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A Call to Action for a Comprehensive Earthquake Education Policy in Nepal

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Abstract Earthquakes in Nepal are among the most damaging natural hazards, claiming many lives and causing more widespread destruction than any other natural hazard. Yet, due to other difficulties and challenges, earthquakes are at the forefront of people's attention only after major events, such as the 1934 or 2015 earthquakes. As a result, current preparedness of the population to earthquakes is far below the optimal level. This calls for an immediate and widespread educational effort to increase awareness and to raise the current young generation responsibly. After describing the current status of earthquake education at various school levels in Nepal, we here propose a series of actions to undertake towards an official education policy, starting from full openness and use of languages, via coordination and teacher's training, to the content, frequency and style of curriculum. We conclude on a timeline of actions, which have various lengths but should start today. We hope that by sharing our researcher and educational experience and thoughts, the actual preparation of the earthquake education policy for Nepal will start being developed under a dedicated team. Elements of the proposal presented here can be used and adapted to other regions at risk around the world.

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सारांश **(Nepali)**

नेपाल भौगोलिक रुपमा उच्च भूकम्पीय जोखिममा पर्छ साथै अन्य प्राकृतिक प्रकोपको तुलनामा धेरै ज्यान लिने र धेरै क्षति पुर्याउने प्राकृतिक प्रकोप भूकम्प हो । मानिसहरुको चेतनास्तर, आर्थिक स्थितिलगायत विभिन्न कठिनाइहरुले गर्दा भूकम्प सुरक्षा जनताको प्राथमिकतामा पर्दैन । जब ठुला (वि.स.२०७२ सालको जस्तै) तथा महाभूकम्प (वि.स.१९९० सालको जस्तै) हरु नेपालमा जान्छन तब मानिसहरु यसको बारेमा सचेत भएको जस्तो देखिन्छ । वर्तमान अवस्थामा मानिसहरुले भूकम्प सुरक्षाको लागि गरेको तयारी पर्याप्त छैन । फलस्वरूप, वर्तमान युवा पुस्तालाई भूकम्प सुरक्षामा जागरुक गराउन तथा भूकम्प तयारीमा जिम्मेवार बनाउनको लागि तत्काल र व्यापक शैक्षिक प्रयासको आवश्यकता छ । हामीले नेपालका विभिन्न विद्यालयमा भूकम्प शिक्षाको वर्तमान अवस्थाको बारेमा अध्ययन गरेका छौं साथै उक्त अध्ययनपश्चात भूकम्प सुरक्षाको लागि आधिकारिक शिक्षा नीति निर्माणको लागि आवश्यक योजनाहरु पनि प्रस्ताव गरेका छौं । हाम्रा प्रस्तावहरुमा स्थानीय तथा विभिन्न भाषाको प्रयोग, निः शुल्क शैक्षिक सामाग्रीको उपलब्धता, सम्बन्धित विषयमा शिक्षकहरुलाई तालिम र तालिमको निरन्तरता, तथा पाठ्यक्रम परिमार्जन र पाठ्यक्रमको शैली आदि छन् । हामीले प्रस्ताव गरेका शैक्षिक नीति निर्माणको लागि गर्नुपर्ने कामहरु फरक फरक समय र अवधिमा सम्पन्न गर्न सकिन्छ । नयाँ योजनाहरु कार्यान्वयन गर्न र प्रतिफल आउन धेरै समय लाग्ने भए पनि उक्त योजनाहरु तत्काल सुरु गर्न सकिने प्रकारका छन् । नेपालको लागि भूकम्प शिक्षा नीति निर्माणको वास्तविक तयारीमा हाम्रा अनुसन्धानका परिणाम, शैक्षिक अनुभव तथा सोचहरु उपयोगी हुनेछन र नीति निर्माणको तयारी एक छुट्टै टोलीले गर्नेछ भन्ने आशा लिएका छौं । यहाँ प्रस्तुत भूकम्प शिक्षा नीति निर्माण प्रस्तावहरु विश्वमा भूकम्पको जोखिम रहेका अन्य देशहरुमा पनि प्रयोग तथा अनुशरण गर्न सकिन्छ ।

Introduction

Earthquakes in Nepal are the natural hazard with one of the highest rates of casualties and the most powerful and widespread destruction capability (Figure 1; Subedi, 2020). This is not only an observation of the past, but because the collision between the India lithospheric plate and the Tibetan Plateau as well as the related geological processes will continue the same way over millions of years, it is also Nepal's future. However, the preparedness level of Nepal's population to earthquakes is poor, and clearly below the risk represented by earthquakes. This calls for a multitude of actions, among which the introduction of a comprehensive education policy is the one that will reach the entire society.

