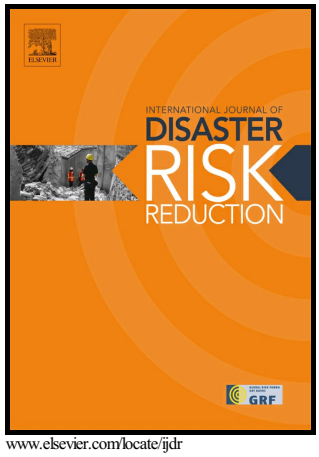
Indigenous Mountain People's Risk Perception to Environmental Hazards in Border Conflict Areas

Bayes Ahmed, Peter Sammonds, Naomi M. Saville, Virginie Le Masson, Kavita Suri, Ghulam M. Bhat, Naveen Hakhoo, Tsering Jolden, Gulzar Hussain, Kuenga Wangmo, Bindra Thusu



www.elsevier.com/locate/ijdr

PII: S2212-4209(19)30009-3
DOI: https://doi.org/10.1016/j.ijdrr.2019.01.002
Reference: IJDRR1063

To appear in: *International Journal of Disaster Risk Reduction*

Received date: 4 April 2018
Revised date: 2 January 2019
Accepted date: 2 January 2019

Cite this article as: Bayes Ahmed, Peter Sammonds, Naomi M. Saville, Virginie Le Masson, Kavita Suri, Ghulam M. Bhat, Naveen Hakhoo, Tsering Jolden, Gulzar Hussain, Kuenga Wangmo and Bindra Thusu, Indigenous Mountain People's Risk Perception to Environmental Hazards in Border Conflict Areas, *International Journal of Disaster Risk Reduction,* https://doi.org/10.1016/j.ijdrr.2019.01.002

Indigenous Mountain People's Risk Perception to Environmental Hazards in Border Conflict Areas

Authors

Bayes Ahmed [a,b,*] bayes.ahmed@ucl.ac.uk
Peter Sammonds [a,b,c] p.sammonds@ucl.ac.uk
Naomi M. Saville [d] n.saville@ucl.ac.uk
Virginie Le Masson [e] v.lemasson@odi.org.uk
Kavita Suri [f] snowy132@rediffmail.com
Ghulam M. Bhat [g] bhatgm@jugaa.com
Naveen Hakhoo [g] naveen@jugaa.com
Tsering Jolden [h] tseringjordan23@gmail.com
Gulzar Hussain [i] suhail490@gmail.com
Kuenga Wangmo [j] kuenga@gmail.com
Bindra Thusu [c] b.thusu@ucl.ac.uk

Affiliations

[a] Institute for Risk and Disaster Reduction, University College London (UCL), UK
[b] UCL Humanitarian Institute, University College London (UCL), UK
[c] Department of Earth Sciences, University College London (UCL), UK
[d] Institute for Global Health, University College London (UCL), UK
[e] Overseas Development Institute (ODI), London, UK
[f] Department of Lifelong Learning, University of Jammu, India
[g] Institute of Energy Research and Training, University of Jammu, India
[h] Department of Sociology, University of Jammu, India
[i] Department of Geology, University of Jammu, India
[j] Centre for Archaeology and Historical Studies, Royal University of Bhutan, Bhutan

* Corresponding author: Bayes Ahmed, UCL Institute for Risk & Disaster Reduction and UCL Humanitarian Institute, University College London (UCL), London WC1E 6BT, UK.
Email: bayesahmed@gmail.com

Abstract

This study aims to understand community risk perception to environmental hazards in a border conflict zone context in high-mountain areas. Participatory rural appraisal (PRA) tools were applied by the social science team. The results were validated with a hazard map prepared by a separate team comprised of geologists. Turtuk, the northernmost village in Ladakh, India located near the line of control with Pakistan was undertaken as a case study. Turtuk represents a high mountain indigenous rural community which has experienced several major disasters (flash flooding and landslides in 2010, 2014, and 2015) and territorial conflicts (wars in 1971 and 1999 with Pakistan) in recent times. The villagers were able to identify various environmental hazards and associated risk zones through participatory timeline, hazard and dream mapping exercises. The PRA maps matched the geological hazard map of Turtuk, demonstrating that community people are highly aware of surrounding hazards regardless of differences in age, sex, education, occupation, and religion. They apply indigenous knowledge to deal with the adverse climate and calamities. The technique, of analysing community vulnerability in the context of conflict and disasters by applying qualitative PRA tools and validating the mapping results, as piloted in this study is novel and replicable in similar settings.

Keywords

Participatory rural appraisal; Hindu Kush Himalaya; Flash-flooding; Landslides; Line of control; India

Highlights

- Understanding community vulnerability in the context of disasters and conflict
- Application of participatory hazard and dream mapping in analysing community risk perception
- The high mountain communities in Ladakh are resilient to environmental hazards
- They incorporate traditional and indigenous cultural knowledge
- They need assistance to develop a risk sensitive landuse plan

Ethical approval

The project went through standard UCL ethical approval (ID: 6141/001), UCL data protection registration (ID: Z6364106/2017/05/83), and UCL risk assessment procedures.

Role of the funding source

The Natural Environment Research Council (NERC), the Arts & Humanities Research Council (AHRC) and the Economic & Social Research Council (ESRC), have funded this work [NERC Reference: NE/P016138/1]. The UK based funding bodies had no influence or involvement in study design; in collection, analysis and interpretation of data; in writing the paper; or in the decision to submit the article for publication.

Declaration of interest

The authors declare no conflict of interest.

1. Introduction

The Hindu Kush Himalaya (HKH) region (Fig. 1) provides the basis for livelihoods to a population of around 210 million people. The mountains are the source of the major river systems in Asia which support more than 1.3 billion people – a fifth of the world's population (Sharma, 2012; ICIMOD, 2017). The landscape of the Himalaya is a result of a continuing competition between collision of tectonic plates, which has raised the Himalaya Mountains, and denudation, which causes erosion. Glaciers and rivers deposit eroded sediments. The high rate of these processes of uplift, erosion and sedimentation creates a highly dynamic environment (Dortch et al., 2009) which is associated with earthquakes, landslides, floods, extreme temperature variation, wind and snowstorm, and drought. They impact lives, livelihoods, and critical infrastructure. The region is also known as the 'Third Pole' since it stores world's 10% freshwater, non-polar ice and snow. By the year 2050, temperatures across the region are expected to rise by 1-2 °C and in some higher altitudes by up to 4-5 °C (Gautam et al., 2013). The impact of regional climate change and uneven development including high levels of seasonal tourism (Le Masson and Nair, 2012) can disrupt the ecosystem and community cohesion and increase vulnerability to environmental hazards.

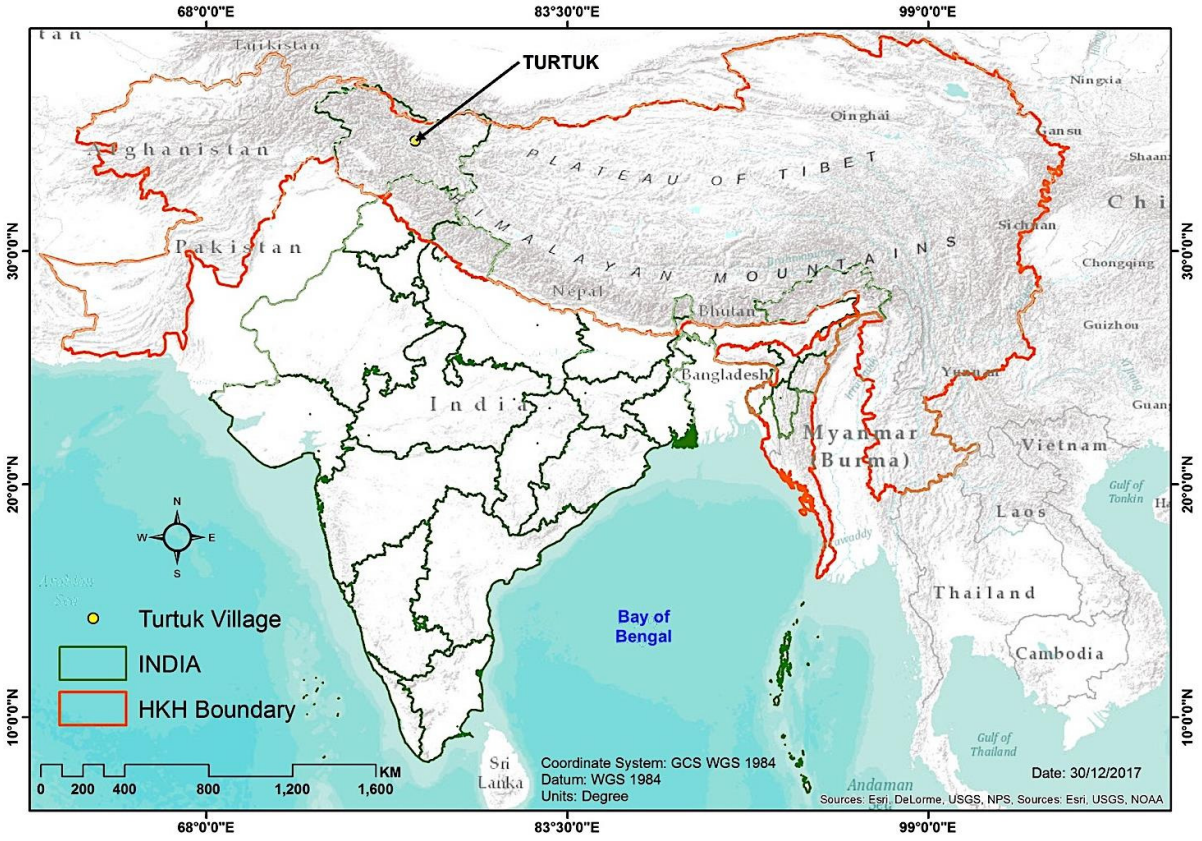


Fig. 1. Location of study area in the HKH region.

Disaster vulnerability often sits at the intersection of poverty and conflict vulnerability; while conflict, from intense armed conflicts to protracted civil unrests, has complex drivers and intersections with disasters. Communities in the HKH not only live in ecologically sensitive geographical areas, historically they have also suffered from economic and political marginalisation (Ganguly, 1990). The Jammu and Kashmir in the Himalayas (Fig. A.1) has a long history of conflict and environmental hazards with lasting impact on indigenous mountain communities. Major environmental hazards in the region were listed as

earthquakes in 1123, 1803, 1885, 1905, 1963, 1972, and 2005; landslides in 2010, 2014, and 2015; and floods in 1841, 1903, 1948, 1959, and 2014. The notable conflicts were the Mongol War (1679-84), First Anglo-Sikh War (1845-46), India's First War of Independence (1857), the Partition – British Withdrawal, and the first India-Pakistan War (1947), China-India War (1962), the Second India-Pakistan War (1965), the Liberation War of Bangladesh (1971), Kashmir Insurgency (1987-1990), the Kargil War (1999), and the ongoing violence in the Kashmir Valley between the civilians, militants and the Indian Army (Kelman et al., 2018). This has divided the mountain communities across borders and increased their vulnerability to environmental disasters (Hewitt, 1992; Hoffmann, 2006). Disaster risks need to be reduced through building resilience in vulnerable or marginalised populations, communities and systems.

Against this background, the objective of this paper is set to understand local people's risk perception and assess community vulnerability to environmental hazards in a conflict zone. Using the unique context of the border conflict between India and Pakistan in Ladakh, this study documents cultural knowledge and traditional practices of an indigenous mountain community by the use of participatory rural appraisal (PRA) tools.

2. Theoretical framework

Natural and anthropogenic hazards, climate-driven extreme events, and intense conflict can trigger disasters. The mainstream DRR community has long neglected the issue of confronting disasters in fragile and conflict-affected areas, although 58% of disaster deaths occur in those states (Peters, 2017). As per the UN Environment Programme (UNEP), more than two billion people have been affected by disasters and conflicts since the start of the new millennium, as the world has witnessed more than 2,500 disasters and 40 major conflicts. Only in 2017, there were 30.6 million new displacements associated with conflict and disasters globally. 39% of them were triggered by conflict and 61% by disasters (IDMC, 2018). The World Bank projects, climate change induced extreme disasters could force over 140 million people to migrate within countries by 2050 (Rigaud et al., 2018). These crises destroy livelihood, ecosystem and infrastructure, and displace people.

Apart from environmental hazards, armed violence or war is considered as the leading social or man-made agent for triggering disasters in the mountains or high-hill areas (Hewitt, 1992). Vulnerable mountain populations are most affected and contribute to the rapidly growing number of refugees and displaced people, some displaced for generations. In conflict zones, disaster-prone communities have shifting and intensified vulnerabilities as they face restrictions on free-movement that hinders emergency relief and evacuation, and finding safer places for relocation. E.g., the landslide risk profile of Lebanon has increased by 75% due to the arrival of over 1.5 million displaced Syrians fleeing armed conflict (Pollock et al., 2018). One contemporary example is the recent (since August 2017) mass exodus of a million Rohingya refugees in the highly landslide-prone hilly district of Bangladesh – Cox's Bazar. The Rohingyas fled from Myanmar's Rakhine State to escape armed conflict, genocide, and serious violations of their human rights by the Burmese military. Around 200 km^2 of hill forests have been destroyed (and still continuing) to build makeshift huts and arrange fuel for cooking for them. They are forced to live on dangerous hill-slopes and flood prone areas, which is now hosting the densest concentrations of refugees (Ahmed et al., 2018). It demonstrates how conflict in a neighbouring country can destabilize regional peace and security, and increase threats of environmental hazards in another country.

