International Journal of Strategic Engineering
Volume 3 • Issue 1 • January-June 2020

Disaster Management in High Risk Regions:
A Case Study of the Indian Himalayas Region

Bright Chinemerem Amajuoyi, University of Northampton, Northampton, UK
Oguguo C. Njoku, University of Northampton, Northampton, UK
Joachim Kodjo Arthur, University of Northampton, Northampton, UK
Dilshad Sarwar, University of Northampton, Northampton, UK

ABSTRACT

The occurrence of several cases of natural disaster and its impact on high-risk regions remains an issue that continues to attract continued research, most especially from a global perspective. Despite the devastating impact of several known natural phenomenon such as flooding, tsunamis, earthquakes, glaciers and tornadoes, there seem not to be well-structured disaster management approach from stakeholders in high-risk disaster-prone regions to cope with eventual disaster cases. The Indian Himalayan region under review within this research article has been conducted investigated, and a review on how the build of poorly constructed residences have impacted the lives of people living within this region. This article addresses this problem in a line with well-structured thematic sections that examines community resilience, effective stakeholder communication and community preparedness can result in effective disaster management approach.

KEYWORDS

Climate Change, Community Resilience, Disaster, Disaster Management, Indian Himalayas, Poorly Constructed Residential Buildings

INTRODUCTION

The concepts of sustainable development and resilience are sometimes used interchangeably (Farsi et al., 2017; Hosseinian-Far & Jahankhani, 2015), and have routes in disaster management as a subject area. The concept of resilience refers to the ability of a system to sustain its operation when affected by external forces. The same concept applies within the context of resilience to disasters. After the disastrous Tsunami that hit the Indian Ocean region in December 2004 (Suppasri et al., 2015), there has been an increased sensitization in recent years on the likely damaging impacts of tsunamis (Older, 2015) and several life-threatening natural events (Stephan et al., 2017). Communities along the coastal lines are the most vulnerable to naturally induced disaster situations (Mallick et al., 2017) partly due to climate change (Aliagha et al., 2015) and some unnatural causes resulting from human activities on their environment (Noy, 2015). However, research in the area of disaster management is becoming

DOI: 10.4018/IJoSE.2020010105

intensified, as global development agencies are focused on formulating relief frameworks and actions (Managi and Guan, 2017) to prevent the adverse impact of natural disasters (Witvorapong et al., 2015).

Intriguingly, over the past decade, there have been a rise in the number of natural disasters across the world (Cassar et al., 2017). Figures released by the Emergency Events Database (EM-DAT) in 2018 indicates a 62.9% increase in global disaster rates, with death tolls margin around 84.3% (Auzzir et al., 2018) resulting to economic damage of about 120% in the same year (Lahai and Lahai, 2019). An average of 32.3 million people around the world was displaced by disasters associated with weather or climate changes (Hossain, 2015).

Statistics from 2012 showed that the global disaster levels rose by approximately 2.4% against the preceding year (Jeppesen et al., 2015), this was majorly attributed to weather-related events (Kelman et al., 2016). The mortality index ratio for people residing in high-risk disaster-prone regions has also increased in recent times (Wong et al., 2016). Finding between the late '80s and a decade of a millennium confirms that in Canada, there was at least 41.9% known incidents of floods and 31.8% resulting from wildfire (Townshend et al., 2015). However, incorporating a modern approach to managing disaster and it's after effect poses a huge concern to stakeholders across the world (Ferraro and George, 2016). The adverse impact of global warming and climate change (Johnson et al., 2018) on the ecosystem further stresses the demand for the adoption of preventive measures to alleviate future catastrophes (Cutter et al., 2013; Shao, 2016; Hosseinian-Far et al., 2011; Hosseinian-Far et al., 2010).

Over the years, several natural events have resulted in individuals and communities being exposed and prone to disaster situations (Alfred et al., 2015; Ostadtaghizadeh et al., 2016; Linnenluecke and McKnight, 2017). This level of vulnerability which has a been widely researched area examines the extent of susceptibility of a defined group, society or community (Bergstrand et al., 2015; Gil-Rivas and Kilmer, 2016) to natural disasters (Maikhuri et al., 2017; Kang and Skidmore, 2018) and accessing their response framework (Himes-Cornell et al., 2018; Serfilippi and Ramnath, 2018).