Earthquake research and information sent to schools and society in Nepal have been ongoing for decades, yet to our knowledge there is no country-wide effort nor policy that would regulate and coordinate actions in this theme. The National Earthquake Monitoring and Research Centre (NEMRC) has been active for more than four decades, and does an excellent job locating earthquakes and sending information to the government and

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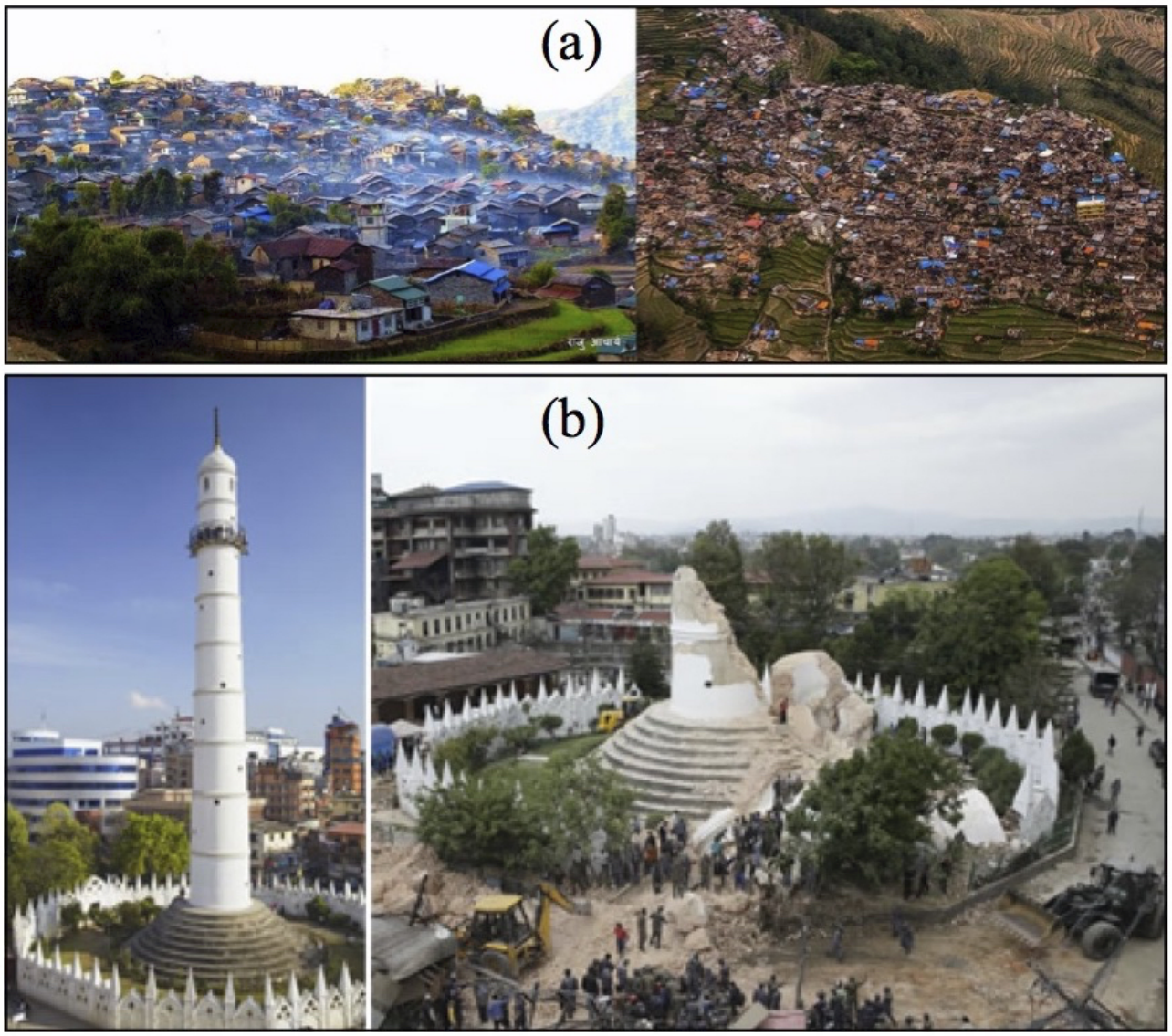