Community vulnerability is dynamic, varies across temporal and spatial scales (Zhou et al., 2014; Jamshed et al., 2017); and depends on social, economic, demographic, cultural, political, institutional, and ecological factors (Quarantelli, 1998; Wisner et al., 2004). Risk perception refers to people's subjective awareness of risks, i.e. the likelihood of an adverse effect resulting from the occurrence of a hazard in a vulnerable setting (Plapp and Werner, 2006). How people judge the risks posed by environmental hazards in a given geographical area depends on a combination of influencing factors at both individual and collective levels. Natural scientists might rely on technical processes to collect and interpret data from past disasters to better anticipate the probability and magnitude of future events; social scientists might examine a range of historical, socio-economic, cultural or political factors to better identify vulnerable settings; local authorities might consider risks in relation to other development priorities; and local inhabitants might rely on their own observation, experience and understanding of risks that they are exposed to (Plattner et al., 2006; Siegrist and Gutscher, 2006; Rana and Routray, 2016).

It is important to assess how people understand risks, why people decide (or not) to deploy protective strategies (e.g. Harries, 2008) or why some disaster preparedness measures are implemented more than others. In Trinidad, Martin et al. (2016) found that people's past experience of floods influenced their high perception of flooding risk. Gioli et al., 2014 found that the marginalized mountain communities in the Gilgit-Baltistan Province of Pakistan adopted strategies such as livelihood diversification and male labour migration to cope with cooler summer and erratic precipitation. In the same region, Azhar-Hewitt and Hewitt (2012) revealed that social conditions are responsible for making the local women vulnerable to mountain hazards. In case of New Zealand, the relationships between personal, social and civic agencies were essential in managing volcanic disasters (Paton et al., 2008).

Social scientists have also argued that high perception of risk does not necessarily lead to protective behaviours (Wachinger and Renn, 2010). In the Philippines, Gaillard (2008) shows that the socio-economic pressures that people face in their daily life (e.g. poverty, lack of access to basic services) weighed heavier than the threat posed by recurring natural hazards such as mudflows. People's behaviour towards risk also depend on non-hazard-related factors such as structural constraints (Gaillard, 2015), and trust in governance (Wachinger and Renn, 2010). Overall, risk perception studies have produced an extensive literature, including in the context of mountain hazards (Bjønness, 1986; Le Masson, 2013; Liu et al., 2018). However, the evaluation of risks in multi-hazard mountain environments where conflicts and border disputes also constitute a threat, has received much less attention.

Indigenous people usually live within geographically distinct ancestral territories, self-identify as indigenous or tribal, and typically aspire to remain distinct culturally, geographically and institutionally (UNDP, 2000). Indigenous knowledge is characterized by originating within the community, maintaining a non-formal means of dissemination, collectively owned, developed over several generations and subject to adaptation, and embedded in a community's way of life as a means of survival (Shaw et al., 2008). In the Chittagong Hill Tracts of Bangladesh, traditional forest management system, housing design, beliefs and values, social structure and land tenure system help the tribal communities to tackle landslides (Ahmed, 2017). The nomadic people of the central region of Mongolia apply traditional knowledge and practices such as seasonal migration, taboos and rituals, and maintain variations in livestock for grazing to combat pasture degradation and desertification due to climate change (Youlin et al., 2011). Despite some contemporary works, another important research gap has been identified as the role of

cultural knowledge and indigenous people's risk perception in DRR (Alexander, 2000; Cannon, 2015).

Risk perception research related to environmental hazards is primarily dominated by random sampling-based household questionnaire surveying (Ainuddin et al., 2014; Antronico et al., 2017) and quantifying the results by applying multivariate statistical and Pearson correction methods (Qasim et al., 2015), and linear regressions (Ardaya et al., 2017). Kelman et al. (2015) argues – DRR research is overlooked by quantitative statistical approaches that are not able to incorporate all the various dimensions of social vulnerability, and fail to distinguish between the people and natural world. In contrast, participatory rural appraisal (PRA) technique, developed in the 1990s (Chambers, 1994), has enabled people's realities to be captured by shifting a closed system (e.g. structured interviews, self-administered questionnaires or controlled experiments) to an open system (Bryman, 2016). In PRA, local people determine what goes into a diagram or map. By ensuring group work and democracy on the ground, PRA increases the level of interaction with local people and builds rapport with externals (Kumar, 2002; Cronin et al., 2004; Singh, 2014; Reichel and Frömming, 2014). PRA methods stress more on capturing how communities as a whole interpret their social world, compared to pre-set structured-questionnaires (Michener, 1998; Pelling, 2007). PRA emphasizes on the contextual understanding of social behaviour and social system (i.e. heritage, values, beliefs and culture) as a process that can be investigated in real time (Bryman, 2016; Ahmed, 2017). PRA tools should be prioritized into vulnerability assessments to enable understanding of the full scenario (Sudmeier-Rieux et al., 2012; van Tuan, 2014; Ahmed and Kelman, 2018).

In summary, findings from the literature review suggest that there are specific gaps in assessing indigenous communities in the Himalayas, and their overall social vulnerability to disasters in the confluence of environmental hazards and conflicts. This article intends to overcome such limitations by giving voice to the mountain people through PRA method to depict their own vulnerability and propose solutions based on indigenous knowledge.

3. Material and methods

3.1. Kashmir and Turtuk – a history of conflict and disasters

Kashmir (the former 'Princely State of Jammu and Kashmir') has a long history of border conflict as the territory had been administrated by a number of rulers notably the Mughal Empire, the Durrani Empire, the Sikh Empire, and the Dogra Dynasty (Bamzai, 1994). Kashmir was politically an independent territory even after the independence and partition of India from the British Empire on 15 August 1947. The last ruling Maharaja of Kashmir from the Dogra Dynasty, Maharaja Hari Singh, agreed to the 'Dominion of India' by signing the 'Instrument of Accession' document on 27 October 1947 to defend a tribal rebellion attack backed by Pakistani troops (Ganguly, 1995). Since then major border disputes followed by wars have been persistent between India and Pakistan. Both countries fought five major wars (i.e. 1947-48, 1965, 1971, 1984, and 1999) since their partition from the British Raj in 1947. Out of these, four were directly related to taking possession of Kashmir, and the 1971 war was linked to the creation of Bangladesh because of the internal conflict between the East and West Pakistan (Ganguly, 1995; van Schendel, 2009; Dasgupta, 2015). The Aksai Chin territory of Kashmir that separates China from India is administered by China despite India's claim upon it.

At present, the line of control (LOC) divides the northern areas including Azad Kashmir (now administered by Pakistan; referred to as Pakistan Occupied Jammu and Kashmir by India) and the Jammu and Kashmir State (administered by India). India has been occupying the Siachen Glacier since 1984 and yet there is no internationally defined boundary between India and Pakistan (Fig. A.1). Minor armed conflicts are common in areas adjacent to the LOC. For instance, on 23 December 2017, Pakistani soldiers attacked an Indian Army post near the Azad Kashmir LOC and killed four Indian Army personnel including a Major. The Indian Army retaliated by crossing the LOC and killing three Pakistani soldiers (The Times of India, 2017). Eventually, these conflicts mean that the indigenous mountain communities residing near the bordering areas suffer hugely.

An example of such an indigenous mountain community from Kashmir, where it is attempted to study community risk perception to environmental hazards, is Turtuk (also known as Turtok). Turtuk is the northern-most village in Leh District in Jammu and Kashmir located at 34.847° north latitude and 76.827° east longitude (Figs. 1 and A.1). The line of control is just 6 kilometres away from the village (Fig. 2a). A permanent Indian Army base camp is located in between Turtuk and Tyakshi. India took control of this village from Pakistan during the 'Indo-Pakistani War of 1971' which is also known as the '1971 Liberation War of Bangladesh'. The villagers in Turtuk witnessed another major conflict with Pakistan during the Kargil War in 1999. As it is forbidden to cross the border, the community is isolated and can be accessible by only one motor road. It impacts tourism activities, health care facilities, and other social and humanitarian works that can be considered as barriers for sustainable development.

Turtuk is predominantly a Shia Muslim village where 3,371 people (from 384 households) live in an area of 1.53 sq.km. The residents mainly speak Balti and Urdu, and they belong to the Baltistani ethnic group of Tibetan descent (Census of India, 2011). Turtuk is located at 3,000 meters above sea level on the banks of the mighty Shyok River which flows in the east-west direction. A tributary stream, locally known as 'Turtuk Lungpa', flows in the south-north direction from the hills to the north (Fig. 2b).

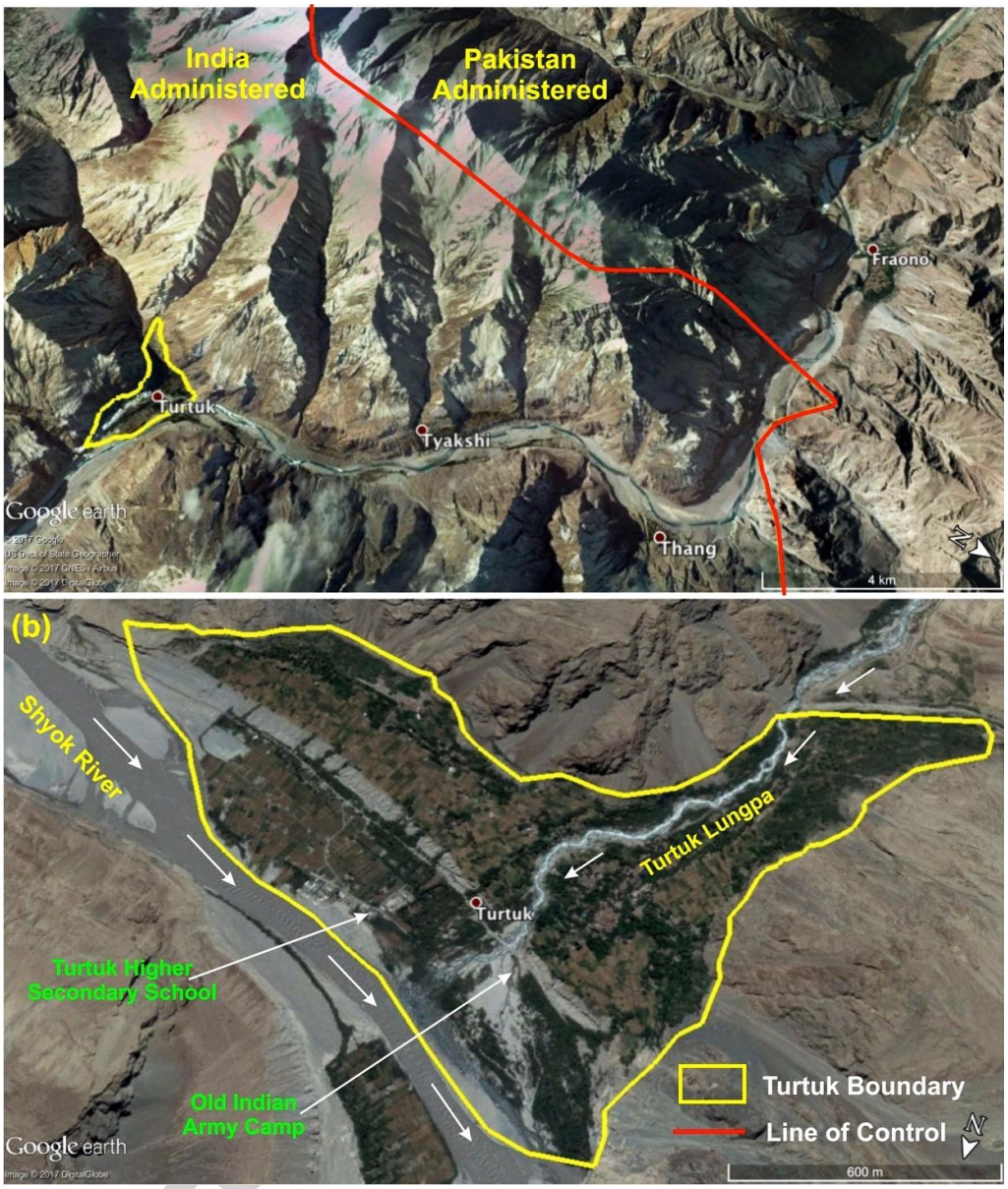


Fig. 2. Location of Turtuk village with respect to the line of control.

Turtuk is characterized by cold-arid climate and is bounded by the Karakoram Range to the north and the Ladakh Range to the south. The Ladakh region is categorized into four seasons: winter (December–March), pre-monsoon (April–June), monsoon (June–August), and post-monsoon (October–November). Regionally, the temperature can rise up to 34.8 °C in summers and drop to as low as -27.9 °C in winters. The average precipitation ranges from 0.5 to 1.5 mm/day throughout the monsoon and cloudbursts occur during the same period. Roads are hardly accessible during the winter season and the village becomes isolated. The region is experiencing a rapid increase in temperature and varied precipitation patterns in recent decades (Chevuturi et al., 2018), which is adversely impacting the mountain communities.