It is believed that decades of social ideals and routine practices (Cretney, 2016; Rogers et al., 2016) have played significant roles in helping communities cope with their vulnerability to known devastating natural catastrophes (Manning et al., 2015; Weichselgartner and Kelman, 2015; Kelman et al., 2016). This further establishes the fact that in order to survive (Misanya and Øyhus, 2015; Landry et al., 2016), it is imperative that residents in hazard-prone communities unite (Baytiyeh, 2017; Ramos-Castillo et al., 2017) as multiple factors such as marginalization (McKinnon et al., 2016) and inadequate access to resources (Deen, 2015; Dumenu and Obeng, 2016) as an individualistic approach could prove insufficient (Lowe et al., 2015; Tint et al., 2015).

In recent times, there have been increased global concerns over the Himalayan region which has often been hit by series of natural and anthropogenic calamities (Malik et al., 2016; Agnihotri et al., 2017; Haq et al., 2019) thereby making it one of the most disaster-prone regions in this modern era (Elalem and Pal, 2015; Shrestha et al., 2015; Stanley and Kirschbaum, 2017). Also, the influence of global warming within the Himalayas has impacted negatively on the region (Li et al., 2016; Sigdel et al., 2018) resulting in glacial retreats and unpredictable seasons (Gao et al., 2016; Kattel et al., 2017; You et al., 2017). Understanding the interconnectivity between people and their natural environment has remained a much-explored topic of intensive academic and practical research discussion for many decades (Oken et al., 2015). The conceptualisation of this interaction gives a clear insight into the perceived affinity people have regarding their environment. However, this supposed relationship between humans and their environment could be impacted by notable change such as rise in sea levels, wetland loss, desertification (Silver and Grek-Martin, 2015).

Above and beyond the recurrent reports of forest fires and environmental degradation that has characterised the Himalayan regions (Bali et al., 2017), subjective disaster cases of massive flash flooding in 2013 which wrecked the Kedarnath valley of Uttarakhand (Shekhar et al., 2015). This led to the devastating loss of life and property, one that was documented as the biggest disaster in the history of the Indian Himalayan region (Mehta et al., 2016). Although, previous research around the region have revealed that 90% of the disasters recorded in the Indian Himalayan region

were mainly due to the poor residential building constructions on the mountainous region (Chandel et al., 2016). Rural settlers especially those within the mountain seismic zones located around the Rudraprayag districts have been defenceless against the high risk of landfalls due to heavy rainfall (Sahana and Sajjad, 2017).

Emphasis has been on the poor level of construction for residential buildings around the Indian Himalayan region poses a major risk to human life, considering the area is also characterized by first-degree earthquakes. An investigation on the region shows that the houses within the region are constructed with materials which could not stand during disaster situations. Hence, it is however important to take into perspective the quality and standard of residential building construction projects within the region and how it impacts human life during an eventual disaster situation.

This paper attempts to investigate the effect for poorly constructed residential buildings within the constructs of disaster management and how it impacts human lives: A case study on the Indian Himalayan region. The objective of this research work is to address the topic through the following approaches:

- Exploring the impact of a disaster on poorly constructed residential buildings in the Indian Himalayan region;
- Examining what disaster management approaches are currently being adopted to assist residents living within the region;
- Carrying out a comparative study to ascertain what measures are used by developed-world nations to reduce the impact of a disaster on residential buildings in parity to those of developing countries.

This piece of research will proceed to discuss these key issues in a well sectioned and thematic format in line with relevant academic research. A session on the literature review around disaster and disaster management will be utilised to provide useful analogy around the topic. Subsequent sessions will examine associated impacts of poorly constructed residential buildings and how it impacts the well-being of those living within the Indian Himalayan region. The following session will present a comparative study on developed and under-developed world nations in dealing with residential building construction. A final session will review what policies are currently been adopted to prevent the incessant erection of substandard residential buildings within the region. A conclusion will be drawn based on the findings from the narratives developed from the research paper.

LITERATURE REVIEW

Disaster may be referred to as a natural occurrence which directly or indirectly subjects a community of people to incur losses to property and in more volatile cases loss of life (Ostadtaghizadeh et al., 2016). Besides known natural causes, disaster could occur from several associated factors ranging from environmental, social-economical and in most instances political (Levy and Patz, 2015; Randle and Eckersley, 2015, Whittaker et al., 2015). Although there exists no consensus definition to disaster but a generally accepted illustration to disaster events was put forward by the International Strategy for Disaster Reduction (ISRD) referred to disaster as a state of adverse interruption to the operations of a society or group resulting to an extensive anthropological, physical and financial damage that are beyond the resources of the society to cope with such events (Bier, 2017; Auzzir et al., 2018; Mechler and Bouwer, 2015). Kelman (2018) on the other hand views disaster from a social construct, where the probability for a potential hazard rests on the dynamic interaction between people and their immediate environment.

