1 **Impact of an educational program on earthquake awareness and preparedness in Nepal**

3 Shiba Subedi[1], György Hetényi[1] and Ross Shackleton[2]

4 [1]Institute of Earth Sciences, Faculty of Geosciences and Environment, University of Lausanne,

5 Switzerland

6 [2]Institute of Geography and Sustainability, Faculty of Geosciences and Environment, University

7 of Lausanne, Switzerland

9 **Keywords: School education, Hazard, Attitudes, Nepal, Science and education**

11 **ABSTRACT**

12 Scientific education of local communities is key to help reduce the risk associated with natural

13 disasters, such as earthquakes. Western Nepal has a history of major seismic events and is highly

14 prone to further earthquakes; however, the majority of the population is not aware about or

15 prepared for them. To increase earthquake awareness and improve preparedness, a seismology

16 education program was established at 22 schools in Nepal. In each school, educational activities

17 were performed by teaching earthquake related topics in classrooms, offering training to teachers

18 and through installing a low-cost seismometer network which supported both teaching and

19 awareness objectives. To test the effects of this program we conducted two surveys with school

20 children, one before and one after the initiation of the program, with several hundred participants

21 in each. The survey findings highlighted that educational activities implemented at schools are

22 effective in raising awareness levels of children, promoting broader social learning in the

23 community thus improving the adaptive capacities and preparedness for future earthquakes.

24 However, perceptions of risk did not change so much. The high and positive impact of program

25 on the students and the community is encouraging to continue and expand the program.

INTRODUCTION

It is becoming increasingly important to educate people in the era of global change about environmental hazards to ensure they are well prepared to face the rising number of challenges. Education may play a central role for the risk management of natural hazards and help to reduce vulnerability and improve adaptability though allowing people to anticipate and prepare for hazards (Godschalk, 2003; IRGC, 2005).

Exact earthquake prediction is currently not possible, but responses to such events can be prepared for in advance to mitigate the effects they can have on society and human well-being (Turner, 1976). The impacts of earthquake disasters can be minimized by learning what to do before, during and after earthquakes, and by taking a variety of personal safety measures (Lehman & Taylor, 1987). Whether people prepare for future earthquakes or not can be significantly influenced by their education and their engagement on the topic (Tanaka, 2005). All-inclusive public awareness and education is fundamental to reducing causalities, personal injuries, and property damage from natural disasters (NRC, 1991; Torani et al., 2019). Researchers can contribute and play a key role in the education of society; not just to engage more people in research, but also to provide scientific explanations for natural hazards and related consequences to local communities and help to develop polices for mitigation of effects.

Earthquakes are the most common and deadliest natural hazard in Nepal with a long history of impacts in the country (Bollinger et al., 2016). Historical records indicate that many houses and temples in Nepal collapsed during the 1255 earthquake, and one third of the population including the King, Abhaya Malla, was killed. There are also records of an earthquake with a moment magnitude > 8 in 1505 (Ambraseys and Jackson, 2003) and indications that even larger earthquakes are plausible in the Himalayas (Stevens and Avouac, 2016). In 1934, during an earthquake (Fig. 1) with a moment magnitude (Mw) of 8.2 over 8'500 people lost their lives, 200'000 houses were severely damaged and more than 80'000 buildings completely collapsed (Dixit et al., 2013). The most recent major earthquake (Mw 7.8), in 2015, hit central Nepal resulting in about 9'000 causalities, and nearly 800'000 buildings were damaged or destroyed, leaving millions of people homeless. The resulting losses were equivalent to 50 % of total national GDP (Chaulagain et al., 2018). In addition, 19'000 classrooms were destroyed and 11'000 damaged (NPC, 2015b). It is suggested that if people had better awareness, preparations could have been more adequate and the negative impacts might have been lower (Hall & Theriot, 2016).

58 In Nepal, the National Seismological Center under the Department of Mines and Geology has been
59 conducting seismic monitoring since 1978. The Dept. of Education is responsible to develop
60 different educational activities across the nation, and the Dept. of Urban Development and
61 Building Construction has been working for building codes design and implementation. After the
62 2015 earthquake, the National Reconstruction Authority has been established and works for
63 reconstruction of buildings damaged during the Gorkha earthquake. Despite these efforts, the topic
64 of earthquakes is not included at any level of the official school curriculum in the Nepali education
65 system. However, recently the National Society for Earthquake and Technology (NSET) initiated
66 the Public-School Earthquake Safety Program in Nepal, but only in a few districts of the country
67 (Dixit et al., 2014). This program focuses mainly on the retrofitting of school buildings to restore
68 and minimize future damage following the 2015 earthquake; however, educational efforts are still
69 very limited.
70
71 Following the devastating 2015 Gorkha event, and considering the history of major earthquakes
72 and the likelihood of many more as well as poor educational effort on the topic, we initiated and
73 implemented a seismology education program in schools in Western Nepal (Fig. 1; Subedi et al.,
74 2020) including the area affected by the 2015 earthquake and expanding towards the West (Fig.
75 2). The aim of the program is to increase the earthquake awareness levels in Nepal, starting from
76 the schools, with the hope that this knowledge will be spread into the community through social
77 learning, and partly through the establishment of a low-cost seismic network (Figs. 1, 3). In this
78 study, the effects of the education program for earthquake awareness and preparedness are
79 evaluated. The evaluation was performed by collecting data from students through two surveys,
80 one before and one after the initiation of the education program.
81
82

83 **METHODS**
84 The data for this study were collected using two questionnaire surveys on paper, conducted in
85 Nepali language: in 2018, before the initiation of the education program, and in 2020, nearly a year
86 after the full implementation of the program.
87 Before the initiation of the education program, we undertook fieldwork to help inform our strategy
88 and the educational materials, and to ensure the education program was well adapted to the Nepali

89 education system. In 2018, during the first visit, we talked with the school leaders about the
90 program and its benefits, and gave sample lectures (ca. 1-2 hours including questions) to students
91 between the ages of 14-16, providing key information on earthquakes. Before the sample lecture
92 and in each school, students were requested to fill in a paper questionnaire survey on earthquake
93 related questions. In special lectures we also taught students how to prepare before an earthquake,
94 how to save lives during an earthquake, and what to do after an earthquake. We also provided a
95 flyer containing detailed information and pictures (Fig. 4), of which we distributed 500 copies.
96 Similarly, we designed a sticker to remind people about earthquake hazards (Fig. 3), and
97 distributed this to students and teachers (3'000 so far).
98 In April-May 2019, during the second visit, the program was fully implemented with the
99 installation of an educational, low-cost seismometer in every school. The seismometer's record is
100 displayed on a computer, which is easily accessible to students in their physics class, or through
101 an online application. During the visit, we also identified the open place near the school where
102 students should meet in case of earthquake and installed an Emergency Meeting Point sign in
103 Nepali. To increase the efficiency of the learning and to ensure long-term uptake, we organized a
104 2-day workshop for nearly 100 school teachers, which was very well received. The full details of
105 the program are documented in an earlier paper (Subedi et al., 2020) and all the material is
106 accessible on the program website (www.seismoschoolnp.org).
107
108 In this article, we focus on evaluating the efficiency of our program in terms of knowledge and
109 behavior change of students related to earthquakes. Out of 22 schools participating in the program,
110 15 schools were chosen for the survey, covering a range of socio-economical contexts. Students
111 for the surveys were selected randomly from grades 9 and 10, representing the 14-16-year-old age
112 group. The total number of responses collected was 318 in 2018 and 480 in 2020, respectively.
113 For logistical reasons, some responses in the pre- and post-survey (27 %) came from different
114 schools, but this is not expected to affect the results as they were independent samples. While the
115 first set of students surveyed had no earthquake education whatsoever, those who filled out the
116 second survey were exposed to information and lectures frequently about earthquakes from the
117 teachers who were trained in our program.
118 When the exact same question was asked before and after our program's implementation, we
119 quantify the change using χ^2 test analysis. In doing so, our null hypothesis (H_O) is that our program

120 had no effect on the students. If this null hypothesis is unconfirmed (i.e., the χ^2 value is above the

121 threshold for the corresponding number of possible answers, and the respective p-value is below

122 5%), then we interpret that the program had an effect on the students as their answers show a clear,

123 statistically significant change. The complete set of questionnaires are available in the

124 Supplementary materials file.

125

126

127

128 **RESULTS**

129 The first measurement of this study, performed in the 2018 survey, was about the experience of

130 the 2015 Gorkha earthquake. The majority of respondents, 94 %, felt the shaking. As the

131 earthquake was on Saturday, schools were closed and students were at home; 71 % of students

132 answered that they ran out of a building, and only 15 % hid under a table, 8 % did not know what

133 to do, 3% stood next to the wall or the doorframe, 3% had other reaction.