Figure 1 Examples of damage from the 2015 Gorkha earthquake. (a) Gorkha Barpak (epicenter village) before and after the Gorkha earthquake when the earthquake destroyed almost all houses (Adhikari, 2021). (b) Historic Kathmandu tower "Dharahara" before and after the 2015 Gorkha earthquake (Shrestha, 2016).

the public. However, because of the lack of human resources and direction from the government, NEMRC is currently not involved in any earthquake awareness activity. The National Society for Earthquake Technology (NSET) has been working in Nepal to build earthquake-safe schools so that local communities develop their capacities to cope with earthquakes. The School Earthquake Safety Program has been running since 1997 to protect schools against earthquakes. However, these efforts remained primarily focused on the Kathmandu region to assess school buildings' structural and non-structural vulnerability and retrofitting, and have not reached the countryside, which is in dire necessity of development.

Kathmandu Valley has benefited from a few case studies for earthquake risk management and risk mitigation. With the main objectives of formulating a plan for earthquake disaster mitigation and protecting life and property, the Japan International Cooperation Agency (JICA) carried out a study in 2001-2002. Their report suggested establishing an earthquake early warning system, a municipality disaster management institution, building code improvement, and a comprehensive database for earthquake mitigation (Dixit et al., 2000). Similarly, a project in the Kathmandu valley was implemented by NSET in association with GeoHazards International (USA). While a building code has been published, its implementation would need to be at a significantly higher level across the country.

In the meantime, the Government of Nepal has initiated an annual National Earthquake Safety Day (NESD). It was first held in 1999, on the day of the 1934 earthquake: the 2nd day of the Magh month of the Nepali calendar (corresponding to around mid-January), with the goal to raise public awareness about earthquakes (A.D.C.P., 2000). Another project, called SAFER Nepal,

led by the University of Bristol (UK), aims to develop a comprehensive scheme for enhancing the seismic safety and resilience of school buildings in Nepal (www.safernepal.net). Kathmandu's students, teachers, and residents benefited from the Nepal Red Cross Society training in essential disaster management planning in 2010 (https://reliefweb.int/report/nepal/training-schoolchildren-earthquake-preparedness).

After the most recent major earthquake in 2015, the Gorkha earthquake Memorial Day has been added to the list of annual events and earthquake-related official programs. The implementation of a revised building code became mandatory for new constructions, mainly in big cities and municipalities. In 2015, the Nepal Academy of Science and Technology (NAST) installed an Earthquake Early Warning system for testing purposes with the support of the Chinese Government. Regarding earthquake education, a minor update in the official curriculum added a new chapter for grade 12 students who chose the optional physics class, entitled "Recent Trends in Physics: Seismology". In general, the theme of earthquakes is widely covered in national and mostly local newspapers, television, and social media if there is an earthquake of felt level.

However, even after the 2015 Gorkha earthquake, when national and international non-governmental organizations tried to initiate earthquake preparedness projects around Kathmandu for local people, the efforts remained geographically rather limited. In 2015, the Government of Nepal established the National Reconstruction Authority to oversee and fast-track reconstruction work, which has now merged with the National Disaster Risk Reduction and Management Authority (NDRRMA). In addition, the Asian Development Bank (ADB) approved the Earthquake Emergency Assistance Project and more stable schools were constructed to meet disaster risk-resilient standards (see at http://dx.doi.org/10.22617/BRF220261-2). USAID and UNICEF also contributed to disaster risk reduction training to establish education in earthquake-affected districts. Many of these projects and programs have a limited duration, however, reflecting the difficulty to secure long-term foreign funding.