Being surrounded by high altitude mountains and glacial melt rivers, flooding, rock fall and landslides frequently hit Turtuk. The region is also vulnerable to earthquakes (EEFIT, 2008). As narrated by the local people, Turtuk was severely damaged during the 2010 and 2015 flash floods. The Indian Army base camp was previously located just beside the intersection point between the Turtuk Lungpa and Shyok River. During the July 2010 flash

floods the old camp was devastated (Fig. 3c) and 18 soldiers were killed. Pakistani soldiers bombarded the same area during the Kargil War. Just opposite to the old Indian camp, a memorial is erected (Fig. 3a) where an Indian soldier (Sapper Satish Kumar) was killed due to enemy shelling on 26 July 1999. Considering all these events, Turtuk village sets the ideal context for investigating an indigenous mountain community that face harsh climatic conditions and is concurrently affected by environmental hazards and border conflicts.

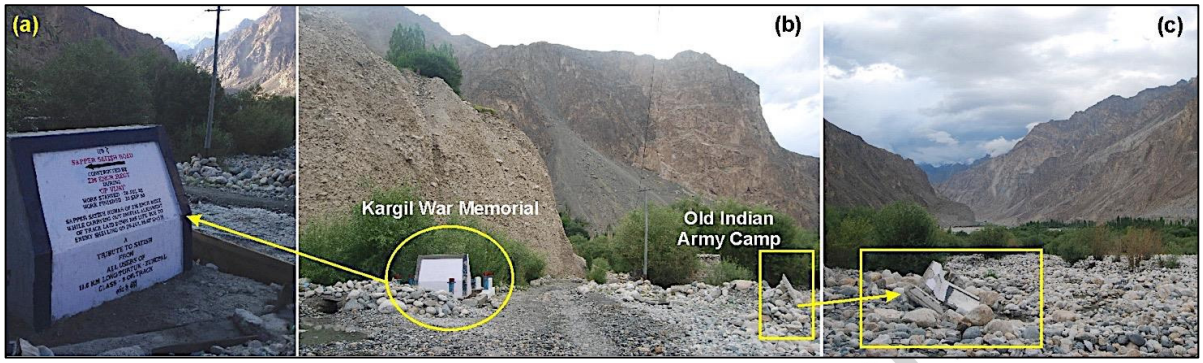


Fig. 3. A site in Turtuk village that was affected by both war and geo-environmental hazards. Source: Bayes Ahmed, July 2017.

3.2. Methodology

The authors of this article were divided into two groups: the social scientist group was responsible for conducting the community-based forensic workshop, and the natural scientist group prepared the geological hazard map of Turtuk. Before starting the fieldwork, activities such as ethical approval, risk assessments and security checks were undertaken. They included UCL ethical approval (project ID: 6141/001), UCL data protection registration (ID: Z6364106/2017/05/83), UCL risk assessment, authorization from the University of Jammu, Indian visa approval, security inspection at various Indian Army check-posts from Leh to Turtuk, and lastly fieldwork permissions from the Turtuk Army Camp and the local people. The work was conducted as part of the project – "Increasing Resilience to Environmental Hazards in Border Conflict Zones" funded by the Natural Environment Research Council (NERC Reference: NE/P016138/1).

3.2.1. Participatory forensic workshop

A two-day participatory 'forensic' workshop was held from 6-7 July 2017 in the Higher Secondary School, Turtuk that is located near the Shyok River (Fig. 2b). A forensic workshop is defined as a series of community-based activities in focus groups that helps to understand the root-causes of community vulnerability and the best possible alternatives in building resilience. The term 'community' is used synonymously as a 'case study area' that represents the Turtuk village. The workshop focused on historic hazard events and their association with social capital, vulnerabilities and their development. The community people and concerned experts or key informants shared ideas, defined problems, mapped hazard and vulnerability, determined priorities, suggested solutions within their remit and talked about future aspirations through collaborative activities.

The workshop hosted 36 participants, who along with other villagers were invited beforehand, covering local adults and representatives from the local government/ autonomous/ private institutions, school teachers, health care professionals (doctor and nurses), Army officer, Imam of the Mosque, politicians, drivers, farmers, members from the

Gram Panchayat or village council, tourist hotel owners, and university and college students, etc. The workshop participants were purposefully divided into four groups: political (total 7 participants), administrative (10), local women (11), and local men (8). In order to understand the differences or similarities in their risk perceptions, each group was assigned similar tasks. The project team members took the role of facilitators and a translator accompanied each group. The facilitators explained the workshop activities, PRA exercises, ethical issues, and oral consent was taken from the participants as a group for participating in the sessions, taking photographs and audio-recording some parts of the event.

PRA-based qualitative research helps to obtain information on local knowledge, people's risk perceptions and experiences over time, social processes and contextual factors, and local responses in mitigating disaster risks (Skovdal and Cornish, 2015). Timeline, hazard mapping (after preparing social and resource maps), and dream mapping PRA tools were applied (Ahmed and Kelman, 2018). A 'timeline' helps to identify landmark events (war or disasters) and capture their history as recalled by the local people. This helps us to learn what the community consider to be important past events and their historical perspective on current issues (Kumar, 2002; Cronin et al., 2004). Visualization through participatory mapping helps participants to see and understand the inter-connections between various issues related to disaster vulnerability in a local context. Social and resource mapping is used to illustrate the overall spatial dimensions and natural and physical exposure to hazards. The maps included locations of settlements and infrastructure such as roads, health centre, schools, bazaar, shops, water points, and playgrounds; and natural resources such as land, hills/ mountains, rivers, streams and irrigation canals, agricultural fields, apricot orchards, and forests. After participants had prepared their social and resource maps, they were asked to delineate the areas, houses, community facilities and infrastructure that they perceive are vulnerable to various environmental hazards. This is known as 'hazard mapping' (Cronin et al., 2004; Reichel and Frömming, 2014). On the following day, participants were invited to undertake 'dream mapping' where they re-drew their social maps to depict their hopes and aspirations in terms of building a resilient community with respect to the hazards depicted earlier focusing on what would ensure sustainable development for the community.

The workshop venue was the Higher Secondary School hall, which was well equipped with large tables and chairs. Each community group was provided with large A1 sized papers and necessary stationery. Participants were encouraged to discuss within each group and only basic guidelines were provided to initiate the mapping process. The participants drew the maps as per their local and indigenous cultural knowledge, and the authors mostly observed. After completing each task, facilitators asked the participants to explain the diagram or maps (Fig. 4) in group presentations. Field notes were taken in as much detail as possible and were later incorporated in this paper. The large maps were then scanned using a drum-scanner and digitalized (no alteration was made).

Fig. 4. The forensic workshop participants are **(a, b)** preparing the PRA maps and **(c, d)** presenting the maps in groups. Source: Bayes Ahmed, fieldwork, 6-7July 2017.

The PRA maps and diagrams were triangulated through field verification and validation. For this purpose, the PRA maps were compared with the actual hazard map prepared by the natural scientist team. The activities were performed in separate groups who did not communicate results to one another at the time to ensure the legitimacy and triangulation of the results. Researchers have applied PRA methods to understand community risk perception to environmental hazards (Cronin et al., 2004; Sudmeier-Rieux et al., 2012; Ahmed and Kelman, 2018), however, comparing and validating the results with actual geological hazard map, as demonstrated in this work, is unique and novel.

3.2.2. Geological hazard mapping

A geological hazard map of Turtuk was prepared by integrating the field-based investigations and remote-sensing data (satellite imagery), and using ArcGIS software. The field studies involved geological and geo-hazard mapping using the base maps (Survey of India topographic sheet numbers: 52 F/1, 52 F/2, 52 F/5, 52 F/6, 52 F/9, 52 F/10, 52 F/11, 52 F/13, 52 F/14, and 52 F/15), and ground checks of the data obtained from the high and moderate resolution panchromatic Landsat 8 images of the region. Additional data (land use and land cover, population census 2011, geology, and boundaries, etc.) were obtained from *Bhuvan* – the Indian Geo-Platform of Indian Space Research Organization.

4. Results and discussion

4.1. Results from geo-hazard specialists' hazard mapping

The natural scientists observed that in Turtuk, continuous tectonics and geological processes, coupled with anthropogenic activities and climate change have intensified numerous hazards *viz*. earthquakes, landslides and other down-slope movements, floods

and cloudbursts (Fig. A.2). The seismicity in the area associated with the regional and local faults is poorly understood, and the seismic hazards have not been investigated thoroughly. Intense rock deformation has made the mountainous terrain very fragile, weak and highly susceptible to downslope movements. Slopes that are susceptible to these hazards have been identified towards North, South and Southwest, where the slopes range from being (~25° inclination) to very steep (up to ~45° inclination). The rocks depict three prominent closely spaced and dense fractures dipping towards Southwest, Northeast and Northwest. With elevation of 2,500–3,700m, the drainage in the area ranges from being immature (first order) to mature (sixth order), depicting an evolving topography and dynamic landscape. The occurrence and interaction of the rock layering, rock fractures and escarpment slope (inclination) is suggestive of a serious landslide hazard in the area. Additionally, three boulder terraces with steep and vertical scarps pose a significant threat of rock-fall (Fig. 5).

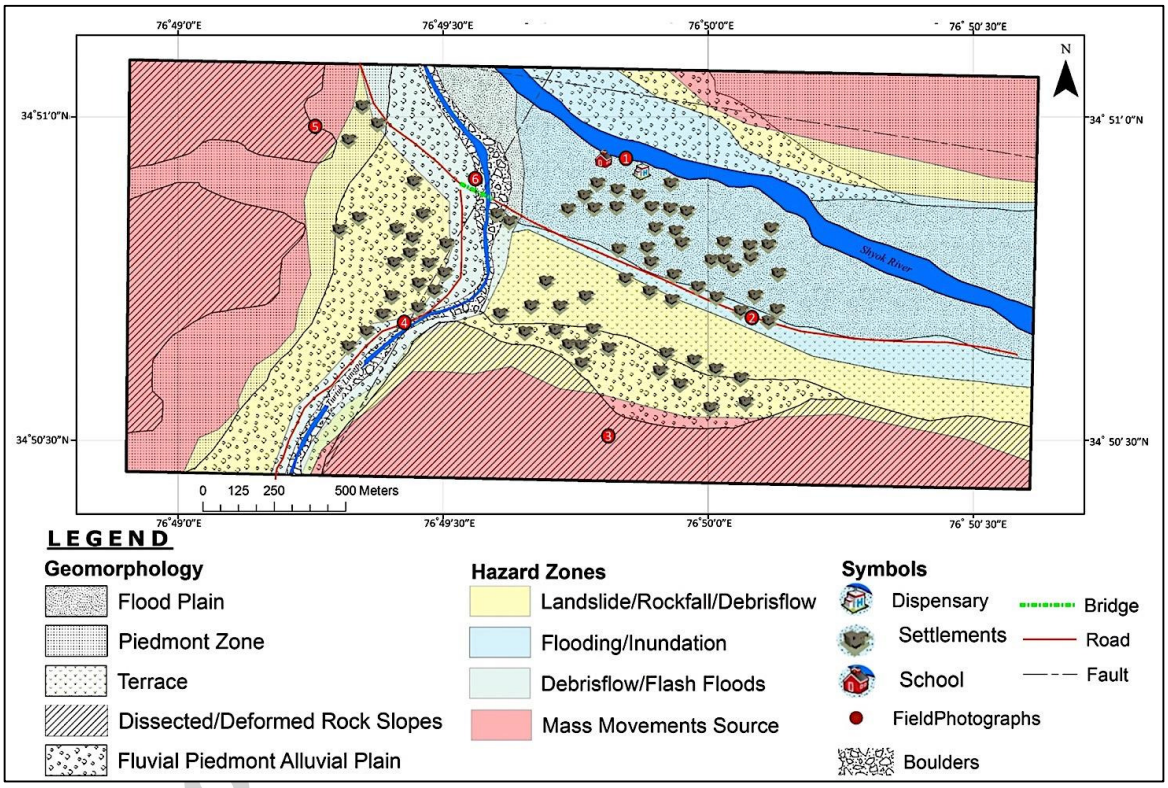


Fig. 5. The geological hazard map of Turtuk.

Flood hazard in Turtuk has been underestimated; here floods (resulting from cloudbursts and rapid glacial melt) can be very severe and powerful, exhibiting unpredictable flow paths and high velocities. These floods may cause considerable erosion in some areas while depositing large amounts of sediment and debris in others. This entire area is covered with intensely fractured and deformed brittle rocks, and very loose eroded material that is highly susceptible to downslope movement and debris flow. The Shyok River flood-plain covered with recent accumulation of sediments has been demarcated as highly prone to flooding. The south-eastern zone covered by dissected, deformed and fractured rock slopes is categorized as highly vulnerable to mass movements. Most of the households are located in these two zones and are highly vulnerable to above-mentioned hazards. Settlements on the western side of the 'Turtuk Lungpa' are identified as highly susceptible to flooding, debris flow and flash flooding (Fig. 5). In Turtuk, a detailed hazard analysis and mapping is required for micro-zonation of hazards to delineate the safer zones.

