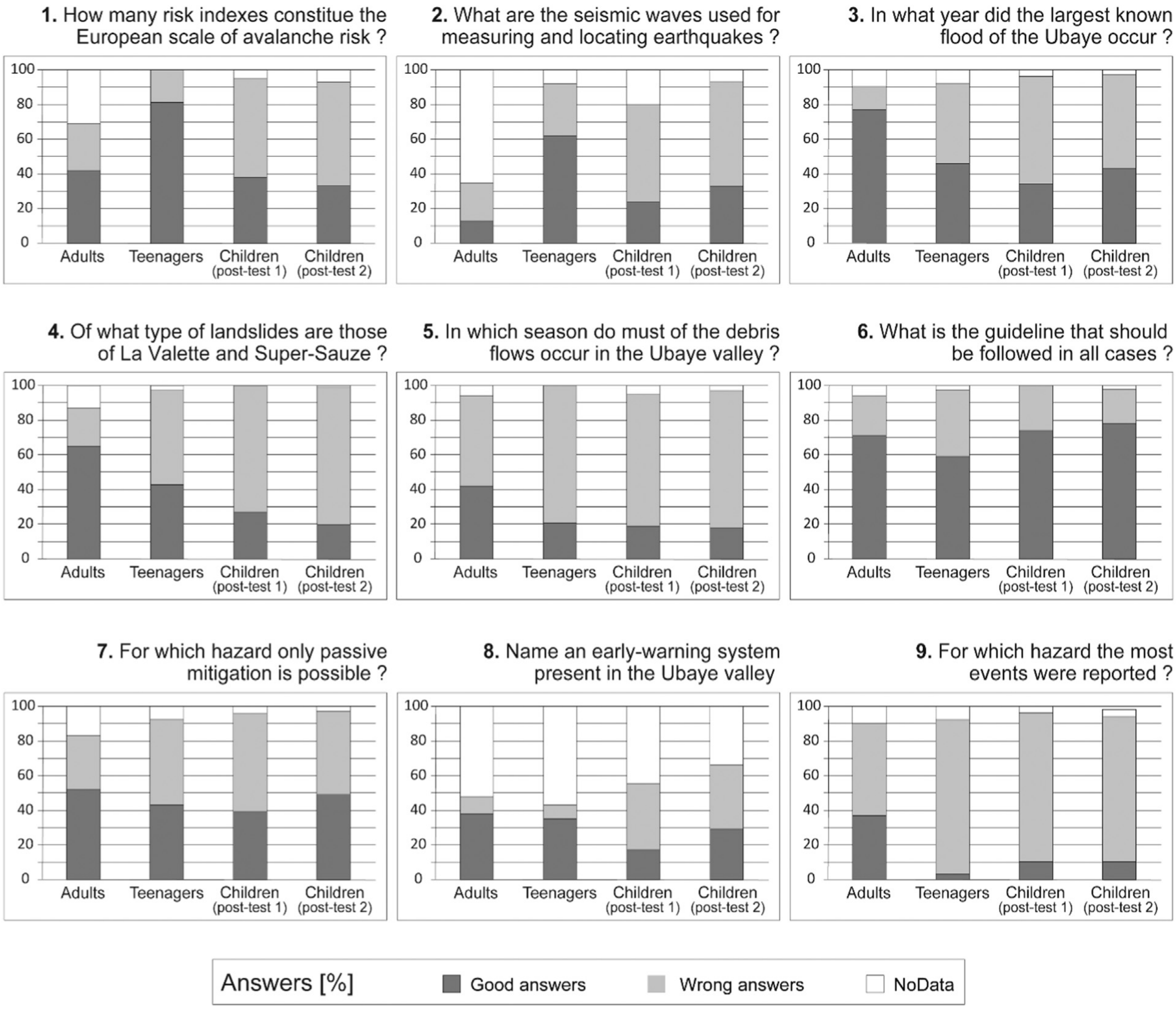

Fig. A6. Results of the hard knowledge questions in percentages for all post-tests (adults, teenagers, children's post-test 1 and children's post-test 2).