134

135 **Knowledge about the causes and possibility of earthquakes in Nepal**

136 Before the implementation of the program, 7 % students believed that earthquakes were caused by

137 a moving fish carrying the Earth (a Hindu belief and myth). However, 64 % still chose the correct

138 scientific answer: plate tectonics. The majority of students, 84 %, chose the "plate tectonics"

139 answer in 2020, and the percentage of responses relating to the cultural/religious reasons dropped

140 to 2 % (Fig. 5).

141 Regarding the probability of a future earthquake greater than in 2015, more students knew that

142 such an earthquake in their region was quite likely after the education program (Fig. 6a). At the

143 same time, there was a clear drop in the number of responses for very unlikely (17 % in 2018 to 5

144 % in 2020) and a slight drop in the percentage answering that a future great earthquake is

145 impossible.

146 Relating to the effects of a Mw > 8 earthquake, after the program, the answer *I could die* has

147 increased by a factor of 1.8, and all other answers (*I could be buried alive*, *I could get hurt*, *I could*

148 *lose friend* and *My home could collapse*) are increased by a factor of at least 1.3 compared to 2018

149 (Fig. 6b; multiple answers were possible).

150 In 2018, 31 % students answered they know when an earthquake will occur, which is reduced to
151 11 % in 2020. The answer itself is not true, and this mis-information could drive people to
152 incorrectly prepare for or act during an earthquake. While our efforts clearly decreased this mis-
153 conception among the students, we could not yet reach each and every student to teach them about
154 the unpredictability of earthquakes. The students answer agreeing on the impossibility of
155 preventing an earthquake was 86 % in 2020, showing an   absolute increase of 18 % from 2018.
156 This question also shows that by 2020, more than double of the respondents have participated in
157 disaster risk education training compared to 2018 (Fig. 7).
158

159 **Knowledge and perceptions about how to behave during and after an earthquake**
160 Three quarters (75 %) of students in 2020 responded that their family knows what to do and where
161 to go during an earthquake, an increase of 55 % from 2018. Only 37 % of students in 2020 believed
162 that their home could resist a large earthquake. For comparison, 65 % students were scared and 22
163 % panicked during the Gorkha earthquake in 2015 (10 % had calm reactions, 3 % did not care)
164 according to answers in 2018.
165 In 2018, 62 % respondents didn't know that they should not call others after an earthquake to leave
166 the phone lines available for rescue operation, but in 2020 nearly 80 % students knew this useful
167 practical point (Fig. 8).
168 After the implementation of our program, 65 % of the students believed that they can survive if a
169 large earthquake occurred at night, whereas 43 % felt they could survive in 2018. This information
170 reflects more confidence of students as they become familiar with earthquake topics and heard
171 more information about them.
172 In 2020, 93 % of children knew that during an earthquake, the majority of injuries and deaths are
173 caused by people being hit by objects, through the collapse of constructions; the proportion of
174 people not knowing this dropped by 2/3 after the educational program was implemented. More
175 than 2/3 of the students in 2020 were aware about the additional hazards, such as fires, landslides
176 and floods that can be triggered by an earthquake. There is a 7% decrease for this answer since the
177 2018 survey, but as students who claimed partial knowledge increased by 7 % as well, a net change
178 in knowledge is not really perceptible on this point.
179 The proportion of students who regularly discuss earthquake related topics within their families
180 has increased by 18 % (absolute increase; see Table 1). This shows that the education program at

181   schools has led to widespread social learning within communities. This is reinforced by the finding

182   that nearly all students (98 %) are interested to learn more about earthquakes in detail, which will

183   aid communities towards better earthquake preparedness in the long run.

184

185   **Earthquake preparedness and adaptation**

186   In 2018, 36 % of students perceived that to remain alive during an earthquake depends on luck,

187   while this number has decreased by a relative 60 % after our program started and is a concern for

188   only 21 % of students (Fig. 9). All possible answers regarding adaptation options to earthquakes

189   record an increase from 2018 to 2020 (Fig. 11). The majority (72 %) of respondents answered that

190   they are aware of the shelter areas and open spaces where they can go in case of an earthquake.

191   The same proportion of people are aware of evacuation areas in 2020, but the increase here is much

192   more important (from 38 to 69 %), potentially thanks to the Nepali Emergency Meeting Point signs

193   we installed in schools. The information about which governmental authority to contact after an

194   earthquake is relatively low, but has increased by 10 % (absolute). Information about earthquake

195   prone areas and the reception of knowledge on earthquake disaster adaptation have increased by

196   the factor of 2.5, from 12 % in 2018 to 31 % in 2020 after the education program.

197   The relatively small number of respondents who claimed that the government will provide help

198   after an earthquake increased by a factor of almost 3: from 8 % in 2018 to 23 % in 2020. This

199   percentage is not yet sufficient in general, but the improvement following our program's

200   implementation is noteworthy. Moreover, the level of confidence in the government's

201   reconstruction activities has also grown, from 13 to 30 %, which is a good sign and shows

202   increasing level of trust. In 2020, 68 % of the respondents knew about the importance of talking

203   about earthquakes with neighbours, friends and colleagues, a nearly two-fold increase in two years.

204   Furthermore, we found that all students discussed their new knowledge and learning about

205   earthquakes with the people around them in the community. Ninety-one percent of the students

206   talk at least with some people in the community, only 9 % discuss this with their parents only, and

207   there is no student who had not had a discussion in her/his surrounding (Fig. 10).

208

209   **Perception of risk**

210   More than 60 % of the answers showed that students considered the level of seismic risk in their

211   city as medium, which means their risk perception is underestimated with respect to the actual

212 seismic risk level in the region (Stevens et al., 2018). Only every 6th person claims to perceive high

213 risk, which is clearly less frequent than people declaring low risk. As opposed to our expectation,

214 there is very little change in the level of risk perception in the group of students from 2018 to 2020:

215 the medium risk level group is the same, and there is minor change in low and high-risk level

216 groups (Fig. 12). This result is a surprise, especially when compared to the 72 % of responses in

217 2020 who believe that there is more than 70 % chance of experiencing an earthquake larger than

218 the 2015 Gorkha earthquake in their life (Fig. 6a).

219

220 **Project acceptance and future education**

221 To measure the program's acceptance level, some questions regarding the program itself were also

222 included in the 2020 questionnaire. It is found that 91 % of the students know that a seismometer

223 is installed in their school for earthquake education purposes. A total of 61 % of the students have

224 observed waveforms recorded by the seismometer, either at the school computer (39 %), on the

225 teacher's mobile phone (18 %) or/and on their parents' or own mobile phone (8-8 %). Furthermore,

226 85 % of the students answered that teachers teach about earthquakes in the classroom regularly

227 (weekly, monthly, on demand, and/or following an earthquake). In 2020, 99 % of the students

228 expressed that they like the earthquake information we have provided them. Regarding future

229 plans, almost all students are very much (69 %) or simply (29 %) interested to learn about

230 earthquakes by inserting the theme in the official curriculum, which can be instituted by the Local,

231 Provincial and Federal Government of Nepal as they have all have some field of possible action.

232 Hence, our program and the methods we use for teaching about earthquakes are well accepted.

233

234 **Statistics**

235 All questions except the last (Question 12 in Table 1, level of interest to learn is 98% in both

236 surveys) record a clear change in the pattern of answers given following our program's

237 implementation (see Supplementary Table 1). The biggest statistical change was seen for Question

238 6 (avoid post-earthquake use of mobile communications) suggesting a big increase in knowledge

239 and a very new information. Each question (excluding those with multiple choice answers) and

240 their corresponding χ^2 and p-values are reported in the Supplementary Table 1.

241

242

DISCUSSION

Have earthquake awareness levels increased?