4.2. Results from the community-based forensic workshop

4.2.1. Findings from the historical timelines

Past events in Turtuk were traced back to Kumdan glacial lake outburst floods (GLOFs) in 1926, 1929 and the 1930's somewhere between 1935 and 1938. Respondents were unsure of the exact date but the Kumdan flood was well known, especially to the older people. According to some respondents, some foreigners intervened to break the blockage and drain some of the water. Kumdan Lake, situated in Tibet, caused widespread damage at that time and impacted the whole Nubra valley from Khardong village to Turtuk and beyond in Abotabad (now in Pakistan). According to some older people, the Kumdan outburst was the second one and that another GLOF had occurred earlier, but they did not have any knowledge about that event. In 2010, floods/cloudbursts damaged many agricultural fields especially in the valley where they graze livestock or grow crops. In that cloudburst a local man and 22 Indian Army soldiers were killed. At that time the community received assistance from the Army but blockage of roads from Leh to Turtuk meant that the government could not help. At that time both men and women of Turtuk and Tyakshi helped to rescue affected people. Being situated on the LOC between India and Pakistan, people of Turtuk, Thang and Tyakshi feel that their lives are at risk.

With the increase in environmental disasters in Ladakh and especially in Nubra valley potential losses from these disasters include agriculture, damage to access roads, communications, water supply, livestock and damage to infrastructure like homes, hospitals, schools and government offices. In 2009, the Indian government has opened this area for tourism, since then it has become a major tourist attraction in Ladakh. The influx of tourists has created income opportunities for the villagers and they are converting homesteads to guesthouses. The new settlements/hotels/resorts are being constructed in hazardous areas due to lack of safer places in Turtuk.

4.2.2. Findings from the hazard and dream mapping

The workshop participants expressed that they are concerned of floods, cloudbursts and landslides (Figures 6-10). They were aware that the settlements below the mountains in the *Kharmang* area are landslide prone and that those who were settled near the *Shyok* River and stream are prone to flood. The area near the school and primary health centre are locally known as '*Chu-thang'* which means 'the water area'. These are at high risk of flooding from Shyok River because they are situated beside the riverbed. A stream divides Turtuk village into two parts named *Yul* and *Farol* and a wooden bridge connects them. This Turtuk stream is one of fastest flowing streams in Ladakh, so *Rantakchan* area has a high risk of floods. The dream maps of all the groups said that they need embankments to prevent flooding of the stream and the Shyok River.

A summary of the hazards discussed, community awareness of vulnerabilities to the hazards, proposed risk mitigation strategies and other developmental changes proposed by each group is provided in Table 1 (for more details please see appendix, Tables A.1-A.4). Each of the four stakeholder groups of community men, community women, political leaders, and administrative officials identified similar kinds of hazards and mitigation strategies. All four groups identified cloudburst / flash flood, large-scale flooding of the Shyok river, rock fall and landslide hazards and all suggested building of levees or embankments, upgrading of health facilities and road building as risk mitigation strategies. Other hazards included earthquakes (though there had been no large earthquake in living

memory) identified by all except political leaders, and war (men and officials). Other important risk mitigation strategies mentioned by all groups except political leaders included building fences or walls to prevent falling boulders from destroying settlements and orchards, and improved mobile phone communications (towers/ 4G connectivity). Community men and women both identified improving bridges so that they are higher above the rivers, community men suggested stabilising slopes with cement, and building disaster-resistant buildings and improving government policy for peace-building with Pakistan. Community members felt that communication problems increased their vulnerability. The mobile network is severely restricted with no Internet connection, and phone calls to relatives in Pakistan are prohibited (though incoming calls from Pakistan are permitted). Non-structural mitigation measures included peace talk with Pakistan, drawing tourists for economic benefit, shift in agricultural practice, creating a DRR taskforce, preparing risk sensitive plans, sustainable tourism activities, and undertaking awareness programs on disaster management and climate change adaptation.

The administrative officials and the community women showed more awareness of vulnerabilities than the political leaders and older community men. All mentioned the risky positioning of buildings along the riverbed flood zone and/ or in the path of falling boulders. Climate change and the influence of increased rainfall was mentioned by political leaders and women, whilst only the administrative leaders mentioned poorly constructed buildings and building on previously agricultural land as increasing vulnerability.

During dream mapping common visions across all the four groups for developing the community included upgrading educational facilities (particularly to make a college of higher education), constructing new roads and making new recreational facilities such as sports arena, horse polo and ice hockey grounds and picnic areas. This was also associated with development of tourism including building of guesthouses and car parking area and developing trekking routes. People are concerned about transportation, communication, medical facilities, education, unemployment and development of tourism in the region. Generally, the administrative officials had a longer list of potential changes than others including intensifying agriculture, developing a waste-management system, reducing corruption, building animal husbandry clinics and creating a state disaster response force. In contrast, political leaders mentioned building of a helipad, making an emergency shelter and establishing a sub-district magistrate office.

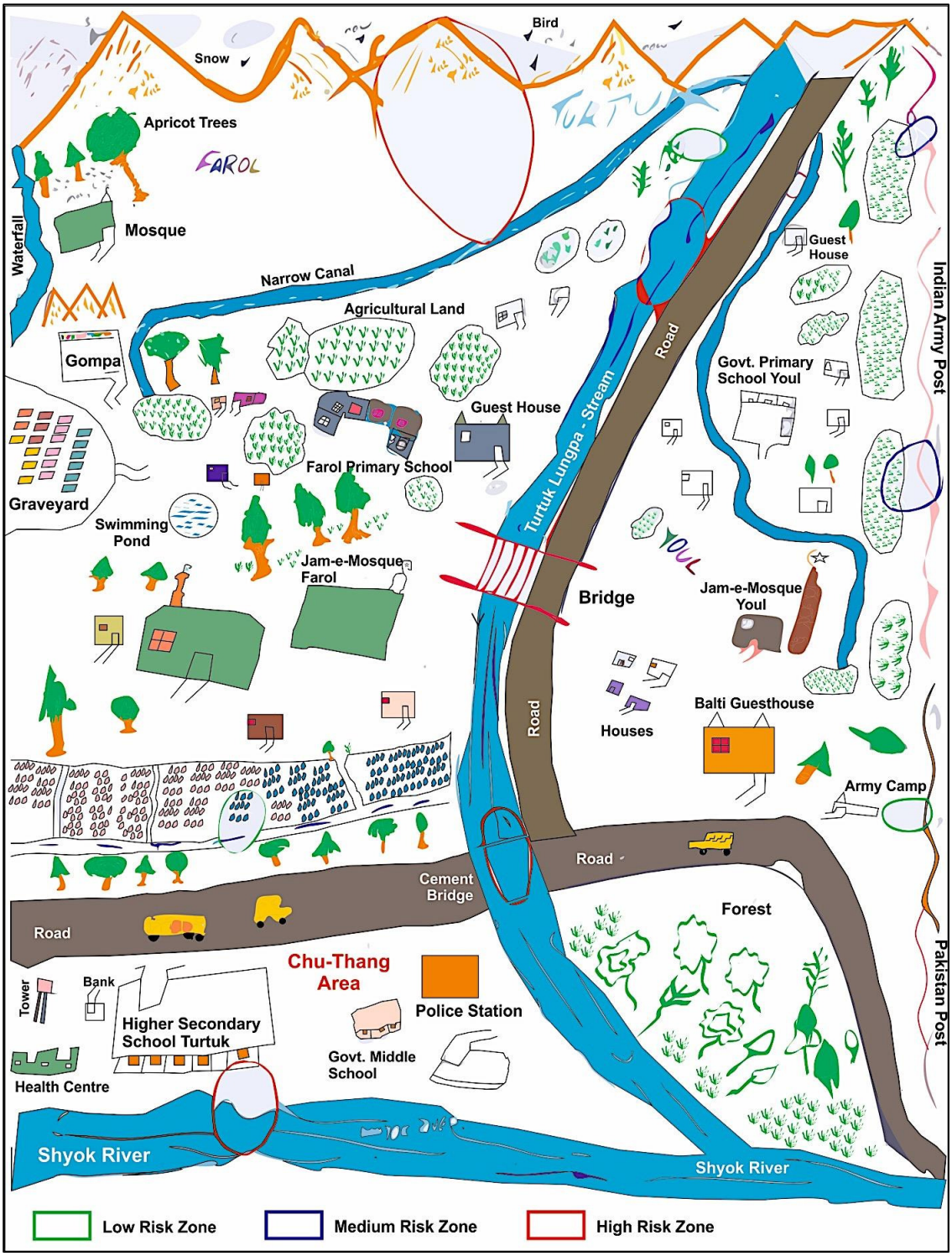


Fig.6. PRA hazard map (not to scale) prepared by the local women group. Source: Community people – Turtuk, fieldwork, July 2017.

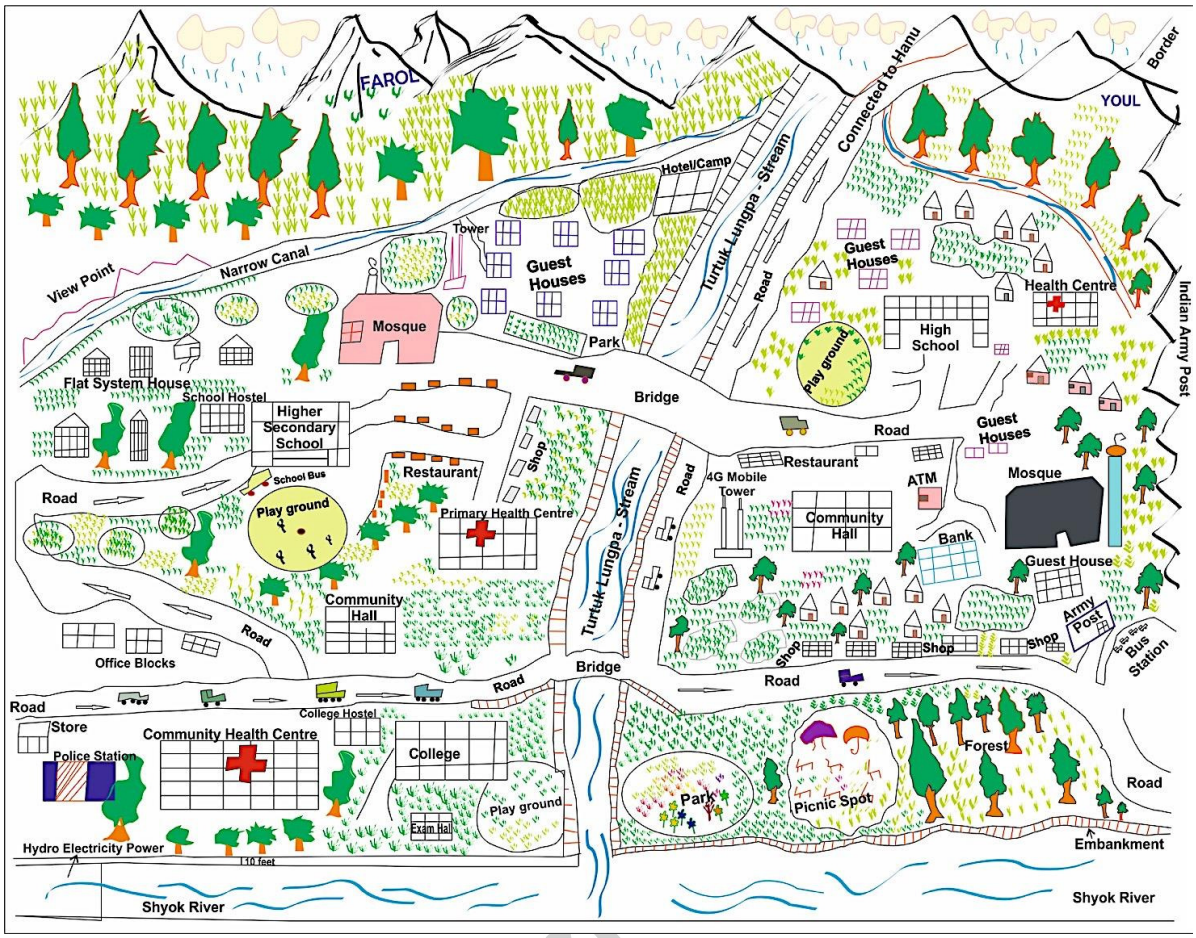


Fig. 7. PRA dream map (not to scale) prepared by the local women group. Source: Community people – Turtuk, fieldwork, July 2017.