In 2018, the Government of Nepal published the National Policy for Disaster Risk Reduction (MoHA, 2018) with the support of the United Nations Development Programme (UNDP). The document is comprehensive, and mentions awareness raising programs. The policy itself (section 7) lists 59 points, among which "education" is mentioned four times. The most prominent and fitting is point 7.1: *"The subject of disaster risk will be incorporated in the curriculum of school and the higher level of education."* This goal is outstanding, but the document gives very little concrete elements describing what is meant, and how it will be implemented. In practice, in the field, we could not find palpable elements reflecting the NPDRR.

Overall, while every project effort towards increased awareness is worthy and laudable, Nepal as a whole still lacks an implementation concept and application scheme of the above policy that would efficiently bring forward the whole society's preparedness. It is to foster the change underlined by the NPDRR that we have written the present document. We have not been responsible for the full development of any legally binding, administrative policy definition so far. However, our intention with this paper is not just mere dreaming: it is based on various backgrounds and experiences. These range from extensive fieldwork in Nepal, especially the initiation and implementation of the Seismology at School in Nepal program (Subedi (2020); www.seismoschoolnp.org), developing Memoranda of Understanding for the scientific cooperation of dozens of research institutions (e.g. Hetényi et al., 2018), and teaching experience at all levels from elementary school (age 6) to university and adults' dedicated training.

This paper begins with describing why earthquake education is needed, with the intention for Nepal to develop its corresponding educational policy and its implementation in a convincing manner. A list of proposals for what to develop is discussed, together with thoughts on how. This development is highly relevant for better preparedness of the public, and for minimizing damage at future earthquakes. As one of our colleagues, Mark Vanstone, rightly said at a workshop: "Earthquake education in the UK is simply a matter of motivation. Proper earthquake education in Nepal is a question of death or life."

1 Data on earthquakes and education

1.1 Earthquakes

It is the same geological processes which have formed the Himalaya that cause earthquakes. These processes have happened for tens of millions of years, and from that point of view even devastating earthquakes happen often. However, compared to a human life's timescale, which is measured in just tens of years, devastating earthquakes occur relatively rarely. This is only an apparent perception. When reading the historical and geological records of the past hundreds to few thousand years, we find numerous large earthquakes that have devastated the region of Nepal (Table 1). Therefore, and because such geological processes repeat in time, we can be 100% sure that similar earthquakes will happen again and again, it is only a question of time. As a consequence, adequate preparation is sorely needed.

For those to whom the above comparison of times is too far-fetched, let us recall the main elements of the 2015 Gorkha earthquake: despite that the magnitude was not the highest of the region (7.8), and that Kathmandu Valley has experienced fairly little damage, nearly 9000 people died (http://drrportal.gov.np/), and the financial damage amounted to 50% of Nepal' annual Gross Domestic Product. Similar or worse events are likely to happen within the next human generations' time span.

1.2 Education in Nepal

We base our assessment on the current education situation in Nepal. This is rooted in the National Cur-

Date	Magnitude (M_w)	Max. intensity	Region	Summary	Source references
2015.05.12	7.2	VII	Kodari	• Destructive landslide in Langtang valley • More damage in Sindhupalchok	U, K15, A16
2015.04.25	7.8	IX	Gorkha	• ∼ 9000 casualties • ∼ 22 000 injured • ∼ 886 000 affected families • ∼ 7 billion USD damage (50% of annual GDP)	A15, P17, M15, U
2011.09.18	6.9	?	Sikkim	• Total of 111 casualties of which 6 deaths in Nepal • Epicenter close to Nepal border	IG
1988.08.20	6.8	?	Udayapur	• >700 casualties • >6000 injured • >20 000 houses destroyed	IG
1980.08.29	6.5	?	Bajhang	• >170 casualties • >10 000 houses destroyed	IG
1936.05.27	6.9	?	Rukum	-	IG
1934.01.15 (became Nepali earthquake safety day)	8.4	IX	Eastern Nepal	• >8500 deaths in Nepal • >7200 deaths in India • >80 000 houses destroyed in Nepal	CM97, S13, S16
1833.08.26	7.6	VIII	Central Nepal	• ∼500 casualties	AD04
1808.06.04	?	?	Kathmandu	• Major destruction	R35, P02
1505.06.06	> 8	XII	Western Nepal	• Epicenter close to Mustang • Felt in India and Tibet	I99, AJ03
1344.09.14	?	XII	Central Nepal	• Major destruction • The King died	P02
1255.06.07	?	XII	Eastern Nepal	• One third of the population killed • The King died • Major destruction	P02