As a result of the novel school-based education program, themes related to earthquakes are more familiar to the students now than in the past, and their awareness level have increased since the program was initiated. Students know more about the earthquake phenomena and have changed their behavior to better prepare and adapt to forthcoming earthquakes. Earthquake related knowledge learnt by students at schools has also reached across the broader community, though social learning processes (Reed et al. 2009).

Why have the awareness levels increased?

Beyond the prescribed school education, our program has provided an opportunity for informal and free-choice education forms, in which people can learn about topics outside of formal educational settings, which has been well supported by enthusiastic teachers (Falk & Dierking, 2002). This form of social learning enables an increase in knowledge, and through further communication with others, it spreads knowledge in communities, which may lead to changes in attitudes, behavior, and building of trust in society (Reed et al., 2010). This method is widely applied for the study of natural hazards and its management (e.g., Brody, 2003; O'Keefe et al., 2010). During our program's implementation, despite being in contact only with the school children, the knowledge has spread much more widely in local communities through social learning, thus reaching and impacting the original and intended target group.

People's behavior can also be developed through education. The idea is that if people are made knowledgeable of earthquakes, they are more likely to adopt and perform behaviors that will increase their earthquake awareness and preparedness (Hungerford and Volk, 1990). This has similarly been shown for other environmental issues like invasive species, where campaigns building knowledge and awareness changed behaviors therefore minimizing risk (e.g. Cole et al. 2019).

As a result of our educational program, earthquake related knowledge has increased and the behavior to cope with earthquakes has also changed. Despite this, the earthquake risk perception of students has not fully changed yet. Our results show that a realistic and appropriate distribution of earthquake related knowledge and increased awareness level are not (or not yet) sufficient to influence the perception of risk. Perceptions are a complex phenomenon and can take a long time

274   to change (De Dominicis et al., 2015; Estévez et al., 2015; Cole et al., 2019; Shackleton et al.,
275   2019). Education and awareness raising is the key factor for changing long-term risk perceptions
276   – although programs need to be well tailored to appropriate audiences (Lee et al., 2015). Although,
277   some studies discuss that increased knowledge does not always relate to increased risk perceptions,
278   and increasing perceived risk does not necessarily result in the reduction of risk behavior (e.g.
279   Noroozinejad, 2013; Petros, 2014). In addition, knowing more of a given topic makes people more
280   certain, self-confident, which may lead to underestimate the related risk (e.g. Stringer, 2004).
281   Moreover, increased knowledge and behavior to adapt and feel more secure during an earthquake
282   should reduce the fear of associated risk and therefore reduce the risk perception. The limited
283   change in risk perception in this study may be due to better knowledge of the hazard and how to
284   mitigate it (Ndugwa Kabwama and Berg-Beckhoff, 2015).
285   Hence, how people perceive risk is not necessarily related to the actual risk. We cannot draw a
286   definitive conclusion as the related knowledge can contribute to the amplification or the
287   attenuation of the related risk; as such, it could be one of the potential reasons for the low risk
288   perception of people having more knowledge (Reintjes, 2016). Risk perception is thus important
289   for preventative actions, but risk perceptions are often biased (Weinstein, 1988). It could be that
290   more time is needed to change students' risk perceptions, and it is also likely that there are other
291   factors such as economic status, gender, age group, location of home in city, etc. that may influence
292   the level of risk perception of people. A repeated survey in the same age category in a few years'
293   time may give an answer to this question. We suggest that further monitoring and adaptation of
294   the education system might be needed to better link awareness raising, behavior change and risk
295   perception change.
296
297

298   **Further action needed**
299   Since other sources of information, such as newspapers and television, are not easily available to
300   people in the Nepali countryside, we believe that the school is the best platform to transfer
301   knowledge to the community. The proper education at school reaches deep across the families and
302   into the community, and the discussions in those circles are essential to prepare the whole society
303   for future earthquakes. The proportion of students who regularly discuss earthquake related topics
304   within their families has increased by 18 % (absolute increase; see Table 1). This shows that the

305 education program at schools has led to widespread social learning within communities, and
306 possibly beyond our program's current area. We therefore, advocate for a continuity of this
307 program and to get education about environmental hazards more deeply embedded in the Nepali
308 education system.
309
310 Although this program has increased the earthquake awareness level among students and the
311 broader community in the program area, it is alone not sufficient for seismic risk reduction. Further
312 monitoring and adaptation of the program to promote changes in risk perception and improved
313 learning is advised. Education will help communities to prepare for future earthquakes, but the
314 local, national and regional governments are responsible for the rescue, support and reconstruction
315 operations in the case of a severe earthquake and well as developing and implanting policy to
316 mitigate against threats. People's situation after an earthquake depends on how well they are
317 prepared for the event, so developing policy, for example, on construction quality depending on
318 expected shaking intensities is advised. Since the shaking level of an earthquake cannot be
319 controlled, the impact of an earthquake on the community is strongly dependent on the actions
320 taken by the government for its preparedness, such as education (so far our program's effort) as
321 well as, for example, a suitable, locally calibrated and enforced building code. For both aspects,
322 the provincial governments could overtake some of the efforts drawing on our bottom-up
323 approach, and adapt them to continue earthquake education in schools, which is an efficient way
324 to make earthquake safer communities. In parallel, local initiatives are encouraged to strengthen
325 these efforts.
326

327 **CONCLUSIONS**
328 The Seismology at School in Nepal program has been successfully implemented and achieved the
329 aim of raising earthquake awareness and preparedness by educating students in their schools. The
330 program itself and the methods we used for teaching about earthquakes and demonstrating with
331 low-cost seismometers are well accepted by students and teachers. The new knowledge learned by
332 the students at school reaches their parents and is transferred into the local community. The results
333 we observed through two surveys, before and after initiation of the education program, are
334 measurable, statistically significant and with positive changes for earthquake related knowledge
335 and preparedness level, but not (yet) for the perception of the related risk. A high and positive

336 impact of the program on the students and their communities is encouraging for the continuation

337 and expansion of the program in the region. Governmental institutions are encouraged to build on

338 this experience as well as develop further policy to mitigate the risk of future earthquakes in Nepal.

339

340 **ACKNOWLEDGEMENTS**

341 We greatly acknowledge students, school teachers and principals from the school participating in

342 the program. We are very thankful to people who helped carrying out the surveys. We highly

343 appreciate the American Geophysical Union for their AGU-Celebrate-100 grant support which

344 allowed us to invite Nepali teachers to the workshop. We greatly acknowledge the Institute of

345 Earth Sciences and the Faculty of Geosciences and Environment at the University of Lausanne for

346 hosting Shiba Subedi as a doctoral student, and for their support for instrumentation. The funding

347 from Federal Commission for Scholarships for Foreign Students, Switzerland, for Shiba Subedi's

348 PhD thesis is well acknowledged. We warmly thank Anne Sauron, Peter Loader and Paul Denton

349 for valuable suggestions and useful discussions. We are also thankful to Mrs. Apsara Pokhrel for

350 translation and typesetting of the survey questionnaire in Nepali language.

351

352 Figure 1: Map of Nepal, with the locations of schools participating in the Seismology at School in

353 Nepal program. Background represents population density data (CIESIN and CIAT, 2005). The

354 Main Frontal Thrust (MFT), the surface trace of the fault underlying most of Nepal and hosting all

355 great earthquakes in the region, is indicated in red solid line. Three colored segments represent the

356 rupture extent of the corresponding major and great earthquakes with moment magnitude (Mw) as

357 indicated (after Bollinger et al., 2016). For the 2015 Gorkha earthquake the rupture area is also

358 plotted (blue contour). Letters P and K refer to cities Pokhara and Kathmandu, respectively,

359 marked with black circles.

360

361 Figure 2: Students gathered at the morning assembly in the *Shree Himalaya Secondary School,*

362 *Barpak, Gorkha* district. The school building was damaged during the 2015 earthquake and

363 students were in temporary shelters. The construction of the new building is visible at the top of

364 the picture. (Photo: S. Subedi, in May 2018, with permission of the school).

365

Figure 3: Left: The Raspberry Shake 1D low-cost seismometer, installed in 22 schools across Central Nepal (Fig. 1). Right: Earthquake awareness sticker, as a reminder, in English and Nepali language (artwork of M. Dessimoz). The sticker image is available for download from our program's webpage: www.seismoschoolnp.org.