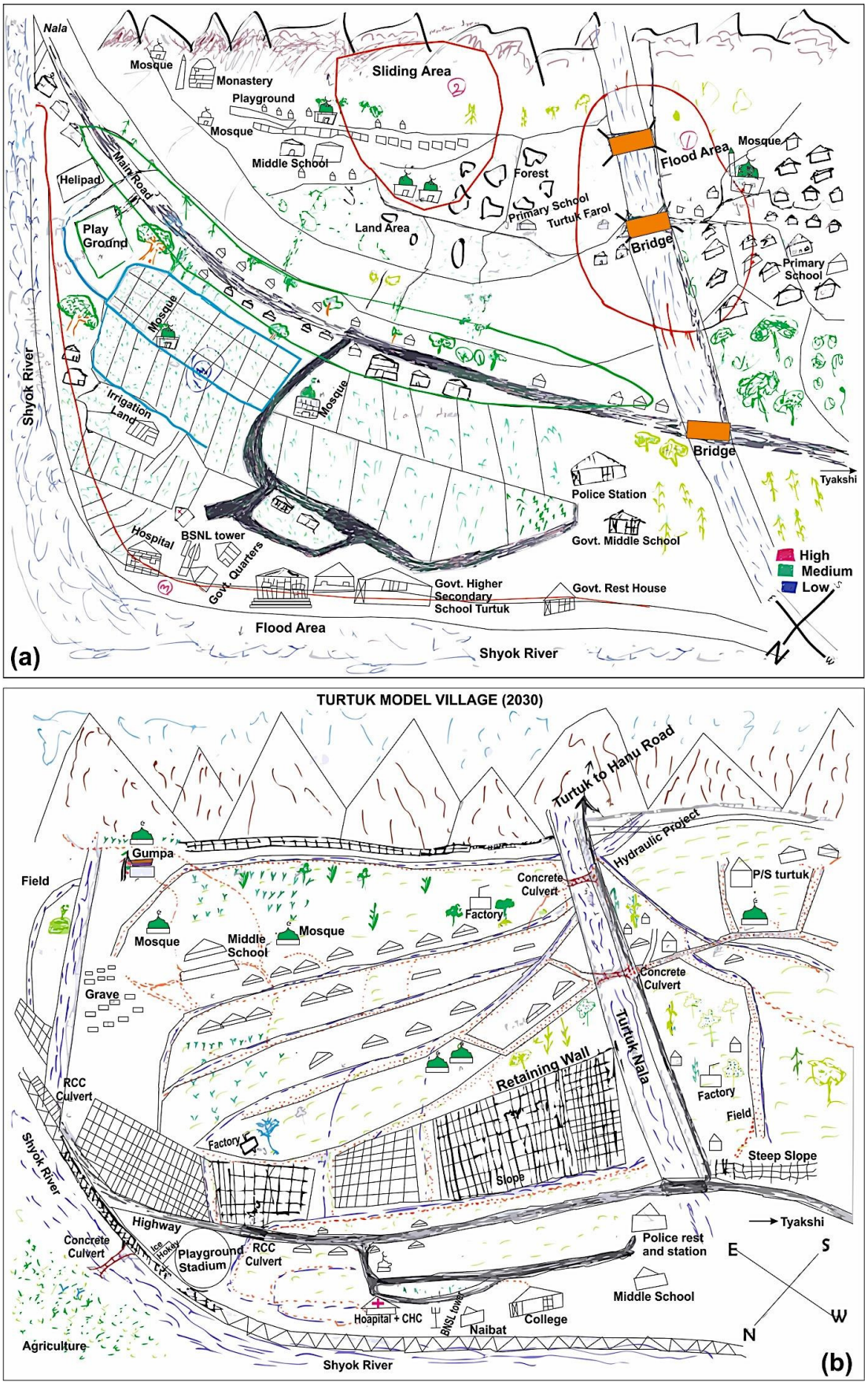


Fig. 8. PRA **(a)** hazard and **(b)** dream map (not to scale) prepared by the local men group. Source: Community people – Turtuk, fieldwork, July 2017.

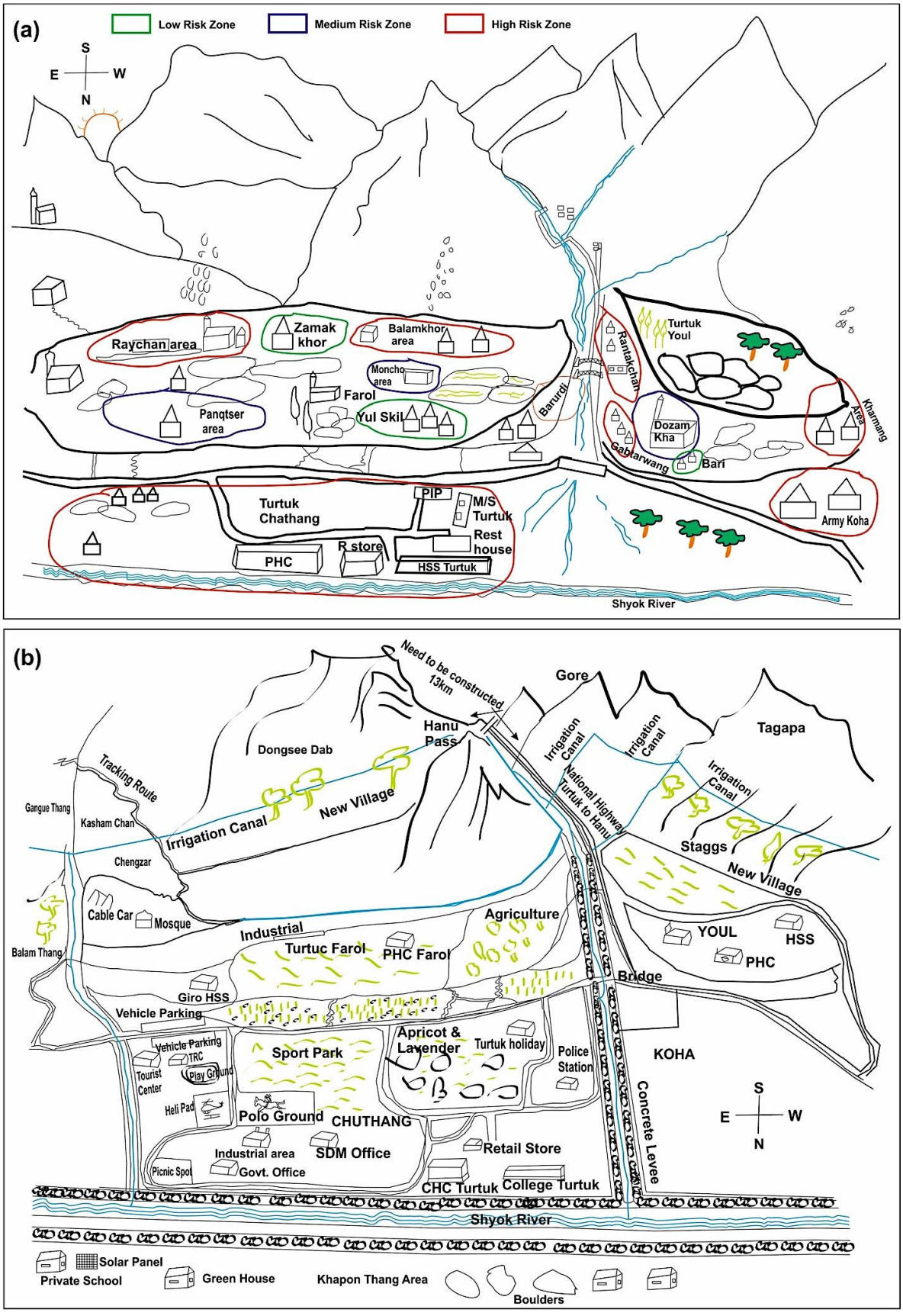


Fig. 9. PRA **(a)** hazard and **(b)** dream map (not to scale) prepared by the political leaders group. Source: Community people – Turtuk, July 2017.

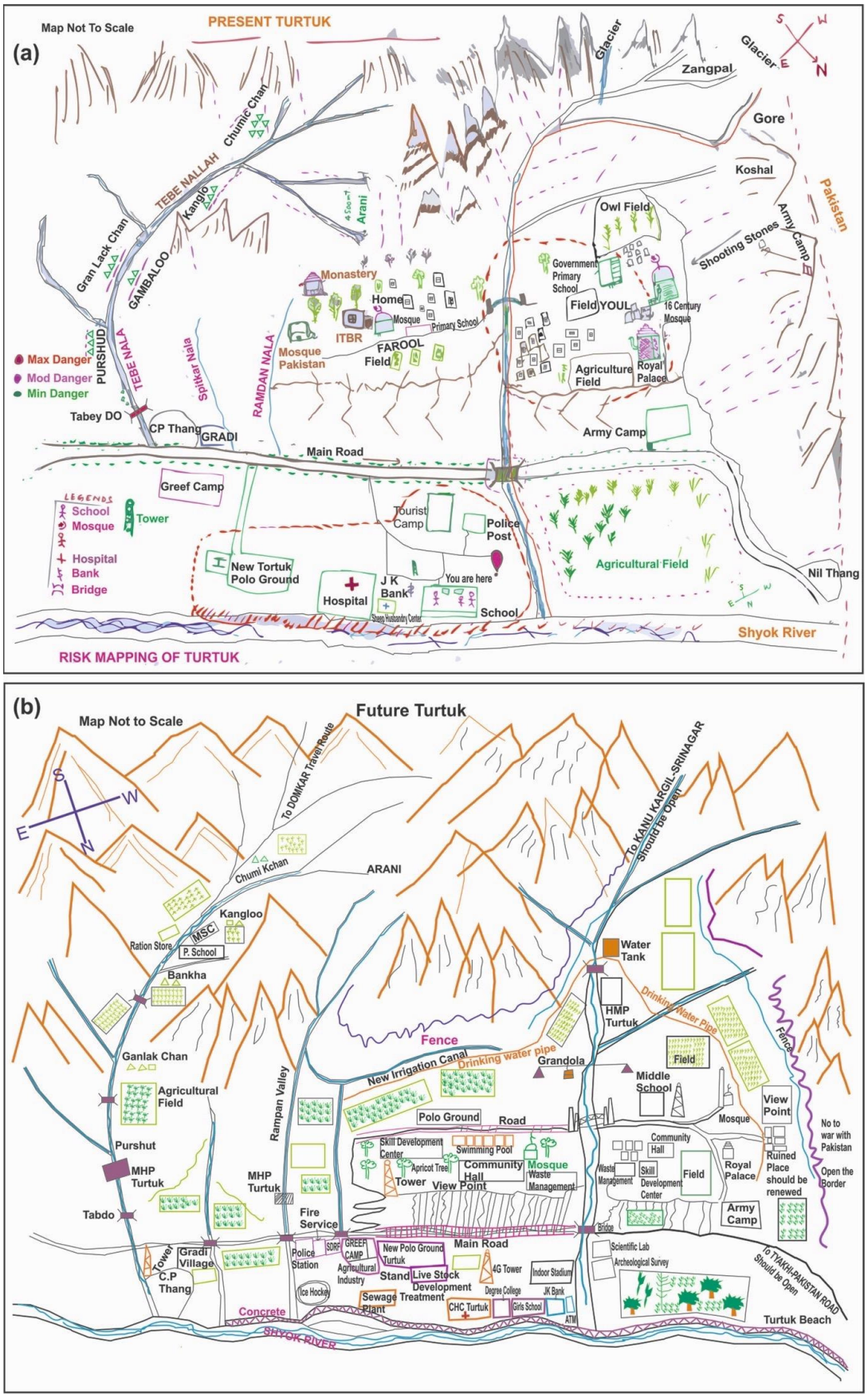


Fig. 10. PRA **(a)** hazard and **(b)** dream map (not to scale) prepared by the administrative officials group. Source: Community people – Turtuk, July 2017.

Table 1. Summary of hazards, vulnerabilities and risk mitigation strategies obtained from the forensic workshop.

Hazard and dream mapping	Community men	Political leaders	Administrative officials	Community women / girls	Score
Type of hazard outlined					
Cloudburst / Flash floods	1	1	1	1	**4**
Shyok river flooding	1	1	1	1	**4**
Rock falls	1	1	1	1	**4**
Landslides	1	1	1	1	**4**
Earthquake	1		1	1	**3**
Pests destroying agricultural production (apricots)	1	1		1	**3**
War /Invasion from Pakistan	1		1		**2**
Tourism			1		**1**
Animal disease			1		**1**
High winds / storms	1				**1**
Vulnerabilities that community was aware about					
Buildings positioned in risky locations (river bed, rock fall or landslide prone areas)	1	1	1	1	**4**
Bridges / road to low over river			1	1	**2**
Climate change - increased rainfall		1		1	**2**
Conversion of fields into built areas			1		**1**
Poorly constructed buildings			1		**1**
Climate change - increased temperatures				1	**1**
Type of risk mitigation strategy proposed					
Embankments / levee for river / stream	1	1	1	1	**4**
Upgrading health facilities	1	1	1	1	**4**
Building access roads (to Hanu or Farol)	1	1	1	1	**4**
Fence or wall to stop falling boulders	1		1	1	**3**
Better communication/ network (towers/ 4G)	1		1	1	**3**
Moving buildings to safer location (especially critical infrastructure)			1	1	**2**
Building bridges higher above the stream	1			1	**2**
Slope stabilisation with cement grouting	1				**1**
Build disaster-resilient engineered concrete buildings	1				**1**
Tree planting				1	**1**
Build animal husbandry clinics			1		**1**
Create a State Disaster Response Force post in town			1		**1**
Making a helipad for emergency assistance		1			**1**
Building an emergency shelter		1			**1**
Others changes					
Build sports / recreation infrastructure / art and culture centre / picnic areas	1	1	1	1	**4**
Upgrade education opportunities (higher education)	1	1	1	1	**4**
Develop tourism (guest houses/ trekking routes/ car parking)		1	1	1	**3**
Power plants / Hydropower			1	1	**2**

Hazard and dream mapping	Community men	Political leaders	Administrative officials	Community women / girls	Score
Create an industrial area	1	1			**2**
Intensify / improve agriculture		1	1		**2**
Develop waste management			1		**1**
Less corruption			1		**1**
Build multi-storey houses (with flats)				1	**1**
More shops				1	**1**
Sub-District Magistrate office		1			**1**
Government policy for peace building with Pakistan	1				**1**
Paved footpaths	1				**1**

Source: Community people – Turtuk, fieldwork, July 2017.