Contrary definitions by Jon (2019) and Wilkin (2019) view disaster an event that exposes communities to harm with limited or no means to survive the event. Disasters may also be defined as a sequence of unpredictable and calamitous events (Keerthiratne and Tol, 2018) that are widely linked to variations in climatic conditions (Townshend et al., 2015). Weichselgartner and Kelman

(2015) further suggest that a society can experience certain levels of harm and loss without there necessarily been a disaster for the society itself.

From a social standpoint, Dodds (2015) saw disaster to be creations of a precise age and political philosophies that tend to evolve with time. The increase in the occurrence of disaster has evidenced the need to develop suitable recovery mechanisms (Rautela, 2016) to reduce or alleviate the impact of potential disaster situations has become imperative from a present stance (Matyas and Pelling, 2015). There have been different assertions on the impact of catastrophises across the globe over the past decades (Coetzee et al., 2016). Therefore, understanding the concept of disaster management provides insight into possible ways to averse identified natural or human-caused danger (Cretney, 2016). Some definitions of disaster management put forward by most scholars would throw more light on the context of disaster management.

Disaster management can be defined as an array of targeted actions aimed at controlling disaster and emergencies (Dahlberg et al., 2015). Lam and Kuipers, (2019) went further to describe disaster management as an approach towards delivering a framework that helps people cope with the consequences of a risk event. Vaidya et al. (2019) believe that disaster management involves a systematic method of identifying and analysing a particular risk event over a period to take improved measures to guard or prepare for a potential future occurrence. A contemporary approach to the definition of disaster management argues that it is not an act of response to extreme risk situations (Nappi and Souza, 2015) but rather a means of reducing the overall impact of a potential risk that matters (Kato and Charoenrat, 2018).

Managing disasters in high-risk disaster-prone communities require the adoption of a viable resilient framework as a mean of coping with these uncertain natural events (Townshend et al., 2015). A typical framework for disaster management includes these three basic components: community resilience; community problem-solving; communicating as a communal unit (Horita et al., 2017). Samaddar et al., (2015) in their definition of community resilience within the context of disaster management is referred to it as the adaptive capability of a society that is prone to disaster to respond and recover timely from the impact of a major catastrophic event. Aldrich and Meyer, (2015) on the contrary, thinks of community resilience as the process by which a community deals with a hazard event and still possesses the ability to function. A community can also be said to be resilient when its members are known to take a shared approach to salvage the impact of disaster (Aldunce et al., 2015), including their ability to study their immediate environment to survive (Imperiale and Vanclay, 2016). However, it is argued that obtaining the level of a community's resilient approach to disaster may be hindered (Khalid and Shafiai, 2015), due to the absence of standard conditions that helps in establishing the aptitude of the community to deal with calamity (Kelman et al., 2016).

Understanding the benefits of incorporating an effective community communication system in dealing with disaster is important from a communal standpoint. As emphasised by (Bunker et al., 2015) communal communication allows for a shared information approach, proactive decision making (Steigenberger, 2016) and measures that contribute in the reduction of loss to human life and property (Bradley et al., 2016).

Further studies have contributed to expanding on the existing knowledge provided on the above disaster management components (Houston et al., 2015), but here, we noticed that the framework underpins those factors that focus on community resilience (Aldrich and Meyer, 2015) and the ability of communities to cope with disaster situations (Kelman et al., 2016). This review has discovered that the processes leading to resilience can be viewed in terms of the ability of a community to deal with disaster effectively and return to its functional state within a short period.

Drawing from the different scholarly meanings to disaster listed above will further help in analysing the disaster situation in the Indian Himalayan regions and how this has shaped the lives of those residing within the region.

IMPACT OF DISASTER IN THE REGION

The Indian Himalayan region has over the past decades been known as one of the most disasters ravaged regions in the world. Consequently, these isolated catastrophes that have hit the region are mainly attributed to both human and natural dynamics (Mallick et al., 2017). These range from the impact of climate change as well as the poorly constructed residential buildings that cannot withstand disaster situations (Rumbach and Follingstad, 2019).