Figure 4: Educational flyer in Nepali language on what to do before, during and after an earthquake. The flyer has been translated and adapted from an English version, compiled by and available from the CPPS earthquake education centre in Sion, Switzerland (www.cpps-vs.ch). The Nepali flyer is available for download from our program's webpage: www.seismoschoolnp.org.

Figure 5: Student opinions on what causes earthquakes (Q1), before and after the initiation of our education program. ($\chi 2 = 78.15$, p-value = < .00001, the change is significant).

Figure 6: *(a)* Student views on how likely the occurrence of a next earthquake bigger than the 2015 Gorkha earthquake is (Q3), before and after the initiation of our education program. ($\chi 2 = 43.59$, p-value = < .00001, the change is significant). *(b)* Student answer on the outcome of a potential Mw>8 earthquake in Nepal (Q2), before and after the initiation of our education program. *Multiple answers were possible.

Figure 7: Students' personal knowledge about earthquakes (Q13), before and after the initiation of our education program. *Multiple answers were possible.

Figure 8: Student's knowledge on the recommendation to avoid making phone calls after an earthquake to leave lines available for rescue operations (Q6), before and after the initiation of our education program. ($\chi 2 = 138.72$, p-value = < .00001, the change is significant).

Figure 9: Student's own opinion on earthquake preparedness (Q14), before and after the initiation of our education program. *Multiple answers were possible.

Figure 10: Student activities to transfer the knowledge to the community (question e), after initiation of our education program.

397

398 Figure 11: Student ideas about earthquake adaptation (Q15), before and after the initiation of our

399 education program. *Multiple answers were possible.

400

401 Figure 12: Students' perception of the level of seismic risk in their respective location (Q10),

402 before and after the initiation of our education program. ($\chi 2 = 6.33$, p-value = 0.042, the change is

403 slightly above significant level).

404

405

406

407

408

409

No	Question	Answer in 2020 survey			Answer in 2018 survey		
		Yes	Partially	No	Yes	Partially	No
Q7	If a large earthquake occurred at night, could you save yourself?	65%	-	35%	43%	-	57%
Q8	Do you know that the majority of injuries that occur in earthquakes are caused by people being hit by or stumbling over fallen objects?	93%	-	7%	76%	-	24%
Q9	Do you know that earthquakes can make additional damage such as fire, landslides and floods?	68%	21%	11%	75%	14%	11%
Q11	The preparedness for a major earthquake is the most important thing. Are you	71%	-	29%	53%	-	47%

	regularly discussing this topic with your family?						
Q12	Are you interested to know more about earthquakes and its preparedness in details?	98%	-	2%	98%	-	2%

Table 1: Questions and respective answers about earthquake preparedness among students who participated in the surveys, before and after our education program was initiated in Central Nepal. Respective statistical indicators are reported in Supplementary Table 1.

References

Ambraseys, N., & Jackson, D.: A note on early earthquakes in northern India and southern Tibet. Current Science, 570-582, 2003.

Bollinger, L., Tapponnier, P., Sapkota, S. N., & Klinger, Y.: Slip deficit in central Nepal: Omen for a repeat of the 1344 AD earthquake? Earth, Planets and Space, 68(1), 12, 2016.

Brody, S. D.: Are we learning to make better plans? A longitudinal analysis of plan quality associated with natural hazards. Journal of Planning Education and Research, 23(2), 191-201, 2003.

Center for International Earth Science Information Network (CIESIN), Columbia University; and Centro Internacional de Agricultura Tropical (CIAT), 2005.

Chaulagain, H., Gautam, D., & Rodrigues, H.: Revisiting major historical earthquakes in Nepal: Overview of 1833, 1934, 1980, 1988, 2011, and 2015 seismic events. In Impacts and insights of the Gorkha earthquake, Elsevier, ,1-17, 2018.

436

Cole, E., Keller, R. P., & Garbach, K.: Risk of invasive species spread by recreational boaters remains high despite widespread adoption of conservation behaviors. Journal of environmental management, 229, 112-119, 2019.

De Dominicis, S., Fornara, F., Cancellieri, U.G., Twigger-Ross, C. and Bonaiuto, M.: We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. Journal of Environmental Psychology, 43, 66-78, 2015.

Dixit, A. M., Yatabe, R., Dahal, R. K., & Bhandary, N. P.: Initiatives for earthquake disaster risk management in the Kathmandu Valley. Natural hazards, 69(1), 631-654, 2013.

Dixit, A. M., Yatabe, R., Dahal, R. K., & Bhandary, N. P.: Public school earthquake safety program in Nepal. Geomatics, Natural Hazards and Risk, 5(4), 293-319, 2014.

Estévez, R.A., Anderson, C.B., Pizarro, J.C. and Burgman, M.A.: Clarifying values, risk perceptions, and attitudes to resolve or avoid social conflicts in invasive species management. Conservation Biology, 29(1), 19-30, 2015.

Falk, J. H., & Dierking, L. D.: Lessons without limit: How free-choice learning is transforming education. Rowman Altamira, 2002.

Godschalk, D.R.: Urban hazard mitigation: creating resilient cities, Natural Hazards Review, 4(3), 136-143, 2003.

Hall, J. C., & Theriot, M. T.: Developing multicultural awareness, knowledge, and skills: Diversity training makes a difference?. Multicultural Perspectives, 18(1), 35-41, 2016.

Hungerford, H. R., & Volk, T. L.: Changing learner behavior through environmental education. The journal of environmental education, 21(3), 8-21. doi: 10.1080/00958964.1990.10753743, 1990.

467

IRGC: Risk Governance: Towards an Integrative Approach, Geneva, white Paper No. 1, 2005.

Lee, T.M., Markowitz, E.M., Howe, P.D., Ko, C.Y. and Leiserowitz, A.A.: Predictors of public climate change awareness and risk perception around the world. Nature climate change, 5(11), 1014-1020, 2015.

Lehman, D. R., & Taylor, S. E.: Date with an earthquake: Coping with a probable, unpredictable disaster. Personality and Social Psychology Bulletin, 13, 546–555, 1987.

National Research Council: A safer future: Reducing the impacts of natural disasters. National Academies Press, 1991.

Ndugwa Kabwama, S., & Berg-Beckhoff, G.: The association between HIV/AIDS-related knowledge and perception of risk for infection: a systematic review. Perspectives in public health, 135(6), 299-308, 2015.

Noroozinejad, G., Yarmohamadi, M., Bazrafkan, F., Sehat, M., Rezazadeh, M., & Ahmadi, K.: Perceived risk modifies the effect of HIV knowledge on sexual risk behaviors. Frontiers in public health, 1, 33, 2013.

NPC (2015b) Earthquake, N. N.: Post Disaster Needs Assessment. Sector Reports. Kathmandu: National Planning Commission, Government of Nepal, 2015.

O'Keefe, G. O. B. P., & Swords, Z. G. J.: Approaching disaster management through social learning. Disaster Prevention and Management, 19(4), 498-508, 2010.

Petros, P.: Risk perception, HIV/AIDS related knowledge, attitude and practice of the university community: The case of Ethiopian Civil Service College. HIV & AIDS Review, 13(1), 26-32, 2014.

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., et al.: What is social learning? Ecology and society, 15(4), 2010.