Table 1 Overview of significant earthquakes known to have occurred in Nepal since 1223 A.D. Our records are incomplete and further events occurred earlier in history. Abbreviation of source references: U – USGS, K15 – Kargel et al. (2016), A15 – Adhikari et al. (2015); P17 – Prajapati et al. (2017); M15 – MoHA (2015); IG – ISC-GEM Bondár et al. (2015); CM97 – Chen and Molnar (1977); S13 – Sapkota et al. (2013); S16 – Sapkota et al. (2016); AD04 – Ambraseys and Douglas (2004); R35 – Rana (1935); P02 – Pant (2002); I99 – Iyengar et al. (1999); AJ03 – Ambraseys and Jackson (2003)

riculum, which prescribes the minimum level themes and topics to be taught, in Nepali language (except for English subjects) mostly in public schools, but also in English language in private schools. Nowadays, some public schools have initiated their classes in both languages. This baseline curriculum, however, can be very differently implemented in public and private schools, which often use different books and educational material. Moreover, the implementation of the National Curriculum varies across levels with different bodies intervening in its definition:

- The Curriculum Development Centre (https://moecdc.gov.np/) of the Ministry of Education has the mandate to develop curricula, textbooks, and educational materials for school education (classes 1- 12).
- At the Elementary level (classes 1 to 8), the local governments have explicit authority to develop tailored curricula for local subjects (credit hours: 4

Education level	Grades	Relevant authorities	Seeds of advice
Primary	1-8	• CDC of the Ministry of Education • Local Government	1. Define nation-wide earthquake education curriculum, add content with respect to grade/age of students 2. Introduce regional and local examples
Secondary	9-12	• CDC of the Ministry of Education	1. Add Seismology content/chapter to the Physics class 2. Include earthquakes in a compulsory class, for example social studies
University	Bachelor and above	• CDC of the University	1. Initiate a Department for Earth Sciences 2. Develop an earthquake preparedness plan 3. Include earthquakes in a compulsory subject in all degrees 4. Form teachers' teachers to increase the number of trained teachers in primary and secondary schools

Table 2 Overview of education levels, authorities and seeds of advice for curriculum development. Abbreviation: CDC – Curriculum Development Centre.

out of 32), hence, they can shape the contents. There are 753 local governments, inherently leading to disparities across Nepal.

- At the Secondary level (classes 9 to 12), the Curriculum Development Centre can shape the curricula. Therefore, we can expect more similarity between schools.
- At the University level, it is each university's Curriculum Development Centre (for example, https://tucdc.edu.np/, https://pu.edu.np/academics/cdc/) or special committee formed by the university who can develop, modify and execute the curriculum, which can lead to rather homogeneous teaching provided there is agreement on the source of contents.

These information are summarized by education level in Table 2, together with seeds of advice for curriculum development.

Compared to the administration hierarchy of Nepal, one can observe that the Province Governments are not directly involved in the curriculum shaping. We find that the overall organization landscape is rather complex, and that the introduction of new educational content requires coordination between these different bodies. We anticipate this is better done as early as possible in the process, and holds not only on the content, but also on the frequency of teaching a given topic in the classroom.

2 Methodology

The rationale we present in this paper to suggest key elements for developing an educational policy is based on: a broad, personal experience of growing up in Nepal and following the entire educational pathway there for the second author; extensive field experience in scientific research for the first author; and in-depth exchanges with teachers and students in the frame of the Seismology at School in Nepal educational program we have initiated and carried out together since 2017. These latter efforts have not only covered purely educational aspects, but we have also investigated the Hindu religious perspective on earthquakes (Subedi and Hetényi, 2021), we have triggered and worked across the disciplines to develop and to broadcast the Nepali Earthquake Awareness Song (YouTube link: https://youtu.be/ymE-lrAK0TI; Figure 2), and recently inspired the realization of a new card game (Figure 3) to sensitize students to the importance of earthquake preparedness.