A study on the Uttarakhand region of the Indian Himalayas is one of interest, due to the frequent cases of earthquakes within the region (Maikhuri et al., 2017). Due to the brittle nature of the region, multi-storey buildings and bungalows constructed here for residential purposes are exposed to the disaster situations (Sharma et al., 2016). Surprisingly, the popular residential building construction types noticed within the rocky Indian Himalayan zone were mainly timber made houses, semi-concrete and brick type houses (Rumbach and Follingstad, 2019). Although residents living close to the Himalayan mountains are aware of the dangers of the region (Maikhuri et al., 2017), they still move on erect poorly constructed building that is unable to withstand the shock of an earthquake (Chandel et al., 2016).

Reports from the early 90's provided evidence on the 6.6 magnitudes Chamoli and Uttarkashi earthquakes that shook the Uttarakhand area of the Indian Himalayas (Noy, 2015). Furthermore, these earthquakes resulted in the collapse of several buildings that could not withstand the tremor with accountable death tolls placed at 100 and 75 people respectively Maikhuri et al., 2017). Although there have been several bans on bio-materials, wood and mud for building construction within the region, residents complain about the high cost of materials for erecting more solid structures (Landry et al., 2016).

Based on the above narrative, residents within the Indian Himalayas must seek to adopt the use of high-quality materials such as reinforced concrete in the construction of their residential buildings. The use of reinforced concrete materials allows the building to withstand any form of shock during an earthquake (Gautam et al., 2018). Also, effective and continuous community sensitization on the risk of using poor bio-materials must be incorporated as a disaster management approach to avert future occurrence (Silver and Grek-Martin, 2015).

DISASTER MANAGEMENT APPROACHES

Building a resilience approach is fundamental especially with regards to disaster situations. A review of the regions within the Indian Himalayas shows a broad spectrum of unethical practices in dealing with disaster response within the zone (Gall and Cutter, 2015; Rautela, 2016; Sarwar et al., 2017). Accessing the economic damage and impact of disaster allows communities to plan and prepare for disaster (Sharifi, 2016).

There have been recent calls on residents in the disaster-prone Indian Himalayas region to become empowered towards building their capacity to recover from catastrophic events (Sharma et al., 2016). A comparative study on resilience building in America shows how residents that reside along coastal lines can reduce the impact of a disaster and promptly recover from the aftermath of a hazardous situation (Yoon et al., 2016).

A review on the Nepal community in the Himalayan region showed the lack of effective disaster management practice within the area. The lack of planning and preparedness for disaster events have exposed residents in the Nepal region to even more risk (Gautam et al., 2018). Routine maintenance to partially affected buildings is not commonly practised by residents in Nepal (Dizhur et al., 2016; Sharma et al., 2016), which makes this region suffer the highest mortality rates among other zones in the Indian Himalayas region (Landry et al., 2016; Rai et al., 2016). This situation within the Nepal region gives an indicative outcome of a region that has failed to incorporate community resilience

framework (Aldrich and Meyer, 2015) in dealing with disaster in their region (Bier, 2017; Auzzir et al., 2018; Mechler and Bouwer, 2015).

Building a communication response plan to manage disaster has also been identified as lacking in several disaster risk regions in the Indian Himalayas. A typical example can be cited using the Uttarakhand (Shekhar, 2015), the region was severely hit by disaster due to poor communication structure in place to manage disaster (Tint et al., 2016). It is therefore imperative that regions within the Indian Himalayas adopt a well-structured and functional communication action plan (Bunker et al., 2015), most especially for those individuals residing in a poorly constructed building (Rumbach and Follingstad, 2019. Incorporating this approach within the region will enable residents to prepare ahead and take prompt and decisive actions to reduce the impact of eventual loss.

Also, it also important for communities in risk-prone regions of the Himalayas to strengthen their local capabilities to prepare and respond to a disaster. Developing and incorporating communal policies would form a long-term solution (Johnson et al., 2018) rather than wait for government intervention schemes which may delay or in most cases are not forthcoming (Matyas and Pelling, 2015).

IMPACT REDUCTION IN OTHER REGIONS

Several underpinning issues have slowed down the disaster recovery process especially in high-risk zones of the Indian Himalayas over the past decade. The proposed Tourism development master plan 2007 to 2022 which was meant to address issues on sustainable housing development failed as it didn't have a sustainable disaster driven approach in place (Mishra et al., 2019).

Intervention from global financial institutions like the World bank has extensively funded the re-construction of extremely damaged houses within the disaster-prone areas of the Himalayan region making residents safe and prepared to respond to emergencies (Tambe et al., 2018). Developing strategies and approaches for mitigating has been argued to be insufficient in addressing the need of those who survive from disaster cases (Suppasri et al., 2015). Stephan et al. (2017) believe that not considering the living conditions, wants and choices would further subject them to even greater hardship.