498

499   *Reintjes, R., Das, E., Klemm, C., Richardus, J. H., Keßler, V., & Ahmad, A.: "Pandemic Public*
500   *Health Paradox": time series analysis of the 2009/10 Influenza A/H1N1 epidemiology, media*
501   *attention, risk perception and public reactions in 5 European countries. PloS one, 11(3), 2016.*
502

503   *Shackleton, R.T., Richardson, D.M., Shackleton, C.M., Bennett, B., Crowley, S.L., Dehnen-*
504   *Schmutz, K., Estévez, R.A., Fischer, A., Kueffer, C., Kull, C.A. and Marchante, E.: Explaining*
505   *people's perceptions of invasive alien species: a conceptual framework. Journal of Environmental*
506   *Management, 229,10-26, 2019.*
507

508   *Stevens, V. L., Shrestha, S. N., & Maharjan, D. K.: Probabilistic Seismic Hazard Assessment of*
509   *Nepal. Bulletin of the Seismological Society of America, 108(6), 3488-3510, 2018.*
510

511   *Stevens, V. L., and Avouac, J.-P.: Millenary M w > 9.0 earthquakes required by geodetic strain*
512   *in the Himalaya, Geophys. Res. Lett., 43, 1118–1123, doi:10.1002/2015GL067336, 2016.*
513

514   *Stringer, E. M., Sinkala, M., Kumwenda, R., Chapman, V., Mwale, A., Vermund, S. H., ... &*
515   *Stringer, J. S.: Personal risk perception, HIV knowledge and risk avoidance behavior, and their*
516   *relationships to actual HIV serostatus in an urban African obstetric population. Journal of*
517   *acquired immune deficiency syndromes (1999), 35(1), 60, 2004.*
518

519   *Subedi, S., Hetényi, G., Denton, P. & Sauron, A.: Seismology at School in Nepal: a program for*
520   *educational and citizen seismology through a low-cost seismic network.* Frontiers in Earth Science,
521   2020.
522

523   *Tanaka, K.: The impact of disaster education on public preparation and mitigation for*
524   *earthquakes: a cross-country comparison between Fukui, Japan and the San Francisco Bay Area,*
525   *California, USA. Applied Geography, 25(3), 201-225, 2005.*
526

527 *Torani, S., Majd, P. M., Maroufi, S. S., Dowlati, M., & Sheikhi, R. A.: The importance of education*
528 *on disasters and emergencies: A review article. Journal of education and health promotion, 8,*
529 *2019.*

530

531 *Turner, R. H.: Earthquake prediction and public policy: Disillusions from a National*
532 *Academy of Sciences report (1). Mass Emergencies, 1, 179–202, 1976.*

533

534 *Weinstein, N. D.: The precaution adoption process. Health psychology, 7(4), 355, 1988.*

535

536

537 **CONFLICT OF INTEREST AND ETHICS**

538 The authors declare that the research was conducted in the absence of any commercial or financial
539 relationships that could be construed as a potential conflict of interest. The authors declare that an
540 ethical approval was not required as per local legislation. The authors declare that they have no
541 conflict of interest.

542

543

544 **AUTHOR CONTRIBUTIONS**

545 The project concept and implementation details were developed by S.S. and G.H. Most of the
546 fieldwork was carried out by S.S. with some help by G.H. The preparation of the manuscript,
547 figures, tables and the calculations were done by S.S. and guided and verified by G.H and R.S. All
548 authors discussed the results, and contributed to the final manuscript.

549

550 **SUPPLEMENTARY MATERIAL**

551 The Supplementary Material for this article can be found in supplementary material file.

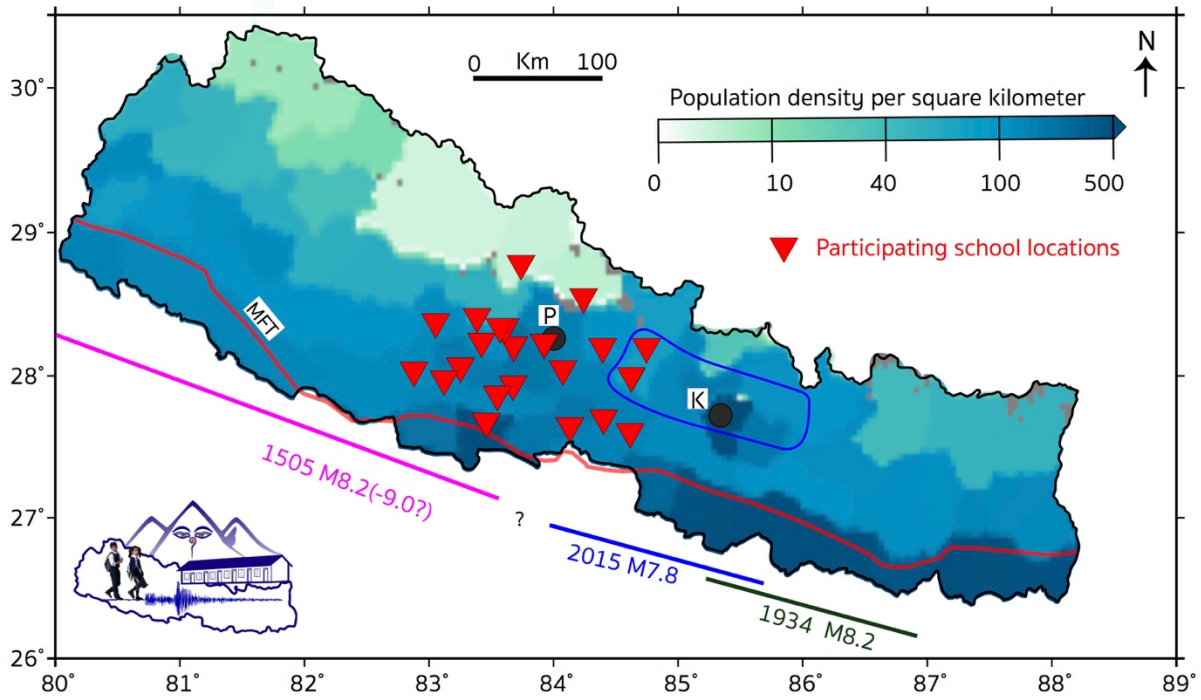
552

553

554 **DATA AVAILABILITY STATEMENT**

555 The datasets used for this study can be available on request to corresponding author.

556

557   Figure 1

558

559   Figure 2

560
561
562
563
564

565 Figure 3

566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588

589   Figure 4

1 भुकम्प जानुपुर्वका तयारी

सुरक्षित ठाउँ पत्ता लगाउनु

तपाई आफैलाई सुरक्षित गर्नको लागी सुरक्षित ठाउँहरु खोज्नुहोस – टेबलमुनी अथवा बेन्चमुनी वा ढोकाको फ्रेम आदी !

वरीपरी हेर्नुहोस

दराज वा झुण्डाइएका समानहरु राम्रोसँग पर्खालमा(भित्तामा) अडिएको छ छैन चेक गर्नुहोस । अल्लो ठाउँमा भएका गह्रौ सामानहरु हटाउनुहोस । पानीका भाडा,ग्यास चुलो र बिजुलीका स्वीचहरु कहाँ छन् याद गर्नुहोस ।

अत्यावश्यक सामाग्रीको तयारी

अत्यावश्यक सामाग्रीको किट (Kit) तयार गर्नुहोस र सजिले उपलब्ध हुने ठाउँमा राख्नुहोस ।
अत्यावश्यक सामाग्रीहरु
पानी/ लामो समयसम्म नकुहिने खानेकुरा / फस्ट एक किट/ सानो ब्याट्री/ टर्चलाइट ब्याट्री सहित/ तातो कपडाहरु/ब्ल्याङकेट/ आफ्नो परिचय दिने कागजको प्रतिलिपी/ केही पैसा आदी ।

आफैले अभ्यास गर्नुहोस/ तालीम लिनुहोस

आधारभुत जीवन रक्षा विधिसँग अभ्यस्त हुनुहोस । यदी परिवाका सदस्यहरु फरक फरक ठाउँमा हुन्छ्न भने आपतकालिन अवस्थामा भेट्ने ठाउँ टुङ्गो लगाउनुहोस ।

2 भुकम्प जाँदै गर्दा

कहिले र कहाँ जाने ?