4.4. Triangulation of the results

It was noticeable that the community awareness of hazards and their PRA maps overlapped quite precisely with those identified using geological mapping. What appears to differ between geologists' / disaster risk reduction (DRR) specialists' and community members' perspectives is awareness of vulnerabilities and choice of risk mitigation strategy. For example, where DRR specialists may have proposed shifting important infrastructure (health facility, secondary and middle school and police station) away from the flood plain, community members gave this less importance. Similarly, DRR specialists would have focused more on disaster-resilient building than the community proposed. The community's focus and apparent trust in the building of concrete levees to contain flooding seemed to be based on very little evidence of the effectiveness of this method to contain flash floods and major flooding events of the large Shyok River. However, the community's prioritisation of road and mobile phone communication and development of health system infrastructure is in line with the kind of strategies that might be proposed by a DRR specialist.

5. Discussion

The Turtuk mountain community is found highly aware of their surrounding disaster risks regardless of differences in age, sex, education, occupation, religion, ethnicity, and family status. This is because the villagers witnessed catastrophic events, especially floods and landslides/rock falls, and major conflicts (in 1971 and 1999) in their lifetime. The results contradict with the work of Azhar-Hewitt and Hewitt (2012) who found that the local women are more vulnerable to disasters in the other side of the LOC. Another misconception exists, i.e. certain culture or indigenous knowledge can be a significant factor in creating higher levels of vulnerability for a particular community. For example, after the Indian Ocean tsunami in 2004 a group of people in Aceh province in Indonesia argued that the disaster was a punishment from God (Paul and Nadiruzzaman, 2013). No such contradictions between culture, traditional knowledge and disaster risk perception was observed in this study. All the groups managed to depict the major historical disaster events and existing hazardous zones in PRA activities. In most cases, the groups prioritized similar strategies to mitigate the disaster risks, except some minor differences. The women only group emphasized on better communication facilities by proposing a direct road through Tyakshi to connect Pakistan and another road in the northeast to

Hanu, and more green spaces, parks, play grounds, shops, apartment blocks and guest houses to attract tourists (Table A.3). The men only group focused on sports facilities, specific zone for agriculture and better mobile networks (Table A.4). The administrative group, comprised of both men and women, proposed to build bunkers to protect themselves from potential wars, to open the nearest border with Pakistan so that it would increase economic growth, reduce corruption in infrastructure development, and create a specialist disaster response team (Table A.2). The political group (unfortunately no woman member was present) highlighted to build a helipad for tacking emergency crisis, an advanced recreational and industrial hub, produce apricot and lavender plantation, and college for higher education (Table A.1) etc. To be specific, all the groups were found to be knowledgeable about the potential hazards within their community and proposed a number of structural and non-structural mitigation measures to tackle them.

Long-lasting war in the border region is having huge implications in the community. Most families in Turtuk have close family members in the other side of the LOC. Nevertheless, they are not permitted to cross the nearest border point, which is only kilometres away. They are forced to take long routes, travel for several days in the other way around and need special permissions to visit their relatives in Pakistan. Even they have specialized and controlled mobile and internet services in Turtuk that hinder the villagers to communicate frequently. It is also difficult to enter Turtuk, as foreigners and tourists require special permissions and need to cross-multiple Army check posts from Leh to Turtuk due to security reasons. The village gets isolated during the snowy winter season. Any environmental disaster occurring during that time period has the potential to impact the community in a catastrophic scale, whereas a conflict or war at the same time can worsen the scenario. Communities in border conflict areas always deal with intensified vulnerabilities, in compared to non-conflict zones. For example, the villagers in Turtuk face restrictions on free-movement, communications, accessibility to modern technology and basic facilities and services. Whereas the earthquake vulnerable communities in Nepal give more importance on social cohesion, relationships, gender inclusiveness in risk governance, neighbourhood, violence against women and girls, and festivals for sustainable disaster recovery (Standing et al., 2017; Thapa and Pathranarakul, 2018; Aryal et al., 2019).

Turtuk is now considered as a major tourist destination in India for its natural beauty and incredible journey through the Nubra Valley. The village was not open to outsiders or tourists until 2009. Before that, the villagers' primary occupation was agriculture and some local men used to work for the Army to carry goods using donkeys. Now, apart from agriculture, they are focused on providing tourism services. Local men mostly drive SUVs from Leh to Turtuk to transport the tourists and work as tourist guides. Women are involved in maintaining the guest houses. People are converting their homesteads to guest houses, and some are under construction in hazard-prone areas. The expansion of tourism could be considered as a new threat for the villagers, but in this case, activities related to livelihood and economic opportunities are getting more importance. One reason might be, during winter they heavily rely on food and savings from summer. There is also growing threats of damage to crops (Table A.4) due to climate change and insect attacks (Table A.3) or shift in agricultural practice (Table A.1). Consequently, dependence on summer tourism activities is becoming trendy in Turtuk. It supplements the findings of Wachinger and Renn (2010) who argued that disaster mitigation measures are not always associated with local people's high perception of risk. Similar findings were verified by Le Messon (2013) in the touristic Leh city where people started rebuilding houses in the same disaster-hit spot after the 2010 Ladakh floods. In La Paz, Bolivia (Cannon, 2014) and in Chittagong, Bangladesh (Ahmed, 2017) hundreds of thousand low-income people live on

dangerous hill-slopes which are at risk of landslides and mudslides. In these contexts, people believe that moving to a safer place is less beneficial than the loss of their livelihoods over the longer term (Cannon, 2014).

Findings from group presentations suggest that training in construction of disaster resilient buildings and safe site selection is needed for local engineers and contractors. Where possible construction should be undertaken with advice from geologists and engineers. Use of cement or iron sheet roofing would protect from heavy rainfall or snow and structures with appropriate reinforced concrete tie beams and pillars would be less likely to fail during floods, landslides and earthquakes. Retrofitting of existing building structures for disaster resilience needs to be initiated. Disaster resilient public buildings need to be built in safe areas to keep essential tools and rations for emergencies and provide shelter for vulnerable members of society like the elderly, pregnant and lactating women and children. A road from Turtuk to Hanu is needed to help connect Turtuk and provide support during emergencies. There is a need for emergency supplies of medicines and food.

In a conflict zone such as Turtuk, the interdependence of the Indian Army and local population is deeply embedded for survival. Most, small towns and villages are cut off from the main supply routes for up to six months in a year. Even during normal winter season, the Army provides all emergency care to local population and it is the same Army which shows up first in any disaster incident. The Army is well equipped and prepared for handling emergencies that can never be matched by the civilian authorities both financially or logistically. Whether it is jobs, medical, food supplies, school education for young children or the medical emergencies, it is the Indian Army which remains at the forefront.

The Indian Government's policy on compensation for disasters needs reviewing, as people are dissatisfied with current levels. Local people must be trained in rescue and relief work. The religious leaders can also be instrumental because most of the people in Turtuk are religious. They perform many rituals (Muslims and Buddhist) for protection from environmental disasters and people have faith in them. People can also use their indigenous knowledge or traditional methods along with modern equipment to enhance DRR (one example is shown in Fig. A.3). The need of the hour is to prepare a risk sensitive land use plan for the Turtuk village to control the spontaneous growth and tackle the impacts of tourism and global climate change.

Future research should cover other mountain communities on the other side of the LOC, building on the work of Azhar-Hewitt and Hewitt (2012). Findings from such research would be useful for development of an integrated disaster and conflict resilient master plan for the HKH region and could contribute to achieving the UN Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction.

6. Conclusion

Indigenous mountain communities in the Hindu-Kush Himalaya (HKH) region suffer frequent disasters and economic/political marginalisation, especially in border conflict zones. This paper aimed to understand community perception of risk and vulnerability to environmental hazards in a remote border conflict zone in Ladakh.

Turtuk lies beside the Shyok River and near the LOC between India and Pakistan. The case study area is frequently affected by flooding, rock falls, landslides, border conflict and has high earthquake risk. India took control of Turtuk from Pakistan in 1971. Restricted movement across the LOC further isolates the community. This work is entirely relying on

primary data following a deductive research method. Using participatory rural appraisal (PRA) tools, community stakeholder groups of local men, women and girls, administrative officials and political/ religious leaders drew maps. Hazard maps depicted location of settlements, fields/ orchards, amenities (schools, health facilities), rivers/ streams and mountains and indicated flood, rock-fall and landslide hazard areas. Dream maps depicted groups' aspirations to decrease vulnerability to hazards and improve their lives. Meanwhile, specialists prepared a geological hazard map by integrating field-based investigations with remote sensing data.

Specialist- and community-produced hazard maps matched in location of high-risk areas for flood, landslide and rock-fall and potential for damage to settlements, infrastructure (schools, health facility, government offices, roads and bridges) and agriculture, though community awareness of risk from earthquakes and poor-quality construction was low. Community members were aware that the positioning of important government facilities on the flood-prone river plain, poorly constructed bridges close to the water, and climate change (especially increased rainfall and pests/ diseases) increased their vulnerability. However, belief in the effectiveness of proposed mitigation strategies such as concrete levees for flood control and fences for prevention of rock fall damage probably surpassed their capacity to prevent damage. Lack of availability of flat, lower-risk land for building, resource limitation and lack of awareness of locally appropriate low-cost options prevent implementation of disaster risk mitigation.

A disaster preparedness plan is needed which should cover: monitoring hazards and climate change, shifting emergency infrastructure (hospital, school, police station) to lower risk areas, and training engineers and masons in- and implementation of- appropriate regulations on disaster resilient building. It should also include awareness-raising on appropriate low-cost community DRR strategies, sustainable tourism development, search and rescue training, road building and improved phone/internet connections, initiate peace talks to resolve border conflicts, and building of levees, slope stabilisation and protective barriers to rock-fall where appropriate and feasible.

At the local scale, this research demonstrates how a particular community deals with extreme hazards and conflicts in a mountainous environment. At the national scale, it promotes awareness of the value of risk perception studies by incorporating participatory maps into the gazetted land-use master plans, and traditional cultural knowledge in DRR initiatives. At the regional scale, this work provides an understanding of the root causes of disaster vulnerability and the characteristics required by a community to tackle them. Scrutinizing various components of environmental disasters applying the proposed method represents an advancement and original contribution to existing body of knowledge in DRR field. Explicitly, this paper fills gaps linked to risk communication solutions between the indigenous mountain people and decision makers, cultures and disasters, and tackling catastrophe in fragile and conflict-affected contexts.

Acknowledgements

The Natural Environment Research Council (NERC), the Arts & Humanities Research Council (AHRC) and the Economic & Social Research Council (ESRC), have funded this work (NERC Reference: NE/P016138/1). We are indebted to the villagers in Turtuk, India for their active participation in the Forensic Workshop and for sharing their ideas with us. We are also grateful to the Local Civil Administration (Ladakh Hill Development Council, Leh) and the Indian Army to permit us to work in a conflict zone near the line of control – without their assistance this work was not possible.

References

1. Ahmed, B. (2015). Landslide susceptibility modelling applying user-defined weighting and data-driven statistical techniques in Cox's Bazar Municipality, Bangladesh. *Natural Hazards*, 79(3), 1707-1737.
2. Ahmed, B. (2017). Community vulnerability to landslides in Bangladesh. PhD Thesis. University College London (UCL), UK.
3. Ahmed, B., and Kelman, I. (2018). Measuring community vulnerability to environmental hazards: a method for combining quantitative and qualitative data. *Natural Hazards Review*, 19(3), 04018008.
4. Ahmed, B.; Orcutt, M.; Sammonds, P.; Burns, R.; Issa, R.; Abubakar, I.; Devakumar, D. (2018). Humanitarian disaster for Rohingya refugees: impending natural hazards and worsening public health crises. *The Lancet Global Health*, 6(5), e487–e488.
5. Ainuddin, S., Routray, J. K., and Ainuddin, S. (2014). People's risk perception in earthquake prone Quetta city of Baluchistan. *International Journal of Disaster Risk Reduction*, 7, 165-175.
6. Alexander, D. (2000). Confronting catastrophe: New perspectives on natural disasters. Terra Publishing, England.
7. Antronico, L., Coscarelli, R., De Pascale, F., and Muto, F. (2017). Geo-hydrological risk perception: A case study in Calabria (Southern Italy). *International Journal of Disaster Risk Reduction*, 25, 301-311.
8. Ardaya, A. B., Evers, M., and Ribbe, L. (2017). What influences disaster risk perception? Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil. *International Journal of Disaster Risk Reduction*, 25, 227-237.
9. Aryal, A., Wilkinson, S., Chang-Richards, A. (2019) Community Participation to Build Back Better: Evidence from the 2015 Nepal Earthquakes. In: Asgary A. (eds) Resettlement Challenges for Displaced Populations and Refugees (pp. 175-183). Sustainable Development Goals Series. Springer, Cham.
10. Azhar-Hewitt, F., & Hewitt, K. (2012). Chapter 4 Technocratic Approaches and Community Contexts: Viewpoints of Those Most at Risk from Environmental Disasters in Mountain Areas, Northern Pakistan. In Climate Change Modeling For Local Adaptation In The Hindu Kush-Himalayan Region (pp. 53-73), (Eds.) Lamadrid, A. and Kelman, I. Emerald Group Publishing Limited.
11. Bamzai, P.N.K. (1994). Culture and political history of Kashmir. M D Publications Pvt Ltd, New Delhi, India.
12. Bjønness, I. M. (1986). Mountain hazard perception and risk-avoiding strategies among the Sherpas of Khumbu Himal, Nepal. *Mountain Research and Development*, 6(4), 277-292.
13. Bryman, A. (2016). Social Research Methods. Oxford University Press, Oxford, UK.
14. Cannon, T. (2014). Chapter 3: Taking livelihoods seriously. In World Disasters Report 2014: Focus on culture and risk (pp. 64-91). International Federation of Red Cross and Red Crescent Societies (IFRC), Geneva, Switzerland.
15. Cannon, T. (2015). Chapter 5: Disasters, climate change and the significance of 'culture'. In Krüger, F., Bankoff, G., Cannon, T., Orlowski, B. and Schipper, E.L.F. (Eds.), Cultures and disasters: understanding cultural framings in disaster risk reduction (pp. 88-106). Routledge, UK.
16. Census of India. (2011). District Census Handbook–Leh (Series-02, Part XII-A). Directorate of Census Operations, Jammu and Kashmir. http://censusindia.gov.in/2011census/dchb/DCHB_A/01/0103_PART_A_DCHB_LEH.pdf (accessed on 28 December 2018).