The effective implementation of post-disaster recovery plans poses major challenges even among developed-world nations (Yoon et al., 2016). A review on countries such as Australia and China and their approaches in dealing with cases of disaster shows the deficiencies in planning and preparedness in responding to disaster within their counties (Cornia et al., 2016). Research has attributed these lapses to the government or stakeholder's not been entirely familiar with the disaster-prone zone in their countries or regions (Pant and Cha, 2019). Furthermore, lack of engagement and improper communication channels between the stakeholders and residential building construction firms has resulted in an increased setback to the fight against disaster in these developed countries (Townshend et al., 2015).

CONCLUSION

Predicting accurately the extent of damage that could result from a possible case of natural disasters is one phenomenon that continued to receive extensive research even in contemporary times. This unpredictable nature of disaster cases has resulted in communities located in high-risk disaster-prone regions of the world to become increasingly susceptible to disaster. Hence, in responding to known natural hazards within a region, communities must adopt measures for disaster management. Experiential studies and recovery approaches in response to disaster allows stakeholders that are exposed to natural disaster reflect on past catastrophises and build up resilient frameworks that are geared towards disaster management. This research piece has attempted to address the issue of disaster management in the light of relevant academic journals and previous research by other authors to proffer a model for disaster management within the Indian Himalayas region.

Recognised as having some of the world's most under-developed countries of the world and recording some of the highest rates of incidence of earthquakes around the world, the Indian Himalayan region is characterised by poorly constructed residential buildings which have resulted in several reported casualties. Failure to adopt sustainable disaster management approaches and the use of building material that cannot withstand earthquakes has further resulted in the region been affected negatively by disaster over the past decades. Although authorities within the region conduct routine sensitisations through the media and other communication channels, residents continue still reside in their partially delipidated buildings.

The incorporation of disaster management frameworks and models such as community resilience, communicating as a communal unit and communal problem-solving approach are some of the measures the stakeholders (residents, government and non-governmental organisations) in the Indian Himalayan region may seek to address disaster events. Furthermore, a review of the approaches adopted in developed countries in coping with disaster especially with respect to the standard and quality of building constructions in disaster-prone regions is also very important from a research context. Countries such as Korea Republic, Canada have to a large extent been able to develop a well-structured policy that enables them to sanction the use of sub-standard building materials for residential houses in disaster regions. Government interventions and shared communal resilient measures within these developed world countries have also allowed them to remain functional even in the aftermath of a calamity.

Finally, a proactive move for swift and effective disaster management approach within disaster-prone regions in the Indian Himalayas is imperative and residents within these high-risk communities must work together to ensure that they build sustainable resilience to disaster within their region.

REFERENCES

Agnihotri, R., Dimri, A. P., Joshi, H. M., Verma, N. K., Sharma, C., Singh, J., & Sundriyal, Y. P. (2017). Assessing operative natural and anthropogenic forcing factors from long-term climate time series of Uttarakhand (India) in the backdrop of recurring extreme rainfall events over northwest Himalaya. *Geomorphology*, *284*, 31–40. doi:10.1016/j.geomorph.2016.10.024

Aldrich, D. P., & Meyer, M. A. (2015). Social capital and community resilience. *American Behavioural Scientist, 59*(2), 254-269.

Aldunce, P., Beilin, R., Howden, M., & Handmer, J. (2015). Resilience for disaster risk management in a changing climate: Practitioners' frames and practices. *Global Environmental Change*, *30*, 1–11. doi:10.1016/j.gloenvcha.2014.10.010

Alfred, D., Chilton, J., Connor, D., Deal, B., Fountain, R., Hensarling, J., & Klotz, L. (2015). Preparing for disasters: Education and management strategies explored. *Nurse Education in Practice*, *15*(1), 82–89. doi:10.1016/j.nepr.2014.08.001 PMID:25578381

Aliagha, G. U., Mar Iman, A. H., Ali, H. M., Kamaruddin, N., & Ali, K. N. (2015). Discriminant factors of flood insurance demand for flood-hit residential properties: A case for Malaysia. *Journal of Flood Risk Management*, *8*(1), 39–51. doi:10.1111/jfr3.12065

Auzzir, Z., Haigh, R., & Amaratunga, D. (2018). Impacts of disaster to SMEs in Malaysia. *Procedia Engineering*, *212*, 1131–1138. doi:10.1016/j.proeng.2018.01.146