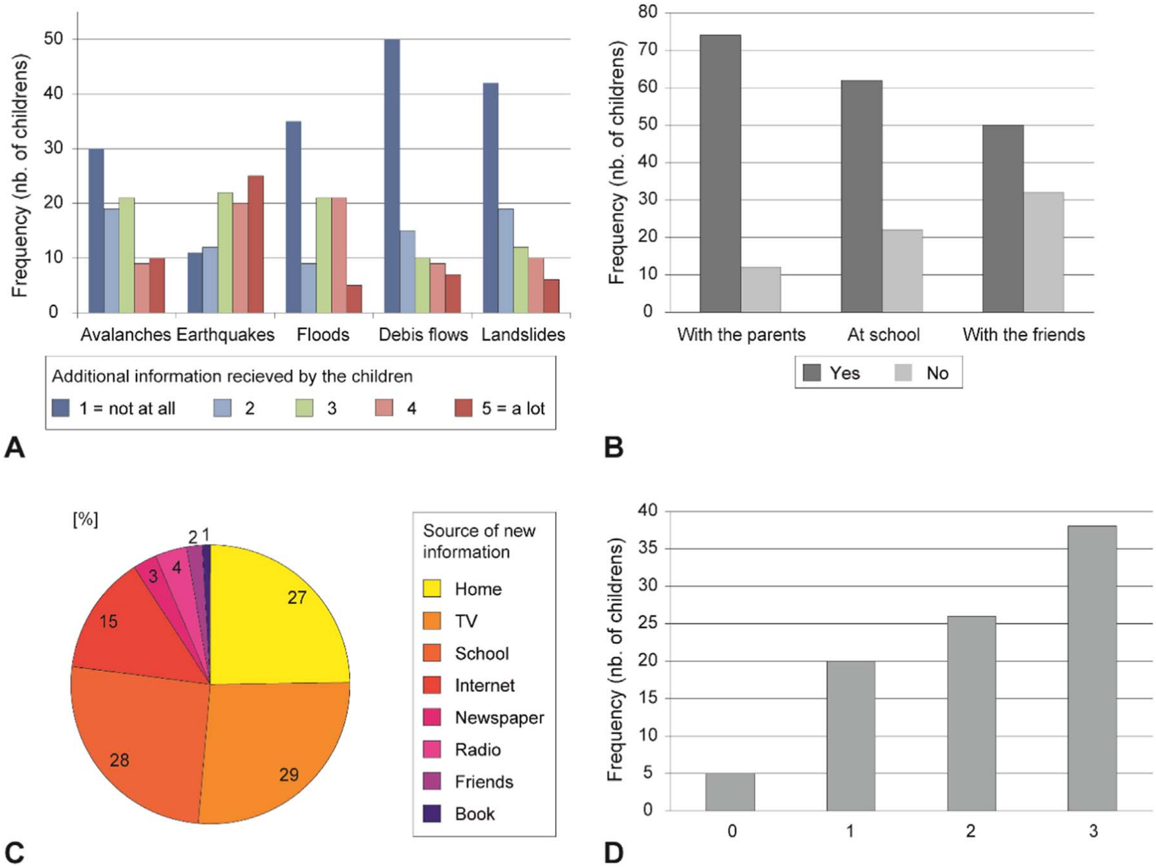

Fig. A7. A-top) Additional information received related to the different hazards by the children (N = 91) in between the two post-tests. Scores correspond to a Likert scale (1 = none to 5 = enormously). Question "Since the visit of the exhibition, how much new information have you received on avalanches/earthquakes/floods/debris flows/landslides?" A-bottom) Number of times the sources of this new information was mentioned by the participants. Open question: "how did you receive this information?". B-top) Number of children that discuss the topic of natural hazard after visiting the exhibition with their parents, at schools or with their friends. B-bottom) Number of children that discuss the topic of natural hazards in none, one, two or three of the discussion settings. Both B graphs derived from the question "Since the visit of the exhibition, have you discussed about natural hazards?".

Table A1
Changes measured by the Wilcoxon signed-ranked test. N = sample size. M1 = median pre-test; M2 = median post-test; Z = test result. All tests are based on negative ranks meaning that there are increases in scores between the two-tests. Significant changes are highlighted in light green for the small effects and in darker green for the medium effects.

			N	M1	M2	Z	p-value	Effect size (*r*)
General indicators								
Ability to mitigate/respond/prepare		Self-reported awareness	221	4	4	-2.03	0.04	-0.14
		Self-reported vulnerability	211	3	3	-2.69	0.01	-0.19
		Self-reported amount of know. and info.	206	3	3	-3.09	0.00	-0.22
		Self-reported amount of resources	63	2	3	-1.83	0.07	
		Self-reported preparedness	211	3	3	-5.07	0.00	-0.35
Specific indicators								
Worry level		Floods	225	2	3	-2.62	0.01	-0.17
		Landslides	219	2	3	-0.05	0.96	
		Debris flows	212	2	2	-1.51	0.13	
		Earthquakes	220	3	3	-1.16	0.25	
		Avalanches	224	4	4	-0.66	0.51	
Attitude to risks	Perceived likelihood	Floods	205	3	3	-3.32	0.00	-0.23
		Landslides	214	3	3	-0.60	0.55	
		Debris flows	208	3	3	-1.90	0.06	
		Earthquakes	221	4	4	-0.38	0.71	
		Avalanches	212	4	5	-2.78	0.01	-0.19
	Perceived consequences	Floods	214	3	4	-5.29	0.00	-0.36
		Landslides	213	3	3	-1.01	0.31	
		Debris flows	209	3	3	-2.10	0.04	-0.15
		Earthquakes	216	4	4	-0.13	0.89	
		Avalanches	219	4	4	-2.71	0.01	-0.18