Beyond these experiences in Nepal, we have also gathered relevant inputs from around the world, through publications (e.g., "The Power of Citizen Seismology: Science and Social Impacts" special volume, available at https://www.frontiersin.org/research-topics/10854/the-power-of-citizen-seismology-science-and-social-impacts#articles), other online information, and personal discussions with experts in this domain, mainly the UK, France, Switzerland, the USA, Hungary, and Italy. It is based on all this information that we have discussed and developed the proposals for a modern earthquake education policy tailored to Nepal.

3 Proposals for and Discussion on an Education Policy

3.1 Openness

We put a large emphasis on full and immediate openness of all educational material. Part of the research community, including seismologists, still employs closed or embargoed data, as well as publications that are only available based on subscription. This is not only unnecessary but also counterproductive in the educational context. The education policy, all educational material and anything that helps efficient knowledge transfer should be publicly, freely, and immedi-

Figure 2 Poster of the Earthquake Awareness Song, an audio-video document to increase earthquake preparedness in Nepal. Lyrics in Nepali and in English are available in the video's description (https://youtu.be/ymE-lrAK0TI).

ately available in locations where users find it without obstacles. We recommend a central website with high-quality, digital and searchable information at least in Nepali and English languages.

3.2 Language

Although the official language is Nepali, we recommend maintaining English as the second language in which the policy and the curriculum are prepared and published. The English version of the policy will facilitate its future update by international experts. For greater inclusivity, we also propose that the main elements of earthquake preparedness, e.g. the "Drop – Cover – Hold" principle, are prepared in every written language and dialect in Nepal (there are 17 with minimum 100 000 speakers each (Central Bureau of Statistics, 2012)). For all other non-written languages and dialects (over 100), we propose that local teachers spread the information orally, or through the radio, TV, and voice messages if these are technically possible and available for the target population.

3.3 Coordination and teacher's training

As described under Data (section 1), education coordination in Nepal involves several actors and layers of hierarchy, such as local government, Curriculum Development Centre, etc. The introduction of a new education theme (earthquakes) in a comprehensive way therefore requires efficient coordination between these groups. Since the topic is in some ways new, and could be initially regarded as out of the ordinary, it is extremely important that the right experts are involved in the coordination. But how can these experts be identified if there is currently no deep-reaching earthquake education in Nepal?

We see this current proposal as the first step to resolve this apparent chicken-or-egg problem. There exists sufficient information on earthquakes to make the first step, to create the policy and to prepare the educational material. However, a very important second step must follow to ensure a sustainable system: the training of teachers, who are able to teach the new theme at every level and in each school. A one-time training of elementary and secondary school teachers is not sufficient. Training should be regular, and for that to be implementable, a large number of expert teachers are required across the country. This calls for the introduction of earthquake science as a proper program at the university level. The current Geology curriculum and the current Physics curriculum are insufficient and unable to fulfill this goal, as earthquake science (seismology) is part of geophysics, which falls between the two. Therefore, for the sustainable implementation of earthquake education policy, a university level geophysics program is desired.

Ultimately, this requires active researchers and teachers to be hired at the University level, to serve as teachers' teachers. This is how most teachers in Western countries are formed: they follow higher level studies at Pedagogical Schools or Teacher Education programs. This idea is not new; for example it has already been employed – in very different contexts – at the end of the 18th century in France (see the *École Normale Supérieure*), and in the 19th century in Hungary (the *József Eötvös Collegium*). The difference to an entire teacher's training curriculum for the current goal of earthquake education in Nepal would be that teachers follow short upgrades or block course to familiarize themselves with the topic and how it can be taught in various classes. In other words, it could become teachers' professional development to attend such trainings, just as they could attend such events on climate change, geopolitics etc. In our experience with workshops organized for teachers in the frame of the Seismology-at-School-in-Nepal program, 1-2 days for 40-100 attendees can be efficient, and also provide a useful venue for teachers to exchange between them. In Nepal, such an effort should be aided by the National Earthquake Monitoring and Research Centre and the Nepal Academy of Science and Technology, but because neither of these are educational institutions nor can they host large number of students, it remains the Universities' role to lead higher education training.