Bakkensen, L. A., Fox-Lent, C., Read, L. K., & Linkov, I. (2017). Validating resilience and vulnerability indices in the context of natural disasters. *Risk Analysis*, *37*(5), 982–1004. doi:10.1111/risa.12677 PMID:27577104

Bali, K., Mishra, A. K., & Singh, S. (2017). Impact of anomalous forest fire on aerosol radiative forcing and snow cover over Himalayan region. *Atmospheric Environment*, *150*, 264–275. doi:10.1016/j.atmosenv.2016.11.061

Baytiyeh, H. (2017). Socio-cultural characteristics: The missing factor in disaster risk reduction strategy in sectarian divided societies. *International Journal of Disaster Risk Reduction*, *21*, 63–69. doi:10.1016/j.ijdrr.2016.11.012

Bergstrand, K., Mayer, B., Brumback, B., & Zhang, Y. (2015). Assessing the relationship between social vulnerability and community resilience to hazards. *Social Indicators Research*, *122*(2), 391–409. doi:10.1007/s11205-014-0698-3 PMID:29276330

Bier, V. M. (2017). Understanding and mitigating the impacts of massive relocations due to disasters. *Economics of disasters and climate change, 1*(2), 179-202.

Bradley, D. T., McFarland, M., & Clarke, M. (2016). The effectiveness of disaster risk communication: a systematic review of intervention studies. In *Effective Communication During Disasters* (pp. 81–120). Apple Academic Press. doi:10.1201/9781315365640-4

Bunker, D., Levine, L., & Woody, C. (2015). Repertoires of collaboration for common operating pictures of disasters and extreme events. *Information Systems Frontiers*, *17*(1), 51–65. doi:10.1007/s10796-014-9515-4

Cassar, A., Healy, A., & Von Kessler, C. (2017). Trust, risk, and time preferences after a natural disaster: Experimental evidence from Thailand. *World Development*, *94*, 90–105. doi:10.1016/j.worlddev.2016.12.042

Chandel, S. S., Sharma, A., & Marwaha, B. M. (2016). Review of energy efficiency initiatives and regulations for residential buildings in India. *Renewable & Sustainable Energy Reviews*, *54*, 1443–1458. doi:10.1016/j.rser.2015.10.060

Cornia, A., Dressel, K., & Pfeil, P. (2016). Risk cultures and dominant approaches towards disasters in seven European countries. *Journal of Risk Research*, *19*(3), 288–304. doi:10.1080/13669877.2014.961520

Cretney, R. M. (2016). Local responses to disaster: The value of community led post disaster response action in a resilience framework. *Disaster Prevention and Management*, *25*(1), 27–40. doi:10.1108/DPM-02-2015-0043

Cutter, S. L., Ahearn, J. A., Amadei, B., Crawford, P., Eide, E. A., Galloway, G. E., & Schoch-Spana, M. et al. (2013). Disaster resilience: A national imperative. *Environment*, *55*(2), 25–29. doi:10.1080/00139157.2013.768076

Dahlberg, R., Johannessen-Henry, C. T., Raju, E., & Tulsiani, S. (2015). Resilience in disaster research: Three versions. *Civil Engineering and Environmental Systems*, *32*(1-2), 44–54. doi:10.1080/10286608.2015.1025064

Deen, S. (2015). Pakistan 2010 floods. Policy gaps in disaster preparedness and response. *International Journal of Disaster Risk Reduction*, *12*, 341–349. doi:10.1016/j.ijdrr.2015.03.007

Dizhur, D., Dhakal, R. P., Bothara, J., & Ingham, J. (2016). Building typologies and failure modes observed in the 2015 Gorkha (Nepal) earthquake. *Bulletin of the New Zealand Society for Earthquake Engineering*, *49*(2), 211–232. doi:10.5459/bnzsee.49.2.211-232

Dumenu, W. K., & Obeng, E. A. (2016). Climate change and rural communities in Ghana: Social vulnerability, impacts, adaptations and policy implications. *Environmental Science & Policy*, *55*, 208–217. doi:10.1016/j.envsci.2015.10.010

Elalem, S., & Pal, I. (2015). Mapping the vulnerability hotspots over Hindu-Kush Himalaya region to flooding disasters. *Weather and Climate Extremes*, *8*, 46–58. doi:10.1016/j.wace.2014.12.001

Farsi, M., Hosseinian-Far, A., Daneshkhah, A., & Sedighi, T. (2017). Mathematical and Computational Modelling Frameworks for Integrated Sustainability Assessment (ISA). In A. Hosseinian-Far, M. Ramachandran, & D. Sarwar (Eds.), *Strategic Engineering for Cloud Computing and Big Data Analytics*. Cham: Springer. doi:10.1007/978-3-319-52491-7_1