Table A2
Changes by age group measured by the Wilcoxon signed-ranked test for the indicators that showed statistically significant changes. N = sample size. M1 = median pre-test; M2 = median post-test; M3 = median second post-test; M1b = median pre-test when compared to second post-test; M2b = post-test when compared to second post-test; Z = z-score, p = p-value; r = size effect; colored data = significant results; Green color = analysis based on negative ranks, i.e. it shows an increase between the two considered tests; orange color = analysis based on positive ranks, i.e. it shows a decrease between the two considered tests. Small effect size in light hues and for the medium effects in darker hues.

General indicators			Effect size (*r*)				
			Adults (pre-test/post-test1)	Teenagers (pre-test/post-test1)	Children (pre-test/post-test1)	Children (post-test1/post-test2)	Children (pre-test/post-test2)
Ability to mitigate/respond/prepare		Self-reported awareness	N=48, M1=4, M2=5 Z=-2.20, p<.05, r=-.22	N=35, M1=3, M2=3 Z=-2.27, p<.05, r=-.27	N=138, M1=4, M2=4 Z=-0.1	N=84, M2b=4, M3=4 Z=-0.32	N=87, M1b=4, M3=4 Z=-0.45
		Self-reported vulnerability	N=45, M1=3, M2=3 Z=-0.93	N=34, M1=3, M2=3 Z=-2.07, p<.05, r=-.25	N=132, M1=2, M2=3 Z=-1.89	N=81, M2b=3, M3=3 Z=-0.11	N=79, M1b=2, M3=3 Z=-1.75
		Self-reported preparedness	N=42, M1=2, M2=3 Z=-2.86, p<.005, r=-.31	N=32, M1=3, M2=3 Z=-1.76	N=137, M1=3, M2=4 Z=-3.99, p<.001, r=-.24	N=85, M2b=4, M3=4 N=-1.38	N=83, M1b=3, M3=4 Z=-3.41, p=.001, r=-.26
		Self-reported amount of know. and info.	N=44, M1=2.5, M2=3 Z=-2.95, p<.005, r=-.31	N=33, M1=3, M2=3 Z=-1.54	N=129, M1=3, M2=4 Z=-1.5	N=82, M2b=4, M3=4 Z=-0.35	N=79, M1b=3, M3=4 Z=-2.27
Worry Level		Floods	N=45, M1=3, M2=3 Z=-0.32	N=37, M1=2, M2=2 Z=-2.01, p<.05, r=-.23	N=143, M1=2, M2=3 Z=-2.15, p<.05, r=-.13	N=86, M2b=3, M3=2 Z=-1.47	N=90, M1b=2, M3=2.5 Z=-0.72
Specific indicators							
Attitude to risks	Perceived likelihood	Floods	N=40, M1=3.5, M2=4 Z=-1.88	N=33, M1=3, M2=4 Z=-2.46, p<.05, r=-.30	N=132, M1=2, M2=3 Z=-1.99, p<.05, r=-.12	N=84, M2b=3, M3=2 Z=-3.43, p<.001, r=-.26	N=83, M1b=3, M3=2 Z=-2.05, p<.05r=-.16
		Avalanches	N=41, M1=5, M2=5 Z=-0.32	N=35, M1=5, M2=5 Z=-0.71	N=136, M1=4, M2=4 Z=-3.08 p<.005, r=-.19	N=89, M2b=4, M3=4 Z=-0.61	N=84, M1b=3.5, M3=4 Z=-1.41
	Perceived consequences	Floods	N=45, M1=4, M2=4 Z=-2.83, p<.005, r=-.30	N=34, M1=3, M2=4 Z=-3.67, p<.001, r=-.34	N=135, M1=3, M2=3 Z=-3.22, p<.001, r=-.2	N=83, M2b=3, M3=3 Z=-0.86	N=83, M1b=3, M3=3 Z=-1.39
		Debris flows	N=43, M1=3, M2=4 Z=-0.51	N=34, M1=3, M2=3 Z=-2.31, p<.05, r=-.45	N=132, M1=3, M2=3 Z=-1.47	N=81, M2b=3, M3=3 Z=-0.61	N=79, M1b=3, M3=3 Z=-0.37
		Avalanches	N=44, M1=3, M2=4 Z=-1.04	N=36, M1=4, M2=4.5 Z=-2.88, p<.005, r=-.28	N=139, M1=3, M2=4 Z=-1.44	N=86, M2b=4, M3=4 Z=-0.07	N=83, M1b=3, M3=3 Z=-0.19

Table A3
Changes in awareness for the adult group by explaining variables measured by the Wilcoxon signed-ranked test. N= sample size, Z= z-score, p = p-value; r = size effect; colored data = significant results. The three hues from light to dark correspond respectively to small, medium and large effect size. All measured changes were based on negative ranks, i.e. it shows an increase between the two considered tests.