3.4 Introduction to the curriculum, diffusion of information, and frequency

The primary way of spreading relevant earthquake and preparedness information to the society should remain the schools. We think that it is not the amount, but the frequency and regularity of teaching that will make a difference. Practically, the amount of material to teach to make an impact is not enormous, but whether the students are exposed to it once a year or once a month does make a huge difference. Teachers participating in our Seismology at School in Nepal program confirm this; a survey taken with hundreds of students before the start of the program as well as 2 years after show that the teaching program has already made a positive impact (Subedi et al., 2020b).

A step in the program-building process will be a comprehensive review of existing programs, practice and effective strategies. Nevertheless, a few points can already be put forward here. In the Elementary levels 1-4, we propose monthly or bi-monthly activities, in a subject that connects to the environment or geography. Any kind of game, for example our educational card game on earthquakes (Figure 3) could be included. In levels 5-8, the frequency could become monthly, and history and social science classes could also include topics related to earthquakes. In the Secondary level (levels 9-12), the compulsory Sciences or Social sciences class could lead, possibly helped by computer science, for example for the search and visualization of earthquake information, or a hands-on exercise of simple earthquake location using the tutorial provided by Subedi et al. (2021). The University level teaching should encompass the full spectrum of information, ideally combined with some computer programming exercises.

At all levels, the students should be shown where the Emergency Meeting Point (Figure 4) of their building/school campus is, and regular earthquake evacuation drills should be performed: run outside if on the ground floor, "Drop-Cover-Hold" if on upper floors. Schools that have the opportunity to use a low-cost seismometer can develop various activities for all age classes around those (Subedi et al., 2020a).

Beyond the school frame, numerous other pathways exist to inform the entire society. Obviously, a selection needs to be made, so that this information forms an official, recognized channel, not too frequently, but in a focused, to-the-point manner. These pathways include social media (e.g., Facebook, Twitter, Instagram), governmental television channel (Nepal TV), radio, private televisions, GSM mobile voice message, as well as internationally used and acknowledged information distribution such as "Recent Earthquake Teachable Moments" by the EarthScope Consortium (Bravo and Hubenthal, 2016) and the "@LastQuake" Twitter bot by EMSC (Chen et al., 2020; Bossu et al., 2023). Here again, the emphasis is on regularity. Finally, all relevant information should be available digitally in an open website.

Figure 3 Some of the cards from the earthquake card game "Beat the Quake". The game was developed in 2021 for the Seismology at School in Nepal program (initial ideas and support: György Hetényi and Shiba Subedi, development and testing: Gergely Szakács, graphics: Levente Forgács).

Figure 4 Emergency assembly point sign in Nepali and English, developed and implemented by the Seismology at School in Nepal program.

3.5 Respect of religious and traditional beliefs, social context

Although we have anticipated this topic before starting our Seismology at School in Nepal, we have encountered a broader range of questions in the field regarding the scientific approach to earthquakes, and how they compare with local beliefs. Although most school students (and people in general) can likely be convinced about the geological approach to earthquakes, one should avoid any conflicts with those who strongly believe in other explanations of earthquakes. Teachers should be aware of this potential source of confrontation, and instead of contrasting scientific and traditional interpretations, they could present both and initiate discussion. A description of how Hindu texts mention earthquake phenomena is presented in Subedi and Hetényi (2021). Adapting this point to other religious contexts around the worlds requires some research and discussion with historians, theologists and sociologists. Furthermore, the perception of hazard and risk in the local communities can be researched further to improve preparedness (e.g. Adhikari et al., 2018).

3.6 Alerting

In Nepal the authority to observe earthquakes and to report them to the government is the National Earthquake Monitoring and Research Centre. Alerts are issued to government institutions once a noteworthy earthquake is identified and confirmed. Public alert is currently not implemented, as it requires the preparation, implementation, and technical testing of an adequate earthquake early warning system. This is a long-term undertaking falling outside the scope of an educational policy; however, the types of alert systems could already be mentioned at school so that future generations are familiar with those. Alert pathways include dedicated sirens, voice messages, television and radio broadcast interruption, SMS through mobile phone, and dedicated smartphone apps. They can be issued nationally, regionally, or locally. It is highly important to discuss the available time to react after receiving an alert, and what false alerts and missed alerts are.