Gall, M., Nguyen, K. H., & Cutter, S. L. (2015). Integrated research on disaster risk: Is it really integrated? *International Journal of Disaster Risk Reduction*, *12*, 255–267. doi:10.1016/j.ijdrr.2015.01.010

Gao, J., Risi, C., Masson-Delmotte, V., He, Y., & Xu, B. (2016). Southern Tibetan Plateau ice core δ 18 O reflects abrupt shifts in atmospheric circulation in the late 1970s. *Climate Dynamics*, *46*(1-2), 291–302. doi:10.1007/s00382-015-2584-3

Gautam, D., Fabbrocino, G., & de Magistris, F. S. (2018). Derive empirical fragility functions for Nepali residential buildings. *Engineering Structures*, *171*, 617–628. doi:10.1016/j.engstruct.2018.06.018

Gil-Rivas, V., & Kilmer, R. P. (2016). Building community capacity and fostering disaster resilience. *Journal of Clinical Psychology*, *72*(12), 1318–1332. doi:10.1002/jclp.22281 PMID:26990644

Haq, S. M., Rashid, I., Khuroo, A. A., Malik, Z. A., & Malik, A. H. (2019). Anthropogenic disturbances alter community structure in the forests of Kashmir Himalaya. *Tropical Ecology*, *60*(1), 6–15. doi:10.1007/s42965-019-00001-8

Himes-Cornell, A., Ormond, C., Hoelting, K., Ban, N. C., Zachary Koehn, J., Allison, E. H., & Okey, T. A. (2018). Factors Affecting Disaster Preparedness, Response, and Recovery Using the Community Capitals Framework. *Coastal Management*, *46*(5), 335–358. doi:10.1080/08920753.2018.1498709

Hossain, M. N. (2015). Analysis of human vulnerability to cyclones and storm surges based on influencing physical and socioeconomic factors: Evidences from coastal Bangladesh. *International Journal of Disaster Risk Reduction*, *13*, 66–75. doi:10.1016/j.ijdrr.2015.04.003

Hosseinian-Far, A., & Jahankhani, H. (2015). Quantitative and Systemic Methods for Modeling Sustainability. In M. Dastbaz, C. Pattinson, & B. Akhgar (Eds.), *Green Information Technology* (pp. 83–92). Elsevier. doi:10.1016/B978-0-12-801379-3.00005-X

Hosseinian-Far, A., Pimenidis, E., Jahankhani, H., & Wijeyesekera, D. C. (2010). A Review on Sustainability Models. In S. Tenreiro de Magalhães, H. Jahankhani, & A. G. Hessami (Eds.), *Global Security, Safety, and Sustainability. ICGS3 2010. Communications in Computer and Information Science* (Vol. 92). Berlin, Heidelberg: Springer.

Hosseinian-Far, A., Pimenidis, E., Jahankhani, H., & Wijeyesekera, D. C. (2011). Financial Assessment of London Plan Policy 4A. 2 by probabilistic inference and influence diagrams. In *Artificial intelligence applications and innovations* (pp. 51–60). Berlin: Springer. doi:10.1007/978-3-642-23960-1_7

Houston, J. B., Hawthorne, J., Perreault, M. F., Park, E. H., Goldstein Hode, M., Halliwell, M. R., & Griffith, S. A. (2015). Social media and disasters: A functional framework for social media use in disaster planning, response, and research. *Disasters*, *39*(1), 1–22. doi:10.1111/disa.12092 PMID:25243593

Imperiale, A. J., & Vanclay, F. (2016). Experiencing local community resilience in action: Learning from post-disaster communities. *Journal of Rural Studies*, *47*, 204–219. doi:10.1016/j.jrurstud.2016.08.002

Jeppesen, E., Brucet, S., Naselli-Flores, L., Papastergiadou, E., Stefanidis, K., Noges, T., & Bucak, T. et al. (2015). Ecological impacts of global warming and water abstraction on lakes and reservoirs due to changes in water level and related changes in salinity. *Hydrobiological*, *750*(1), 201–227. doi:10.1007/s10750-014-2169-x

Johnson, R. M., Edwards, E., Gardner, J. S., & Diduck, A. P. (2018). Community vulnerability and resilience in disaster risk reduction: An example from Phojal Nalla, Himachal Pradesh, India. *Regional Environmental Change*, *18*(7), 2073–2087. doi:10.1007/s10113-018-1326-6