ADULTS - *Effect size (r)*	**Self-reported awareness**	**Self-reported preparedness**	**Self-reported amount of know. and info.**	**Perceived severity of the consequences of floods**
Gender	Men: N=23, Z=-2.39, p<.05, r=-.35	Women: N=21, Z=-2.68, p<.05, r=-.41	Women: N=23, Z=-2,82, p<.005, r=-.42	Women: N=24, Z=-2,14 p<.05, r=-.31
Age	-	51-70 years old: N=18, Z=-2.07, p<.05, r=-.35	-	>70 years old: N=19, -2,14, p<.05, r=-.35
Work related to natural hazards	-	No: N=26, Z=-2.95, p<.001, r=-.41	No: N=29, Z=-2.41, p<.05, r=-.32	No: N=29, Z=-2.36, p<.05, r=-.31
Time living in the valley	-	Not: N=6, Z=-2.24, p<.05, r=-.65	-	More than 20 years: N=26, Z=-2,36, p<.05, r=-.33 Not: N=6, Z=-2,24, p<.05, r=-.65
Last obtained degree	-	Unknown: N=14, Z=-2.23 p<.05, r=-.42	-	Level II: N=6, Z=-2.00 p<.05, r=-.58 Level V: N=6, Z=-2,12 p<.05, r=-.61 Unknown: N=17, Z=-2,12 p<.05, r=-.51
Number of experienced natural hazards*	2: N=8, Z=-2.07, p<.05, r=-.52	1: N=8, Z=-2.06, p<.05, r=-.52 2: N=8, Z=-2.06 p<.05, r=-.52	2:8, N= -2,12 p<.05, r=-.53	Yes: 16, Z=-2,50 p<.05, r=-.44
Suffered damages from the given number of natural hazards*	0: N=39, Z=-2.49 p=.01, r=-.28	0: N=33, Z=-3.46 p<.001, r=-.43	0: N=35, Z=-2.65 p<.01, r=-.32	No: N=42, Z=-2.92 p<.01, r=-.32
Knows people that suffered damages from the given number of natural hazards*	-	0: N=14, Z=-2.39 p<.05, r=-.45	0: N=17, Z=-2.17, p<.05, r=-.37	Yes: N=19, Z=-2.18, p<.05, r=-.35
Prior total information**	2: N=11, Z=-2.06 p<.05, r=-.44	1: N=7, Z=-2.23, p<.05, r=-.6 2: N=10, Z=-2.24 p<.05, r=-.6	1: N=7, Z= -2.05 p<.05, r=-.55 2: N=10, Z=-2.07 p<.05, r=-.46	1: N=14, Z=-2.53, p<.05, r=-.68

* These variables are used differently depending if general or specific indicators are analyzed. In the first case, they become “Number of hazard types, among the 5 possible, experienced”, “Number of hazard types, among the 5 possible, that impacted health and properties” and “Number of hazard types, among the 5 possible, for which they know somebody that was impacted”. In the second case, i.e. in relation to floods’ consequences perception, they were transformed in dichotomous yes/no variables: “floods experienced or not”, “Impacted by floods or not” and “Know somebody impacted by floods”.

** This variable is modified when used to analyzed general indicators. Likert scales scores 1–5) for each of the natural hazards are summed and subsequently categorized in 5 prior information levels 1–5 - > 1, 6–10 - > 2, 11–15 - > 3, 16–20 - > 4 and 21–25 - > 5). This variable is raw, i.e. “prior amount of information received on floods” when used for analyzing the specific indicator.

Table A4
Changes in awareness for the teenagers group by explaining variables measured by the Wilcoxon signed-ranked test. N= sample size, Z= z-score, p = p-value; r = size effect; colored data = significant results. The three hues from light to dark correspond respectively to small, medium and large effect size. All measured changes were based on negative ranks, i.e. it shows an increase between the two considered tests.