पहिलो झट्का अनुभव भएको जतिसक्दो छिटो पहिले छनौट गरेको सुरक्षित ठाउँमा जानु होस । भर्याङ र लिफ्ट प्रयोग नगर्नुहोस । यदी भवनको बाहिर हुनुहुन्छ भने अलिक टाढा जानुहोस ।

आश्रयस्थल पत्ता लगाउनु

तल जानुहोस   आश्रय लिनुहोस   बलियोसँग समात्नुहोस

यदी तपाई विधालयमा हुनुहुन्छ भने तुरुन्तै टेबलमुनी आश्रय लिनुहोस । टेबलका खुट्टाहरु बलियोसँग समात्नुहोस,भुकम्प जाँदै गर्दा टेबलहरु सर्न सक्छन ।

भवन बाहिरको जोखिम

यदी तपाई भवनबाहिर हुनुहुन्छ भने बाहिरै बस्नुहोस र भवनभन्दा टाढा जानुहोस, उच्च विद्युतिय लाइन वा अन्य वस्तुहरु खस्न सक्ने ठाउँभन्दा टाढा जानुहोस । भिरालो ठाउँबाट टाढा जानुहोस भुकम्पले पहिरो जान सक्छ, ढुङ्गा खस्न सक्छन ।

कारभित्र/बसभित्र

यदी तपाई कार/बसभित्र हुनुहुन्छ भने खुल्ला ठाउँमा रोक्नुहोसर सवारी भित्र नै बस्नुहोस । पुलमाथी तथा आकाशे पुलमुनी पार्किङ नगर्नुहोस ।

3 भुकम्प पछाडी सतर्क रहनुहोस्

भुकम्पको झट्का सकिदा बित्तिकै

जब पहिलो झट्का रोकिन्छ, यदी सम्भव छ भने पानी/ग्यास र बिजुली बन्द गर्नुहोस । अत्यावश्यक सामाग्री लिनुहोस र भवनबाट बाहिर निस्कनुहोस ।

सावधानीपूर्वक बस्नुहोस

चेतावनी ! एउटा भुकम्प पछाडी अरु कम्पनहरु पनि आउन सक्छन, जसलाई पराकम्पन भनिन्छ ।
कम्पनको कारणले उत्पन्न हुने अन्य जोखिमहरु जस्तै पहिरो, बाढी, आगोलागीको बारेमा सचेत हुनुहोस ।

मेडिकल केयरको सुनिश्चित गर्नुहोस।

तपाई आफ्नो चोट जाँच गर्नुहोस ,तपाईको वरिपरी यदी कोही जटिल र अप्ठ्यारो अवस्थामा देख्नुभयो भने सहयोग गर्नुहोस ।
अन्य जानकारीका लागी र निर्देशनहरुका लागी रेडियो/टेलीभिजन सुन्नुहोस ।

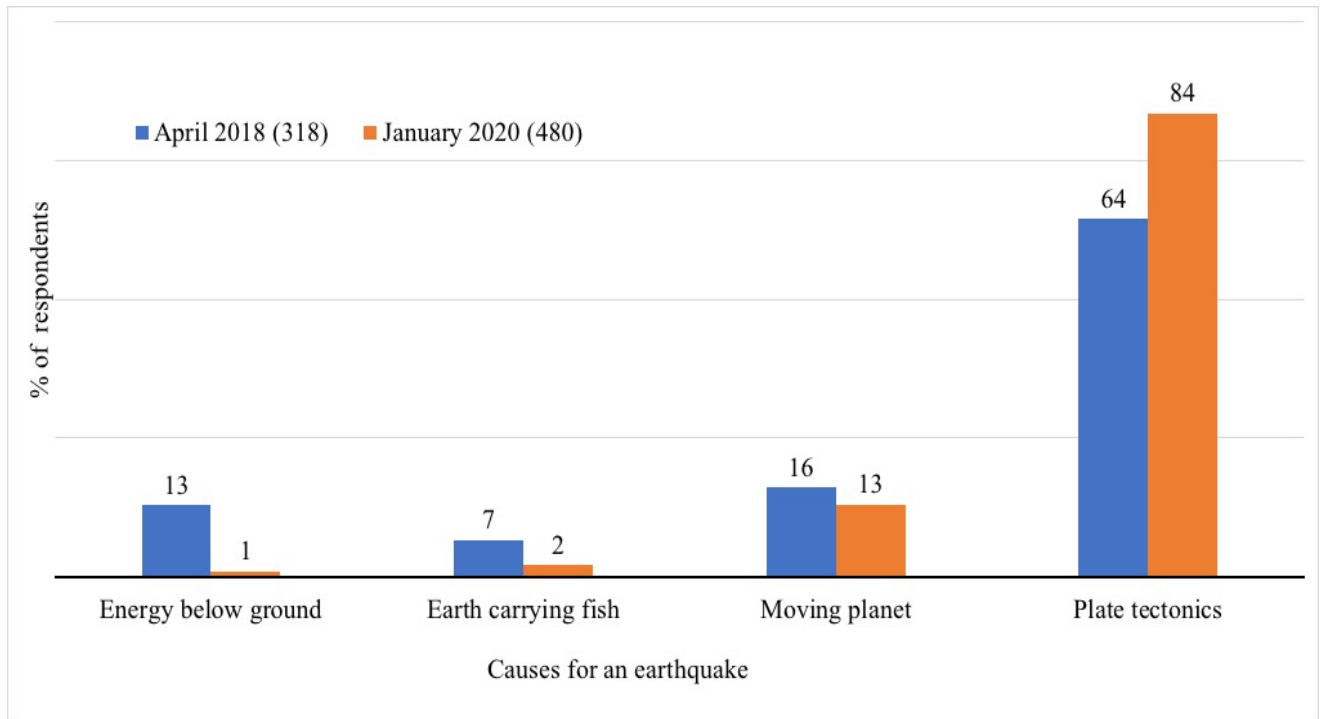
अत्यावश्यक सेवाहरु

आफ्ना साथी र परिवारलाई बारम्बार सम्पर्क गरेर टेलीफोन लाइन व्यस्त नबनाउनुहोस । अत्यावश्यक सेवालाई प्राथमिकता दिनुहोस ।

590
591
592
593
594
595
596
597

598

599

600   Figure 5

601

602

603

604

605

606

607

608

609

610

611

612

613

614

615

616

617

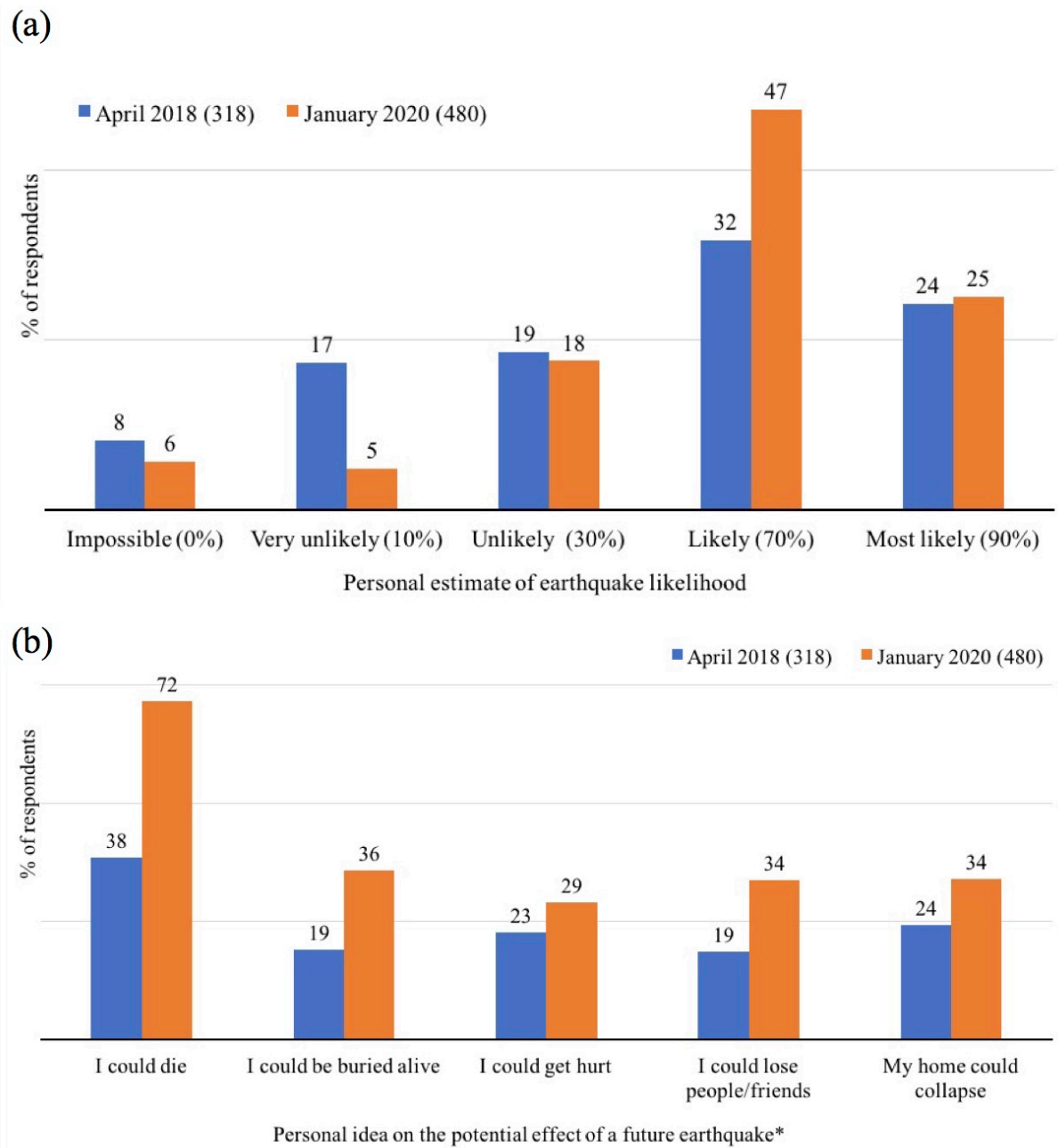
618

619   Figure 6

(a)