17. Chambers, R. (1994). The origins and practice of participatory rural appraisal. *World Development*, 22(7), 953-969.
18. Chevuturi, A., Dimri, A.P., and Thayyen, R.J. (2018). Climate change over Leh (Ladakh), India. *Theoretical and Applied Climatology*, 131(1-2), 531-545.
19. Cronin, S. J., Gaylord, D. R., Charley, D., Alloway, B. V., Wallez, S., & Esau, J. W. (2004). Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu. *Bulletin of Volcanology*, 66(7), 652-668.
20. Dasgupta, S. (2015). Kashmir and the India-Pakistan composite dialogue process. RSIS working paper no: 291. S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University, Singapore. https://www.rsis.edu.sg/wp-content/uploads/2015/05/WP291.pdf (accessed on 28 December 2017).
21. Dortch, J. M., Owen, L. A., Haneberg, W. C., Caffee, M. W., Dietsch, C., & Kamp, U. (2009). Nature and timing of large landslides in the Himalaya and Transhimalaya of northern India. *Quaternary Science Reviews*, 28(11-12), 1037-1054.
22. EEFIT. (2008). Kashmir Pakistan Earthquake of 8 October 2005: A field report by EEFIT. Earthquake Engineering Field Investigation Team (EEFIT), Institution of Structural Engineers, London, UK.
23. Gaillard, J. C. (2008). Alternative paradigms of volcanic risk perception: the case of Mt. Pinatubo in the Philippines. *Journal of Volcanology and Geothermal Research*, 172(3-4), 315-328.
24. Gaillard, J. C. (2015). Does Risk Perception Really Matter?. In People's Response to Disasters in the Philippines (pp. 39-55). Palgrave Macmillan, New York.
25. Ganguly, S. (1990). Avoiding War in Kashmir. *Foreign Affairs*, 69(5), 57-73.
26. Ganguly, S. (1995). Wars without End: The Indo-Pakistani Conflict. *The Annals of the American Academy of Political and Social Science*, 541, 167-178.
27. Gautam, M.R., Timilsina, G.R., and Acharya, K. (2013). Climate Change in the Himalayas: Current State of Knowledge. Policy Research Working Paper; No. 6516. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/15875 (accessed 19.12.2017).
28. Gioli, G., Khan, T., & Scheffran, J. (2014). Climatic and environmental change in the Karakoram: making sense of community perceptions and adaptation strategies. *Regional Environmental Change*, 14(3), 1151-1162.
29. Harries, T. (2008). Feeling secure or being secure? Why it can seem better not to protect yourself against a natural hazard. *Health, risk & society*, 10(5), 479-490.
30. Hewitt, K. (1992). Mountain hazards. *GeoJournal*, 27(1), 47-60.
31. Hoffmann, S.A. (2006). Rethinking the Linkage between Tibet and the China-India Border Conflict: A Realist Approach. *Journal of Cold War Studies*, 8(3), 165-194.
32. ICIMOD. (2017). Hindu Kush Himalayan Region. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal. http://www.icimod.org/?q=1137 (accessed 19 December 2017).
33. IDMC. (2018). Global Report on Internal Displacement 2018. Internal Displacement Monitoring Centre (IDMC), Geneva, Switzerland.
34. Jamshed, A., Rana, I. A., Birkmann, J., & Nadeem, O. (2017). Changes in Vulnerability and Response Capacities of Rural Communities After Extreme Events: Case of Major Floods of 2010 and 2014 in Pakistan. *Journal of Extreme Events*, 4(03), 1750013.
35. Kelman, I., Field, J., Suri, K., & Bhat, G. M. (2018). Disaster diplomacy in Jammu and Kashmir. *International Journal of Disaster Risk Reduction*, 31, 1132-1140.
36. Kelman, I., Gaillard, J.C., and Mercer, J. (2015). Climate change's role in disaster risk reduction's future: Beyond vulnerability and resilience. *International Journal of Disaster Risk Science*, 6(1), 21-27.

37. Kumar, S. (2002). Methods for Community Participation: A Complete Guide for Practitioners. Vistaar Publications, New Delhi, India.
38. Le Masson, V. (2013). Exploring disaster risk reduction and climate change adaptation from a gender perspective: Insights from Ladakh, India. PhD Thesis, Brunel University.
39. Le Masson, V., & Nair, K. (2012). Chapter 5 Does Climate Modeling Help when Studying Adaptation to Environmental Changes? The Case of Ladakh, India. In Climate change modeling for local adaptation in the Hindu Kush-Himalayan region (pp. 75-94), (Eds.) Lamadrid, A. and Kelman, I. Emerald Group Publishing Limited.
40. Liu, D., Li, Y., Shen, X., Xie, Y., and Zhang, Y. (2018). Flood risk perception of rural households in western mountainous regions of Henan Province, China. *International Journal of Disaster Risk Reduction*, 27, 155-160.
41. Martin, H., Ellis, M., and Delpesh, C. (2016). Risk Perception in a Multi-Hazard Environment: A Case Study of Maraval, Trinidad. *The West Indian Journal of Engineering*, 39(1), 32-43.
42. Michener, V. J. (1998). The participatory approach: contradiction and co-option in Burkina Faso. *World Development*, 26(12), 2105-2118.
43. Paton, D., Smith, L., Daly, M., & Johnston, D. (2008). Risk perception and volcanic hazard mitigation: Individual and social perspectives. *Journal of Volcanology and Geothermal Research*, 172(3-4), 179-188.
44. Paul, B.K. and Nadiruzzaman, M. (2013). Religious interpretations for the causes of the 2004 Indian Ocean tsunami. *Asian Profile*, 41(1), 67-77.
45. Pelling, M. (2007). Learning from others: the scope and challenges for participatory disaster risk assessment. *Disasters*, 31(4), 373-385.
46. Peters, K. (2017). The next frontier for disaster risk reduction: Tackling disasters in fragile and conflict-affected contexts. Overseas Development Institute (ODI), London, UK.
47. Plapp, Plapp, T. and Werner, U. (2006). Understanding Risk Perception from Natural Hazards: Examples from Germany. In: Vullet, A.D., Ed., Risk 21—Coping with Risks due to Natural Hazards in the 21st Century, Taylor and Francis Group, London, 101-107.
48. Plattner, T., Plapp, T., and Hebel, B. (2006). Integrating public risk perception into formal natural hazard risk assessment. *Natural Hazards and Earth System Science*, 6(3), 471-483.
49. Pollock, W., Wartman, J., Abou-Jaoude, G., & Grant, A. (2018). Risk at the Margins: A Natural Hazards Perspective on the Syrian Refugee Crisis in Lebanon. *International Journal of Disaster Risk Reduction*. https://doi.org/10.1016/j.ijdrr.2018.11.026
50. Qasim, S., Khan, A. N., Shrestha, R. P., and Qasim, M. (2015). Risk perception of the people in the flood prone Khyber Pukhthunkhwa province of Pakistan. *International Journal of Disaster Risk Reduction*, 14, 373-378.
51. Quarantelli, E. L. (1998): What is a disaster? Perspectives on the question. London: Routledge.
52. Rana, I. A., & Routray, J. K. (2016). Actual vis-à-vis perceived risk of flood prone urban communities in Pakistan. International Journal of Disaster Risk Reduction, 19, 366-378.
53. Reichel, C., & Frömming, U. U. (2014). Participatory Mapping of Local Disaster Risk Reduction Knowledge: An Example from Switzerland. *International Journal of Disaster Risk Science*, 5(1), 41-54.
54. Rigaud, K.K.; de Sherbinin, A.; Jones, B.; Bergmann, J.; Clement, V.; Ober, K.; Schewe, J.; Adamo, S.; McCusker, B.; Heuser, S.; Midgley, A. (2018). Groundswell: Preparing for Internal Climate Migration. World Bank, Washington, DC.

55. Sharma, E. (2012). Chapter 2 Climate Change and its Impacts in the Hindu Kush-Himalayas: An Introduction. In Climate Change Modeling for Local Adaptation in the Hindu Kush-Himalayan Region (pp. 17-32), (Eds.) Lamadrid, A. and Kelman, I. Emerald Group Publishing Limited.
56. Shaw, R., Uy, N. and Baumwoll, J. (2008). Indigenous knowledge for disaster risk reduction: Good practices and lessons learned from experiences in the Asia-Pacific Region. United Nations International Strategy for Disaster Reduction (UNISDR), Bangkok: Thailand.
57. Siegrist, M., & Gutscher, H. (2006). Flooding risks: A comparison of lay people's perceptions and expert's assessments in Switzerland. *Risk Analysis*, 26(4), 971-979.
58. Singh, B. K. (2014). Flood Hazard Mapping with Participatory GIS: The Case of Gorakhpur. Environment and Urbanization Asia, 5(1), 161-173.
59. Skovdal, M., and Cornish, F. (2015). Qualitative Research for Development. Practical Action Publishing, Rugby, UK.
60. Standing, K., Parker, S., & Bista, S. (2017). 'It's breaking quite big social taboos' violence against women and girls and self-defense training in Nepal. Women's studies international forum, 64, 51-58.
61. Sudmeier-Rieux, K., Jaquet, S., Derron, M.-H., Jaboyedoff, M., & Devkota, S. (2012). A case study of coping strategies and landslides in two villages of Central-Eastern Nepal. Applied Geography, 32(2), 680-690.
62. Thapa, V., & Pathranarakul, P. (2018). Gender inclusiveness in disaster risk governance for sustainable recovery of 2015 Gorkha Earthquake, Nepal. International Journal of Disaster Risk Reduction. https://doi.org/10.1016/j.ijdrr.2018.11.019
63. The Times of India. (2017). J&K: Army Major, 3 soldiers killed in firing by Pakistan. Online News at https://timesofindia.indiatimes.com/india/jk-major-3-soldiers-martyred-in-cross-border-firing-by-pakistan-army/articleshow/62222157.cms (accessed on 28 December 2018).
64. United Nations Development Programme (UNDP). (2000). UNDP and Indigenous Peoples: A Practice Note on Engagement. New York, USA.
65. van Schendel, W. (2009). A History of Bangladesh. Cambridge University Press, Cambridge, UK.
66. van Tuan, V.O. (2014). Vulnerability Assessment of Different Socio-Economic Groups to Floods in the Rural Mekong Delta of Vietnam. Ph.D, Rheinischen Friedrich-Wilhelms-Universität Bonn, Bonn, Germany.
67. Wachinger, G., and Renn, O. (2010). Risk Perception and Natural Hazards. CapHaz-Net WP3 Report, DIALOGIK Non-Profit Institute for Communication and Cooperative Research, Stuttgart, Germany. https://www.researchgate.net/publication/228827276_Risk_perception_of_natural_hazards (accessed on 29 December 2017).
68. Wisner, B., Blaikie, P., Cannon, T., and Davis, I. (2004). At risk: Natural hazards, people's vulnerability and disasters. Oxon: Routledge.
69. Youlin, Y., Jin, L.S., Squires, V., Kyung-soo, K and Hye-min, P. (2011). Combating Desertification & Land Degradation: Proven Practices from Asia and the Pacific. The Korea Forest Service (KFS) and United Nations Convention to Combat Desertification (UNCCD), Daejeon City, Republic of Korea.
70. Zhou, Y., Li, N., Wu, W., Wu, J., & Shi, P. (2014). Local spatial and temporal factors influencing population and societal vulnerability to natural disasters. *Risk Analysis*, 34(4), 614-639.

Appendices

Fig. A.1. Location of Turtuk village in the disputed area of Kashmir. Source: The Library of Congress, Central Intelligence Agency, Washington, USA, 2002. https://www.loc.gov/resource/g7653j.ct000803/ (accessed on 22 December 2017).