TEENAGERS *Effect size (r)*	Self-reported awareness	Self-reported vulnerability	Worry level related to floods	Perceived likelihood of floods	Perceived severity of the consequences of floods	Perceived severity of the consequences of debris flows	Perceived severity of the consequences of avalanches
Gender	Girls: N=16, Z=-1.97, p<.05, r=-.35	-	-	-	Boys: N=19, Z= -2.55, p<.05, r=-.41 Girls: N=15, Z=-2.66, p<.05, r=-.49	Boys: N=17, Z=-2.12, p<.05, r=-.36	Boys: N=19, Z= -2.14, p<.05, r=-.35
Work related to natural hazards	No: N=28, Z= -2.37 p<.05, r=-.32	-	-	-	No: N=28, Z=-3.45 p=.001, r=-.46	No: N=28, Z=-2.00 p<.05, r=-.27	No: N=30, Z=-2.60 p<.01, r=-.34
Time living in the valley	Not: N=13, Z=-2.27 p<.05, r=-.45	-	-	-	11-20 years: N=16, Z=-2.28, p<.05, r=-.40 Not: N=12, Z=-2.64 p<.01, r=-.54	11-20 years: N= 17, Z=-2,31, p<.05, r=-.40	-
Number of experienced natural hazards *	1: N=13, Z=-2.88, p<.005, r=-.56	-	-	No:N=27, Z=-2.32 p<.05, r=-.32	No: N=27, Z=-3.34 p=.001, r=-.45	No: N=31, Z=-2.31 p<.05, r=-.29	No: N=24, Z=-2.55 p<.05, r=-.37
Knows people that suffered damages from the given number of natural hazards*	-	-	No: N=19, Z=-2.23 p<.05, r=-.36	No: N=16, Z=-2.72 p<.01, r=-.48	No: N=19, Z=-3.14, p<.005, r=-.51 Yes: N=14, Z=-2.24 p<.05, r=-.42	No: N=31, Z=-2.00, p<.05, r=-.25	-
Prior total information*	-	-	-	-	1: N=11, Z=-2.27, p<.05, r=-.48	-	5; N=24, Z=-2.81, p=.005, r=-.41

The "age" variable was not considered as all teenagers fall in the same category (< 18 years old). Similarly, "Suffered damages from the given number of natural hazards" is not considered as only one teenager had been impacted. Moreover, for obvious reasons, the "diploma" variable is not considered as well. Please refer to footnotes of Table 5 for the explanation on how some variable were modified (*).

Table A5
Changes in awareness for the children group by explaining variables measured by the Wilcoxon signed-ranked test. N= sample size, Z= z-score, p = p-value; r = size effect; colored data = significant results. The three hues from light to dark correspond respectively to small, medium and large effect size. All measured changes were based on negative ranks, i.e. it shows an increase between the two considered tests.

CHILDREN *Effect size (r)*	Self-reported preparedness	Worry level related to floods	Perceived likelihood of floods	Perceived severity of the consequences of floods	Perceived likelihood of avalanches
Gender	Boys: N=75, Z=-2.85, p<.005, r=-.23 Girls: N=62, Z=-2.80, p=.005, r=-.25	-	Girls: N=59, Z=-2.24, p<.05, r=-.21	Boys: N=76, Z=-2.22, p<.05, r=-.18 Girls: N=59, Z=-2.28, p<.05, r=-.21	Boys: N=77, Z=-2.39, p<.05, r=-.20 Girls: N= 59, Z=-1.98, p<.05, r=-.18
Age	8 years old: N=36, Z=-3.43, p=.001, r=-.40	10 years old: N=43, Z= -2,07, p<.05, r=-.22	-	7 years old: N=15, Z=-2.49, p<.05, r=-.45 8 years old: N=34, Z=-2.55, p<.05, r=-.31	7 years old: N=16, Z=-2.55, p<.05, r=-.45 9 years old: N=38, Z=-2.28, p<.05, r=-.26
Time living in the valley	Since born: N=86, Z=-2.32, p<.05, r=-.18 1-5 years: N=36, Z=-2.83, p=.005, r=-.33	-	1-5 years: N=33, Z=-2.2, p<.05, r=-.27	Since born: N=91, Z=-3.79, p=.000, r=-.28	Since born: N=90, Z=-2.41, p<.05, r=-.18
Number of experienced natural hazards *	No: N=9, Z=-2.21 p<.05, r=-.52 1: N=32, Z=-2.46, p<.05, r=-.31	No: N=95, Z=-2.02 p<.05, r=-.15	No: 89, Z=-1.99 p<.05, r=-.15	Yes: N=45, Z=-3.64, p=.000, r=-.38	No: N=84, Z=-3.54, p=.000, r=-.27
Suffered damages from the given number of natural hazards*	0: N=78, Z=-3.86, p=.000, r=-.31 2: N=9, Z=-2.26, p<.05, r=-.53	No: N=112, Z=-2.32, p<.05, r=-.16	No: N=103, Z=-2.28, p<.05, r=-.16	Yes: N=19, Z=-3.14, p<.005, r=-.51	No: N=114, Z=-2.96, p<.005, r=-.20
Knows people that suffered damages from the given number of natural hazards*	0: N=66, Z=-3.05, p<.005, r=-.27	No: N=102, Z=-2.88 p<.005, r=-.20	No: N=91, Z=-2.15, p<.05, r=-.16	No: N=94, Z=-1.97, p<.05, r=-.14 Yes: N=27, Z=-2.24, p<.05, r=-.30	No: N=78, Z=-2.60, p<.01, r=-.21
Prior total information*	3: N=61, Z=-2.71. p<.01, r=-.25 5: -.44	-	2: N=30, Z=-.,01, p<.05, r=-.26	2: N=35, Z=-2.98 p<.005, r=-.36	5: N=39, Z=-2.68, p<.01, r=-.30

For obvious reasons, the "diploma" and "work related to natural hazards" variables are not considered. Please refer to footnotes of Table 5 for the explanation on how some variable were modified (*).