Personal estimate of earthquake likelihood

(b)

Personal idea on the potential effect of a future earthquake*

620

621

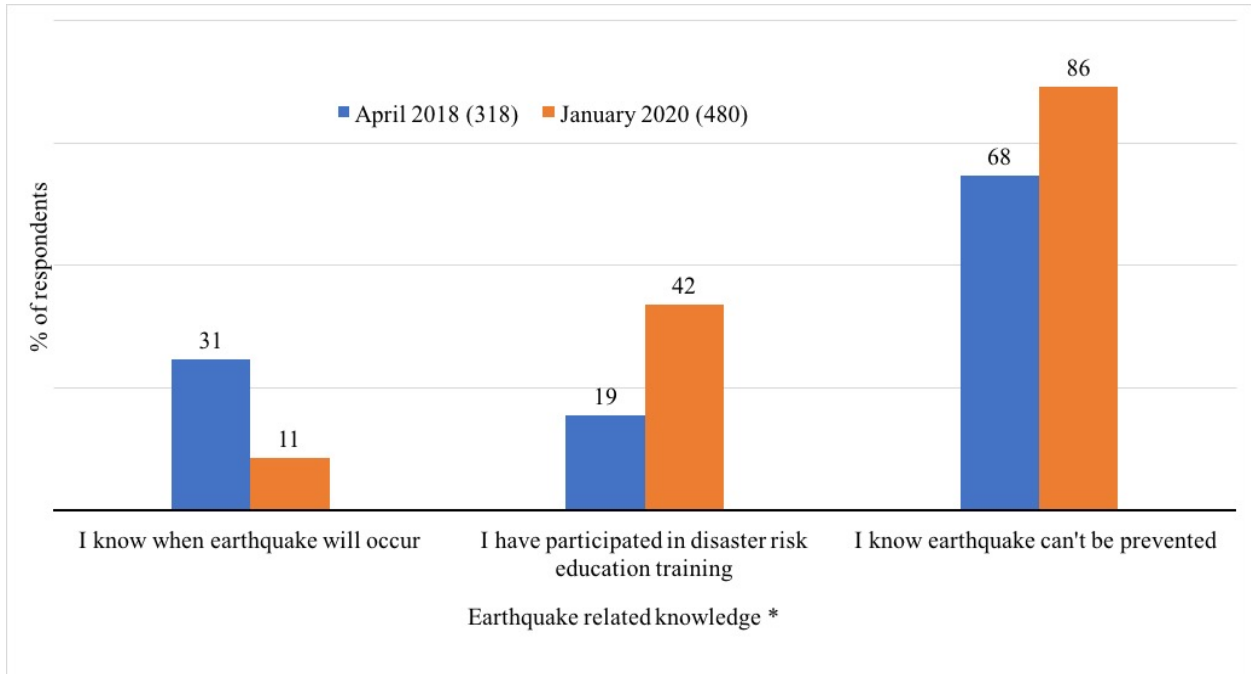
622

623

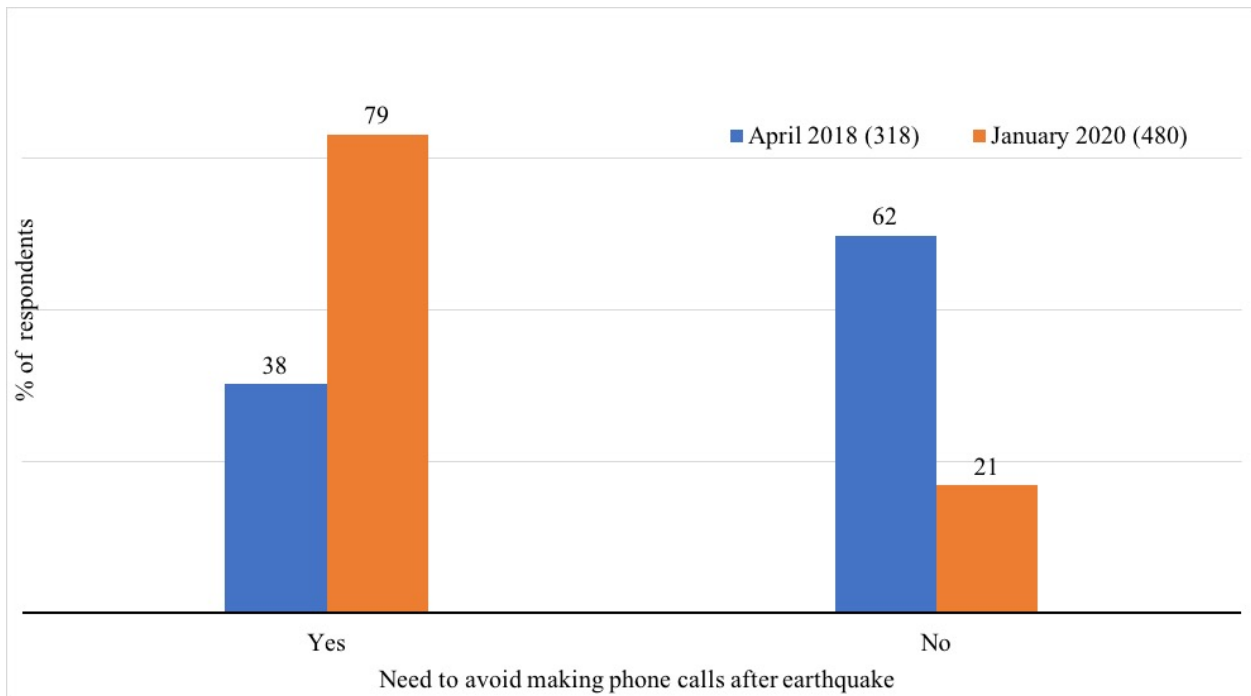
624

625

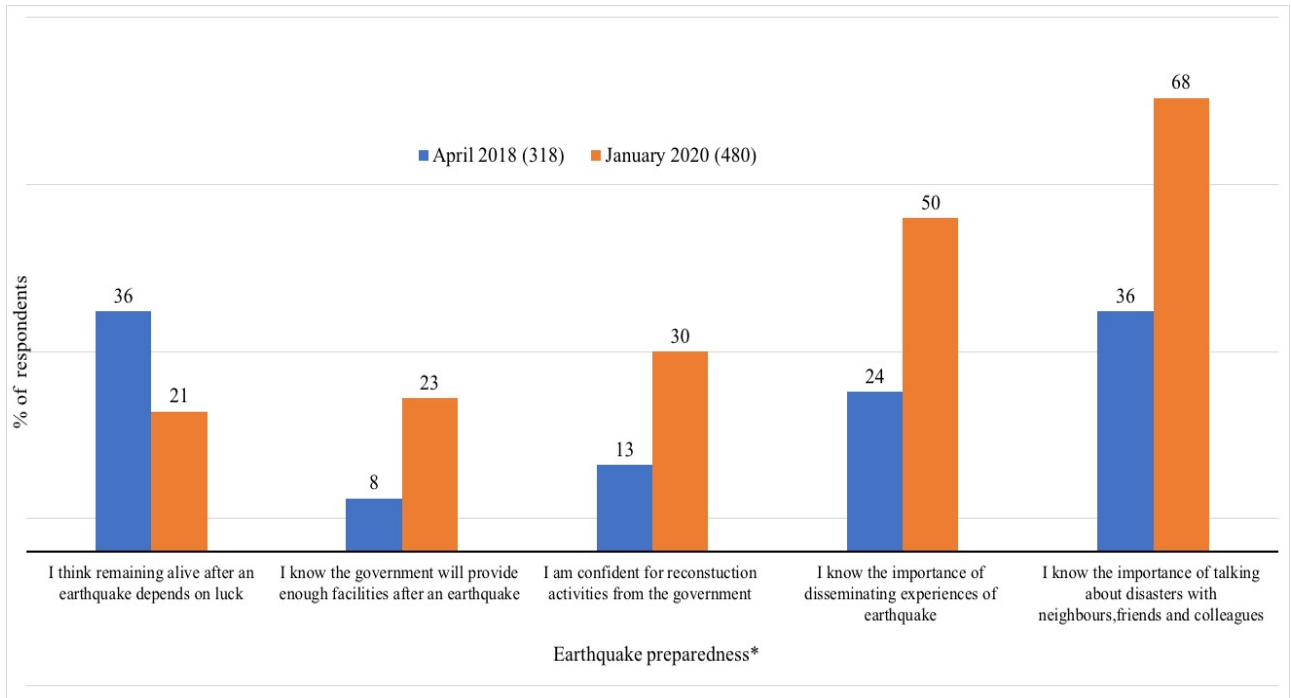