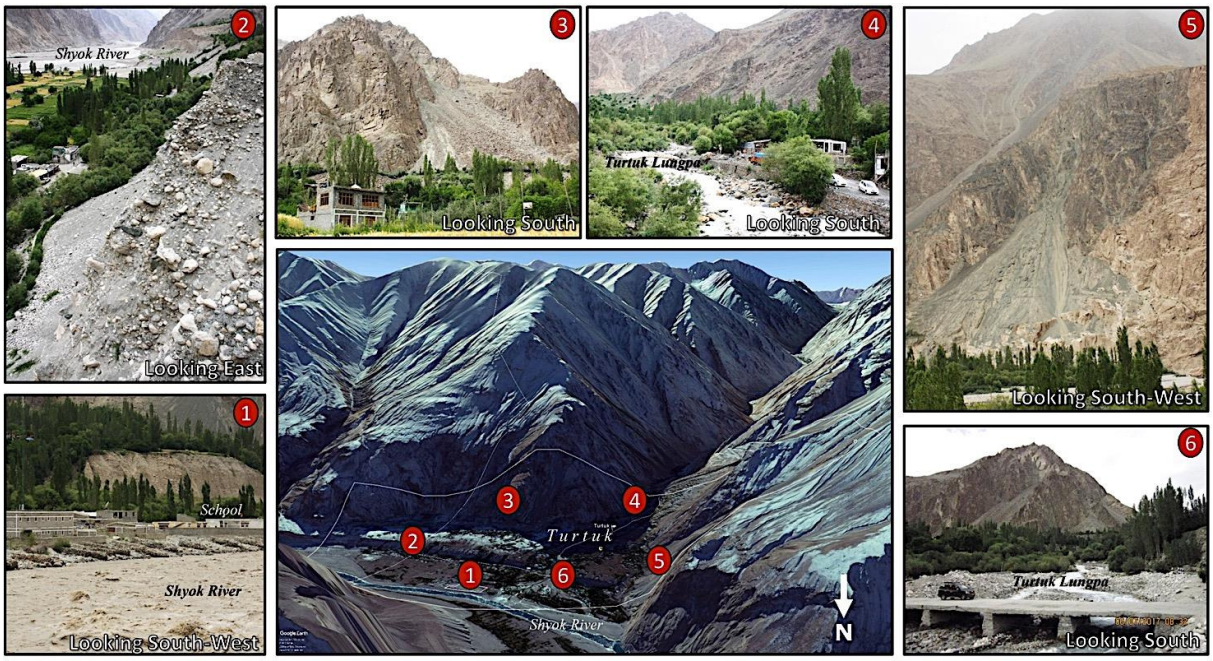


Fig. A.2. An illustration of the multi-hazard context in Turtuk village, India. (1) Flood hazard associated with the Shyok River, (2) landslide, rock-fall and debris flow prone slopes and boulder terraces, (3) rock fall and landslide prone mountain slopes, (4) debris flow and flash floods prone Turtuk Lungpa (Rivulet), (5) rock fall and landslide prone steep rock faces, and (6) flash floods prone area.

Table A.1. Results from the political group's participatory mapping exercises.

Hazard outlined	**Explanation (from timeline, and hazard mapping)**	**Vulnerabilities that community was aware about**	**Risk mitigation suggested (Dream mapping)**	**Other changes requested (not necessarily related to particular hazards)**
Cloudburst / Flash floods			First thing respondents drew on the dream map was a concrete Levee/embankment on Shyok River and on Turtuk stream, which shows its importance.	Construct an Industrial area at *Chu-thang* to use available resources and create employment opportunities for local people. As construction of an industrial area and new buildings will decrease the area under agricultural production, intensify / increase agricultural productivity in upper areas. Apricot and lavender plantation Create two parking areas at the start of village to accommodate extra vehicles with the increase of tourism. Develop a college for further studies for students. For recreation, create a sport park, picnic spot, playgrounds and a polo-ground for horse polo which is popular in Turtuk Bogdang area. Trekking routes from Turtuk to Ramdan, Arani, Teybey valley to Domkhar, to develop tourism. Create Sub-District-Magistrate (SDM) office at Chu-thang area to enable official works to be accessible in the community.
Shyok river flooding	Whole *Chu-thang* area is vulnerable to the flood from the Shyok River. Earlier there was no settlement at *Chu-thang*. Chu-thang itself means water area. Chu means water and thang is land.		Built an emergency shelter above the police station and near apricot plantation. Build an alternative road from Turtuk to *Hanu* as national highway (90 km only) for use during emergencies. Build a vehicular road to *Farol* area, from the main road near parking area. Upgrade the health centres at three areas Yul, Farol and Chu-thang. Make a helipad at Chuthang so that medicine and other essentials can be brought in by air during disasters or other emergencies when roads are blocked due to disasters or extreme climatic conditions.	
Rock falls	Due to rock fall many trees (in the apricot plantation) got damaged			
Landslides	Settlements at Farol and Yul are prone to landslides which damage some houses and trees			
Pests	Insects destroyed apricot trees /	Climate change		

Hazard outlined	Explanation (from timeline, and hazard mapping)	Vulnerabilities that community was aware about	Risk mitigation suggested (Dream mapping)	Other changes requested (not necessarily related to particular hazards)
destroying agricultural production (apricots)	crop in 2016 and 2017.	increases heavy rainfall and this damages apricot trees and crops and makes them vulnerable to pests and diseases.		

Source: Community people – Turtuk, fieldwork, July 2017.

Table A.2. Results from the administrative group's participatory mapping exercises.

Hazard outlined	Explanation (from timeline, and hazard mapping)	Vulnerabilities that community was aware about	Risk mitigation suggested (Dream mapping)	Other changes requested (not necessarily related to particular hazards)
Cloudburst / Flash floods	In 2010, the army camp was destroyed and soldiers died; several houses and bridges were destroyed and livestock were killed. The river that separates the two villages used to be very narrow but the riverbed has widened after the fields along the river have been washed away. In 2010, "we survived, only thanks to the Army".	"Now families want to split up and they have nuclear families, so they build new houses near the stream, this is why there are more disasters".	Debate: Walls are not really an appropriate solution; they secure the embankment with wire mesh but the floods have destroyed those kinds of walls anyway. Despite this debate the participants proposed to build embankments along all rivers on their dream mapping	**Improve the road connectivity:** Build a road to connect both Fayol and Youl to Chutang, to connect with Pakistan and to go to Hannu. The new road to the highway could connect them with Leh in a few hours. Building bridges on different streams and upgrading the existing ones with cement and metal materials, for cars to use the bridges.
Shyok river flooding	In 2015, after heavy rains, the river diverted from its usual course, damaged the middle school and inundated the police camp. If the water level in Shyok river increased, the hospital and school will be gone.	Not enough land available (land dispute with Bogdan) If they win the lawsuit and obtain land rights they could move critical infrastructure to safer ground.	Build a concrete wall along the Shyok river Shift many buildings in Chu-thang We can't really change mountains or rivers, but we can create safe zones.	**Build sport infrastructure:** Community hall, stadium, swimming pool, horse polo ground **Develop waste management** with biodegradable and recycling systems in place + sewage

Hazard outlined	Explanation (from timeline, and hazard mapping)	Vulnerabilities that community was aware about	Risk mitigation suggested (Dream mapping)	Other changes requested (not necessarily related to particular hazards)
Rock falls		Youl is very vulnerable to floods and the fall of boulders that destroy houses near the river	Build a fence along the foot of the slopes to protect houses and fields from falling stones	treatment There should be **less corruption** to receive funding and building materials promised **Upgrade hospital** with all specialists to avoid having to be referred to hospitals elsewhere **Better communication/ network** 24 hours electricity, and 4G coverage Requiring hydro projects on river streams and solar plant to generate heat in winter **Upgrade education opportunities** Make a higher education college **Create a State Disaster Response Force** post in town
Landslides	In 2014, after heavy rains, landslides caused destruction of fields, orchards and the road and all communications were cut for 20 days			
Earthquake	An earthquake has never happened, whereas floods happened 3 times.			
Tourism	Agriculture is converted into areas full of concrete and resort camps. Young people have lost interest in their education to build hotels. New cultures are replacing Balti culture	Different opinions: tourism brings economic resources but also threatens local culture	To create an Art and Culture centre Create productive land	
Animal disease	Often associated with heavy rainfall	There is no medical care in neighbouring valleys	Build animal husbandry clinics	
Invasion from Pakistan	If a war strikes, the entire village will have to evacuate like in 1999. Pakistan could fire at any moment		Build bunkers to protect people But if the border with Pakistan opens, then we don't need this. Remove the border because this would bring economic gains for both sides. High expectations on the role of the government.	
			They received instructions from authorities in Leh to create their own disaster management plan. But "frankly there are no such plans".	

Source: Community people – Turtuk, fieldwork, July 2017.

Table A.3. Results from the local women group's participatory mapping exercises.

Hazard outlined	**Explanation (from timeline, and hazard mapping)**	**Vulnerabilities that community was aware about**	**Risk mitigation suggested (Dream mapping)**	**Other changes requested (not necessarily related to particular hazards)**
Cloudburst / Flash floods			Build embankment but keep the course of the river as it is otherwise "it is dangerous".	**Improve road connectivity** (to the hospital), to upper part of the villages and to Hanu to encourage tourists to go all the way. Create a bus stand. > "Because it is a sign of development" **Upgrading bridges** (higher above the stream) **Upgrade the school system** **>** For students to stay in Turtuk and because the population is increasing **Increase the number of health centres** on both sides of villages **Create picnic areas and playgrounds**, to increase "green areas" **Build more guesthouses** **>** To accommodate the increase of tourists **Develop houses (multi-storey, in cement) with numerous flats** to accommodate the increase of population but to also optimise space and avoid using too much agriculture land. Also build more houses along one of
Shyok river flooding			Discussed where to locate the primary health centre. Decided to place it in the Chu-thang area (near the Shyok river) because it is closer to the main road and so it will become more accessible to people from other villages. But community members discussed the issue of the location in a vulnerable area, and the relative merits of move the buildings or to building an embankment. They finally decided to build the building 100m away from the riverbed AND to build a wall along the river. "It must be big"	
Rock falls			Building a concrete wall to prevent the boulders from falling Planting trees	
Landslides			Planting more trees to protect to prevent the soil to erode and to protect areas from falling rocks	
Pests destroying agricultural production (apricots)	Insects destroyed apricot trees in 2016. They used insecticide to deal with the risk this year but now the apricots are very small	Climate change that increases heavy rainfall and snowfall that damage tree and drive insect infestation		
Earthquake	This did get discussed *as they had observed a major earthquake event*			

Hazard outlined	Explanation (from timeline, and hazard mapping)	Vulnerabilities that community was aware about	Risk mitigation suggested (Dream mapping)	Other changes requested (not necessarily related to particular hazards)
	yet			the river in neighbouring valley because there will be new roads in a couple of decades. **Build more shops** that they locate right above and right below the main cliff above Chu-thang. Build mobile towers to create 4G coverage and have more electricity and Internet access so need to build hydroelectric power.

Source: Community people – Turtuk, fieldwork, July 2017.

Table A.4. Results from the local men group's participatory mapping exercises.

Hazard outlined	Explanation (from timeline, and hazard mapping)	Vulnerabilities that community was aware about	Risk mitigation suggested (Dream mapping)	Other changes requested (not necessarily related to particular hazards)
Cloudburst / Flash floods	Army camp was washed away in 2015 flooding and 22 army men died. People are afraid of flooding of the irrigation canal (*Nala*). Agricultural fields were destroyed. Army hospital and trees damaged. Rain water also flooding and causing roadblocks.	Last 5-10 years, there has been increase in rainfall, both volume and frequency. People are afraid of flooding of the irrigation canal (*Nala*).	Embankments of wall on the both sides and deepening of the canal (Nala). Cement canal to prevent water seepage.	Tiled footpaths for ease of walking and beautification Upgrade and increase the number of schools and a full-fledged hospital. Instalment of new factories and shops Black topped road and connectivity of Turtuk-Hanu road Instalment of new mobile towers for better mobile phone services Bridge over Shyok River for farming on
Shyok river flooding	Shyok river has been flooded in past		It is impossible to change the course of the river so the risk remains constant. However, the construction of an embankment along the river could reduce the risk to some extent.	
Rock falls		People are well aware of or have witnessed rock falls	Construction of wall to block rocks that are bouncing down from above	
Landslides	The road has been constructed by		Treatment of vertical slope by	

Hazard outlined	**Explanation (from timeline, and hazard mapping)**	**Vulnerabilities that community was aware about**	**Risk mitigation suggested (Dream mapping)**	**Other changes requested (not necessarily related to particular hazards)**
associated with the road	cutting the slope but the vertical slope created by that has been left untreated. This has led to many slope failures in recent years.		cement grouting	the other side Playground and ice hockey ground for recreational activities for children
Wind storms				
Destruction of crops				
War	This village has witnessed two major wars in 1971 and 1999 between India and Pakistan. People suffered a lot, and even they were forced to work as porter by army during war. Single casualty of shepherd during 1999 war.	Fully aware that they live in a frontier zone between two countries.	This problem is never ending. Only government policy can stop the war in the future	
Earthquake	Locals had witnessed minor earthquakes.	Not too much aware as no major earthquake is observed in recent times.	Construction of cement (built) buildings with proper engineering techniques	

Source: Community people – Turtuk, fieldwork, July 2017.

Fig. A.3. Traditional storage facilities to deal with extreme climatic conditions in Turtuk village, India. Source: Bayes Ahmed, fieldwork, July 2017.