Table A6
Longitudinal survey - Changes in awareness for the children group by explaining variables measured by the Wilcoxon signed-ranked test. N= sample size, Z= z-score, p = p-value; r = size effect; colored data = significant results. Green color = analysis based on negative ranks, i.e. it shows an increase between the two considered tests; orange color = analysis based on positive ranks, i.e. it shows a decrease between the two considered tests. Small effect size in light hues and for the medium effects in darker hues.

CHILDREN	Self-reported preparedness (pre-test/2nd post-test)	Perceived likelihood of floods (pre-test/2nd post-test)	Perceived likelihood of floods (1st post-test/2nd post-test)
Gender	Boys: N=43, Z=-2.70, p<.01, r=-.29 Girls: N=40, Z=-2.12, p<.05, r=-.24	Boys: N=42, Z=-2.27, p<.05, r=-.25	Boys: N=45, Z=-3.08, p<.005, r=-.32
Age	10 years old: N=26, Z=-2.06, p<.05, r=-.29	11 years old: N=5, Z=-2.0, p<.05, r=-.63	8 years old: N=27, Z=-2.56, p<.05, r=-.35
Time living in the valley	Since born: N=52 Z=-2.54, p<.05, r=-.25	-	Since born: N=53 Z=-2.65, p<.01, r=-.28 1-5 year: N=24 Z=-2.26, p<.05, r=-.33
Number of experienced natural hazards *	3: N=19, Z=-2.44, p<.05, r=-.40	-	No: N=57, Z=-3.17, P=.001, r=-.30
Suffered damages from the given number of natural hazards*	0: N=46, Z=-3.04 p<.01, r=-.32 2: N=7, Z=-2.04, p<.05, r=-.55	No: N=63, Z=-2.62, p<.01, r=-.23	No: N=67, Z=-3.24, P=.001, r=-.28
Knows people that suffered damages from the given number of natural hazards*	0: N=36, Z=2.88, p<.01, r=-.34	No: N=55, Z=-2.15, p<.05, r=-.20	No: N=56, Z=-2.42, p<.05, r=-.23 Yes: N=16, Z=-2.39, p<.05, r=-.42
Prior total information*	3: N=41, Z=-2.24, p<.05, r=-.25 5: N=12, Z=-2.05, p<.05, r=-.42	-	2: N=25, Z=-2.09, p<.05, r=-.30 4: N=9, Z=-2.06, p<.05, r=-.49 5: N=18, Z=-2.62, p<.01, r=-.44
Post total information*	2: N=24, Z=-2.3, p<.05, r=-.33	3: N=21, Z=-3.13, p<.005, r=-.48	3: N=29, Z: -2.82, p=.005, r=.37
Number of settings where natural hazard topic was discussed after the exhibition	1: N=20, Z=-2.2, p<.05, r=-.35 2: N=24, Z=-2.52, p<.05, r=-.36	-	2: N=23, Z=-2.01, p<.05, r=-.39 3: N=36, Z=-2.12, p<.05, r=-.25

* Please refer to footnotes of Table 7 for the explanation on how some variable were modified (*). "Post total information" is modified according to the same logic.