3.7 Proposed timeline

The compilation and implementation of an earthquake education policy requires numerous steps, which, in duration, range between very short to very long.

The initiation of policy making would ideally start very shortly. A dedicated group should dress a more detailed picture of the Nepali education landscape, based on this paper but with further input across the country and the authorities.

The development of the curriculum content can be established in the timescale of a year for the pilot ideas. Likewise, the first implementation could follow relatively shortly, with the most important elements provided to all teachers.

Three tasks take longer than one or two years. Practically, to prepare, print and distribute the updated schoolbooks, with information on earthquake science and practical steps to increase preparedness. Then, the establishment of successful organizational unit within the University frame, to provide research capacity and teachers' teachers, is a multi-year process. Finally, to rigorously test and adapt an effective educational strategy, which may require years and perseverance.

Nevertheless, there is no time to delay the beginning of the process. Earthquakes are unpredictable and institutional preparation and education in this matter should have already started.

3.8 Considerations of HOW to proceed

It is certainly easier to summarize why and what is needed in front of a given challenge, compared to the way it should be implemented. Indeed, many of our colleagues – and the Reviewers – wondered how such goals can be achieved, especially with limited resources. Our rationale below is based on two main observations:

- Projects and programs led from abroad are almost exclusively limited in time. This is because it is incredibly difficult, even for relatively rich countries, to obtain long-term financial support flowing to another region on Earth.

- Adapting educational plans is relatively cheap. It does not require much money to update and improve what is regularly taught in the classroom. Coordination between authorities and schools, as well as updating the teaching material does require manpower, but the Full-Time-Employee need to cover these tasks is negligible compared to the number of administrators or teachers.

Therefore, we argue that the development and implementation of educational policy is not a question of financial resources, but of political and personal will. Moreover, since it has to be a long-term effort in Nepal, it is best led by a Nepali authority or institution. For example (and not a recommendation): the Ministry of Education could take the lead and develop the policy and suggest overall implementation steps together with Nepal Policy Institute. Then, the Ministry of Education could invite provincial and local government representatives, University Rectors/Presidents, representatives of NEMRC, NAST, NSET and of the Seismology-at-School-in-Nepal program, to form a council where further steps of implementation are defined. Foreign help for well-defined tasks with a clear timeline, whether it is for adding up-to-date content, or to bring educational tools to schools, can be solicited, and has good chances to go through as one-time proposals with development agencies once education is under the spotlight of a dedicated educational policy. This should be relatively straightforward to advertise under UN's Sustainable Development Goals, especially #4 "Quality Education".

4 Conclusions

Considering the tragic history and the great threat of devastating earthquakes in Nepal, as well as the poor

level of preparedness, we urge the development of an earthquake education policy. The theme of earthquakes should be added to regular teaching activities as soon as possible. The main challenge is not the development of an overly detailed program, but the frequency of mentioning earthquakes and protective measures at school. A small but regular effort will lead to long-term and broad-reaching preparedness of the population. In this paper we gathered information and proposals on why such a policy is needed, and what we recommend to be included. The "how", or the practical implementation, should go hand in hand with the actual development of the earthquake education policy by a dedicated commission or institution. Our general experience in earthquakes and in teaching led us to draft this paper, with the intention for it to serve as the baseline for the corresponding policy formulation for Nepal. This work will certainly benefit from the experience of countries that have advanced in this domain (e.g., Japan), and elements of a successful Nepali earthquake education policy can be adapted to other regions of high seismic hazard around the world.

A bullet-point summary for policymakers closes this work:

- There is a current policy void in terms of earthquake education in Nepal.
- Earthquake education should be comprehensive, fully open and accessible.
- Actors of curriculum definition and implementation across Nepal should coordinate efficiently.
- The need for teachers' teachers is best realized as an organizational unit within a University.
- Regular and frequent teaching of short but diverse, age-adapted activities are recommended.
- Religious and traditional beliefs should be respected.
- Information should be diffused to the entire society, not only to schools.
- The definition of the main actors in leading this policy writing should start now.

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Competing interests

The authors declare having no competing or conflicting interest of any kind.

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