626

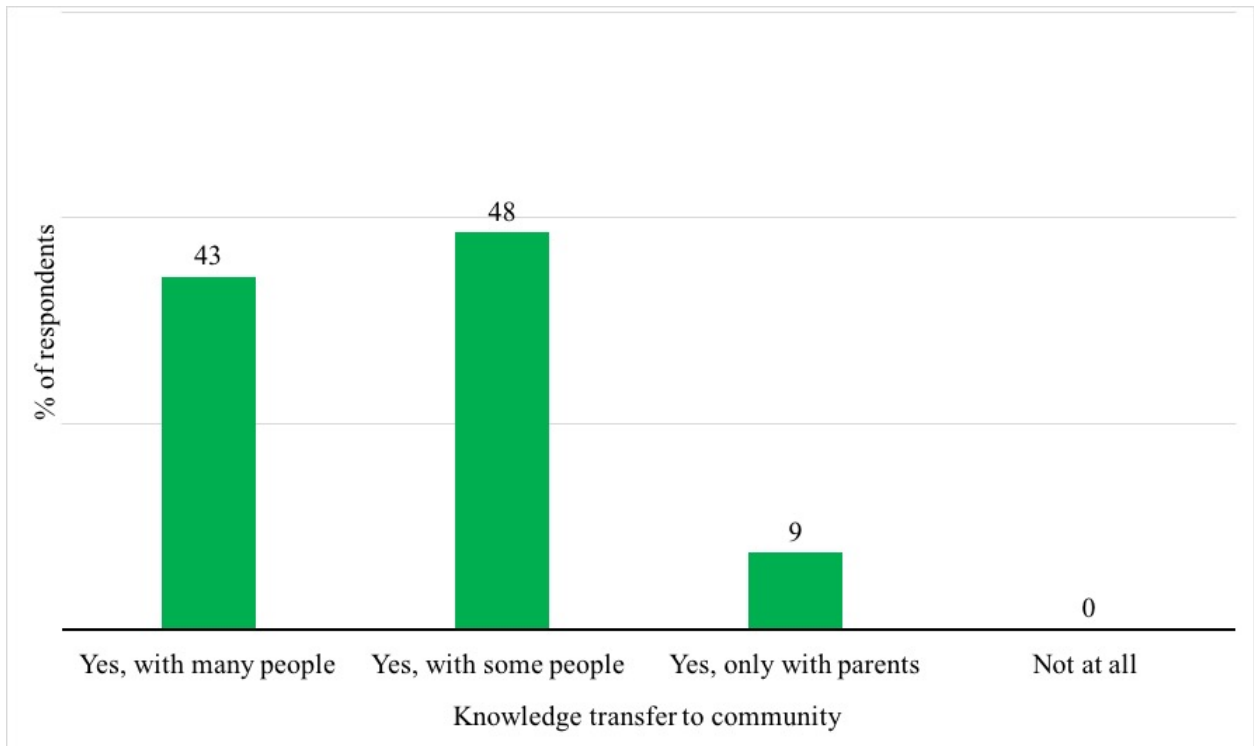
627   Figure 7

628

629

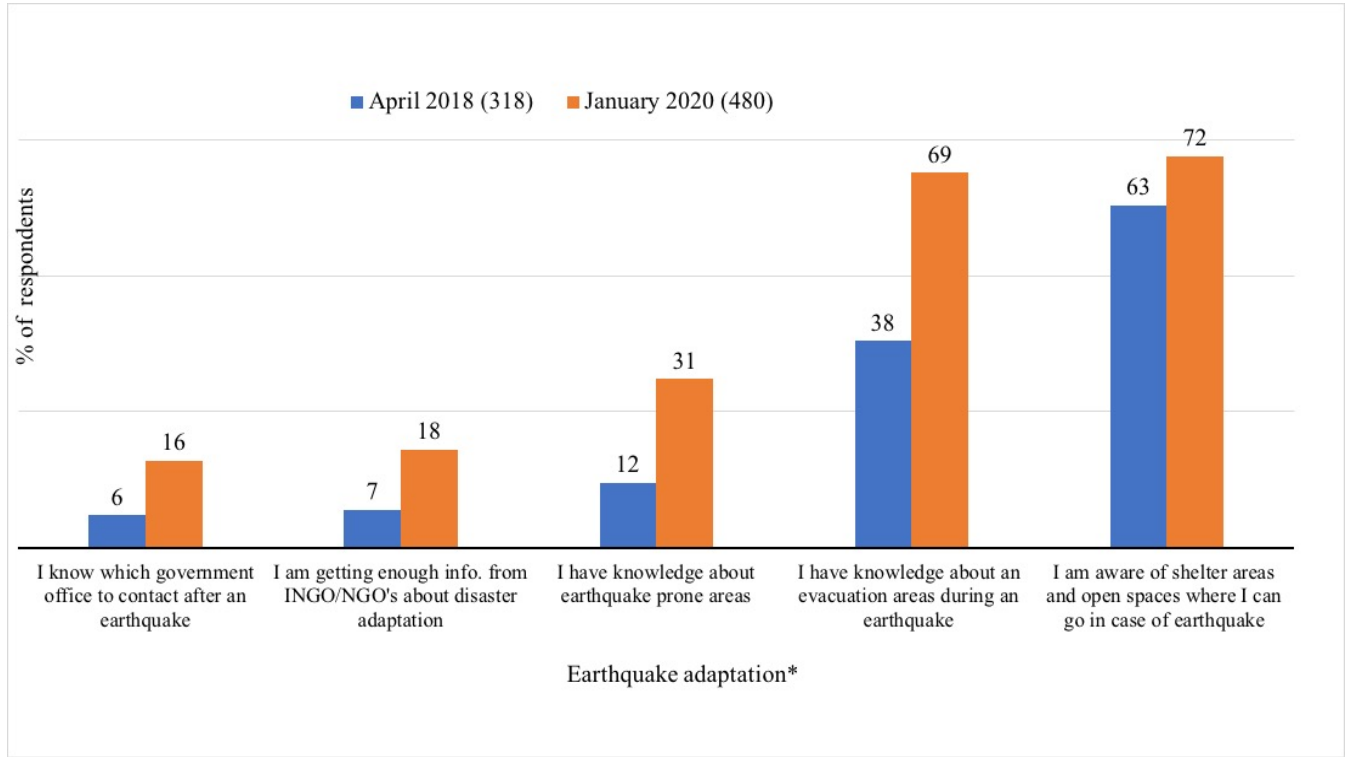
630   Figure 8

631

632

633   Figure 9

634
635
636

637   Figure10

638

639

640   Figure 11

641

642

643

644   Figure 12

645