References

[1] M. Anginard, Applying risk governance principles to natural hazards and risks in mountains. Doctoral dissertation, Technische Universität Dortmund, 2011.
[2] C.J. Atman, A. Bostrom, B. Fischhoff, M.G. Morgan, Designing risk communications: completing and correcting mental models of hazardous processes, Part I, Risk Anal. 14 (5) (1994) 779–788.
[3] G.M. Breakwell, Risk communication: factors affecting impact, Br. Med. Bull. 56 (1) (2000) 110–120.
[4] R. Bell, T. Glade, Multi-hazard Analysis in Natural Risk Assessments, WIT Press, Boston, 2004, p. 132.
[5] V.M. Bier, On the state of the art: risk communication to the public, Reliab. Eng. Syst. Saf. 71 (2) (2001) 139–150.
[6] P. Bubeck, W.J. Botzen, J.C. Aerts, A review of risk perceptions and other factors that influence flood mitigation behavior, Risk Anal. 32 (9) (2012) 1481–1495.
[7] Bureau Central Sismologique Français. Macroseismic database. ⟨http://www.franceseisme.fr/donnees/intensites/details_seisme.php?IdSei=497⟩. (last accessed on the 01 July 2017).
[8] K. Burningham, J. Fielding, D. Thrush, 'It'll never happen to me': understanding public awareness of local flood risk, Disasters 32 (2) (2008) 216–238.
[9] M.K.M. Charrière, S.J. Junier, E. Mostert, T.A. Bogaard Flood risk communication: visualization tools and evaluations of effectiveness, in: Proceedings of the 2nd European Conference on FLOODrisk Management - Science, Policy and Practice: Closing the Gap, Rotterdam, The Netherlands, 20-22 November 2012.
[10] L.W. Chao, J. Gow, O. Akintola, M.V. Pauly, A comparative evaluation of two interventions for educator training in HIV/AIDS in South Africa, Int. J. Educ. Dev. Using Inf. Commun. Technol. 6 (1) (2010) 1–14.
[11] P. Checkland, S. Holwell, Action research: its nature and validity, Syst. Pract. Action Res. 11 (1) (1998) 9–21.
[12] B.H. Cohen, R.B. Lea, Essentials of Statistics for the Social and Behavioral Sciences, 3 John Wiley & Sons, Hoboken, New Jersey, 2004, p. 291.
[13] V. Covello, A. Fisher, E. Bratic Arkin, Evaluation and effective risk communication: introduction. In: A. Fisher, M. Pavlova, V. Covello, editors. Evaluation and Effective Risk Communications Workshop Proceedings, Interagency Task Force on Environmental Cancer and Heart and Lung Disease, Committee on Public Education

and Communication, 1991, pp. xi–xvii.
[14] V. Covello, P.M. Sandman, Risk communication: evolution and revolution, Solut. Environ. Peril (2001) 164–178.
[15] I. Davis, M. Hosseini, Y.O. Izadkhah, Public awareness and the development of a safety culture: key elements in disaster risk reduction, in: Proceedings of the 4th International Conference on Seismology and Earthquake Engineering (SEE 4), IIEES, Tehran, Iran, 12-14 May 2003.
[16] J. Enders, Measuring community awareness and preparedness for emergencies, Aust. J. Emerg. Manag. (2001) 52–59.
[17] A. Field, Discovering Statistics Using IBM SPSS Statistics, 3rd ed., Sage, London, 2009, p. 856.
[18] B. Fischhoff, Communicating Risks and Benefits: an Evidence Based User's Guide, Government Printing Office, Silver Spring, 2012.
[19] J.-C. Flageollet, O. Maquaire, D. Weber, The temporal stability and activity of landslides in Europe with respect to climatic change, Final National Report, 1996. p. 86.
[20] L. Frewer, The public and effective risk communication, Toxicol. Lett. 149 (1) (2004) 391–397.
[21] C. Höppner, M. Buchecker, M. Bründl, Risk communication and natural hazards. CapHaz-Net WP5 report, Birmensdorf, Switzerland, 2010.
[22] C. Höppner, R. Whittle, M. Brundl, M. Buchecker, Linking social capacities and risk communication in Europe: a gap between theory and practice? Nat. Hazards 64 (2012) 1753–1778.
[23] INSEE Evolution et structure de la population en 2012 – POP1B – Population par sexe et âge – Commune de Barcelonnette, 2005a. 〈http://www.insee.fr/fr/themes/tableau_local.asp?Ref_id=POP1B&millesime=2012&niveau=1&typgeo=COM&codgeo=04019〉 (last consulted on the 19th of August 2015).
[24] INSEE Evolution et structure de la population en 2012 – Chiffres clés Diplômes - Formation – Commune de Barcelonnette, 2005b. 〈http://www.insee.fr/fr/themes/tableau_local.asp?Ref_id=FOR&nivgeo=COM&codgeo=04019&millesime=2012〉 (last consulted on the 19th of August 2015).
[25] D.M. Johnston, M.S. Bebbington Chin-Diew Lai, B.F. Houghton, D. Paton, Volcanic hazard perceptions: comparative shifts in knowledge and risk, Disaster Prev. Manag.: Int. J. 8 (2) (1999) 118–126.
[26] W. Kellens, T. Terpstra, P. De Maeyer, Perception and communication of flood risks: a systematic review of empirical research, Risk Anal. 33 (1) (2013) 24–49.
[27] C. Keller, M. Siegrist, H. Gutscher, The role of the affect and availability heuristics in risk communication, Risk Anal. 26 (3) (2006) 631–639.
[28] C. Kuhlicke, A. Steinführer, C. Begg, M. Buchecker, B. De Marchi, C. Höppner, B. Komac, S. McCarthy, O. Renn, S. Tapsell, G. Wachinger, G. Walker, R. Whittle, Knowledge inventory. State of the art of natural hazards research in the social sciences and further research needs for social capacity building. CapHaz-Net WP10 Report, Leipzig, Germany, 2010.
[29] W. Leiss, Three phases in the evolution of risk communication practice, Ann. Am. Acad. Political Soc. Sci. 545 (1996) 85–94.
[30] M.K. Lindell, R.W. Perry, Communicating Environmental Risk in Multiethnic Communities, 7 Sage Publications, Thousand Oaks, 2004, p. 272.
[31] G.F. Loewenstein, E.U. Weber, C.K. Hsee, N. Welch, Risk as feelings, Psychol. Bull. 127 (2) (2001) 267–286.
[32] R. Lundgren, A. McMakin, Risk Communication - A Handbook for Communicating Environmental, Safety and Health Risks, Battelle Press, Colombus, USA, 2004, p. 453.
[33] E. Maidl, M. Buchecker, Raising risk preparedness by flood risk communication, Nat. Hazards Earth Syst. Sci. 15 (7) (2015) 1577–1595.
[34] D.B. McCallum, Risk Communication: a tool for behaviour change, Reviewing the Behavioural Science Knowledge Base on Technology Transfer, 155 NIDA Research Monograph, 1995, pp. 65–89.
[35] R. Miceli, I. Sotgiu, M. Settanni, Disaster preparedness and perception of flood risk: a study in an alpine valley in Italy, J. Environ. Psychol. 28 (2) (2008) 164–173.
[36] Ministère de l'Education Nationale. Programmes du collège – Programmes de l'enseignement de sciences de la vie et de la Terre. Bulletin officiel spécial 6, 2008.
[37] F. Neresini, G. Pellegrini, Evaluating public communication of science and technology, in: M. Bucchi, B. Trench (Eds.), Handbook of Public Communication of Science and Technology. Routledge, New York, USA, 2008, pp. 237–251.
[38] OECD, Climate Change in the European Alps Adapting Winter Tourism and Natural Hazards Management: Adapting Winter Tourism and Natural Hazards Management, OECD Publishing, 2007.
[39] E. Penning-Rowsell, J. Handmer, The changing context of risk communication, in: J. Handmer, E. Penning-Rowsell (Eds.), Hazards and the Communication of Risk, Gower Technical, 1990, pp. 3–15.
[40] A. Plough, S. Krimsky, The emergence of risk communication studies: social and political context, Sci. Technol. Hum. Values 12 (3/4) (1987) 4–10.
[41] B. Rohrmann, The evaluation of risk communication effectiveness, Acta Psychol. 81 (1992) 169–192.
[42] B. Rohrmann, Assessing hazard information/communication programs, Aust. Psychol. 33 (2) (1998) 105–112.
[43] A. Scolobig, B. De Marchi, M. Borga, The missing link between flood risk awareness and preparedness: findings from case studies in an Alpine Region, Nat. Hazards 63 (2) (2012) 499–520.
[44] S. Siegel, N.J. Castellan Jr, Nonparametric statistics for the behavioral sciences, 2nd ed. Chapter 5, The case of one sample, two measures or paired replicates, McGraw-Hill Book Company, 1988, pp. 73–101.
[45] M. Siegrist, The necessity for longitudinal studies in risk perception research, Risk Anal. 33 (1) (2013) 50–51.
[46] P. Slovic, Perception of risk, Science 236 (4799) (1987) 280–285.
[47] P. Slovic, M.L. Finucane, E. Peters, D.G. MacGregor, The affect heuristic, Eur. J. Oper. Res. 177 (3) (2007) 1333–1352.
[48] S.A. Small, L. Uttal, Action-oriented research: strategies for engaged scholarship, J. Marriage Fam. 67 (4) (2005) 936–948.
[49] T. Terpstra, M.K. Lindell, J.M. Gutteling, Does communicating (Flood) risk affect (Flood) risk perceptions? Results of a quasi-experimental study, Risk Anal. 29 (8) (2009) 1141–1155.
[50] UNISDR, UNISDR terminology on disaster risk reduction. Geneva, Switzerland, 2009.
[51] UNISDR. Proposed updated terminology on disaster risk reduction: a technical review.
[52] L. Vaughan, Statistical Methods for the Information Professional: a Practical, Painless Approach to Understanding, Using, and Interpreting Statistics, 367 Information Today, Inc, Medford, New Jersey, 2001, p. 209.
[53] G. Wachinger, O. Renn, Risk perception and natural hazards. CapHaz-Net WP3 Report, 2010.
[54] G. Wachinger, O. Renn, C. Begg, C. Kuhlicke, The risk perception paradox—implications for governance and communication of natural hazards, Risk Anal. 33 (6) (2013) 1049–1065.
[55] P.C. Zingari, G. Fiebiger, Mountain risks and hazards, Unasylva 208 (2002) 71–77.