Jon, I. (2019). Resilience and 'technicity': Challenges and opportunities for new knowledge practices in disaster planning. *Resilience*, *7*(2), 107–125. doi:10.1080/21693293.2018.1461481

Kang, S., & Skidmore, M. (2018). The effects of natural disasters on social trust: Evidence from South Korea. *Sustainability*, *10*(9), 2973. doi:10.3390/su10092973

Kato, M., & Charoenrat, T. (2018). Business continuity management of small and medium sized enterprises: Evidence from Thailand. *International Journal of Disaster Risk Reduction*, *27*, 577–587. doi:10.1016/j.ijdrr.2017.10.002

Kattel, D. B., Ullah, K., Hashmi, M. Z., Tripathee, L., Mohanty, A., & Yao, T. (2017). Atmospheric Pollutants and Its Transport Mechanisms in Soil Along the Himalayas, Tibetan Plateau, and Its Surroundings: A Brief Note. In *Xenobiotics in the Soil Environment* (pp. 9–19). Cham: Springer. doi:10.1007/978-3-319-47744-2_2

Keerthiratne, S., & Tol, R. S. (2018). Impact of natural disasters on income inequality in Sri Lanka. *World Development*, *105*, 217–230. doi:10.1016/j.worlddev.2018.01.001

Kelman, I. (2018). Lost for words amongst disaster risk science vocabulary? *International Journal of Disaster Risk Science*, *9*(3), 281–291. doi:10.1007/s13753-018-0188-3

Kelman, I., Gaillard, J. C., Lewis, J., & Mercer, J. (2016). Learning from the history of disaster vulnerability and resilience research and practice for climate change. *Natural Hazards*, *82*(1), 129–143. doi:10.1007/s11069-016-2294-0

Kelman, I., Gaillard, J. C., Lewis, J., & Mercer, J. (2016). Learning from the history of disaster vulnerability and resilience research and practice for climate change. *Natural Hazards*, *82*(1), 129–143. doi:10.1007/s11069-016-2294-0

Khalid, M. S. B., & Shafiai, S. B. (2015). Flood disaster management in Malaysia: An evaluation of the effectiveness flood delivery system. *International Journal of Social Science and Humanity*, *5*(4), 398–402. doi:10.7763/IJSSH.2015.V5.488

Lahai, Y. A., & Lahai, P. S. Jr. (2019). Geological Context and Statistical Assessment of the Impacts of Sugarloaf Twin Disasters, in Western Sierra Leone. *Journal of Geoscience and Environment Protection*, *7*(06), 226–247. doi:10.4236/gep.2019.76017

Lam, L. M., & Kuipers, R. (2019). Resilience and disaster governance: Some insights from the 2015 Nepal earthquake. *International Journal of Disaster Risk Reduction*, *33*, 321–331. doi:10.1016/j.ijdrr.2018.10.017

Landry, M. D., Sheppard, P. S., Leung, K., Retis, C., Salvador, E. C., & Raman, S. R. (2016). The 2015 Nepal earthquake (s): Lessons learned from the disability and rehabilitation sector's preparation for, and response to, natural disasters. *Physical Therapy*, *96*(11), 1714–1723. doi:10.2522/ptj.20150677 PMID:27277496

Levy, B. S., & Patz, J. A. (2015). Climate change, human rights, and social justice. *Annals of Global Health*, *81*(3), 310–322. doi:10.1016/j.aogh.2015.08.008 PMID:26615065

Li, H., Xu, C. Y., Beldring, S., Tallaksen, L. M., & Jain, S. K. (2016). Water resources under climate change in Himalayan basins. *Water Resources Management*, *30*(2), 843–859. doi:10.1007/s11269-015-1194-5

Linnenluecke, M. K., & McKnight, B. (2017). Community resilience to natural disasters: The role of disaster entrepreneurship. *Journal of Enterprising Communities: People and Places in the Global Economy*, *11*(1), 166–185. doi:10.1108/JEC-01-2015-0005

Lowe, S. R., Sampson, L., Gruebner, O., & Galea, S. (2015). Psychological resilience after Hurricane Sandy: The influence of individual-and community-level factors on mental health after a large-scale natural disaster. *PLoS One*, *10*(5), e0125761. doi:10.1371/journal.pone.0125761 PMID:25962178

Maikhuri, R. K., Nautiyal, A., Jha, N. K., Rawat, L. S., Maletha, A., Phondani, P. C., & Bhatt, G. C. (2017). Socio-ecological vulnerability: Assessment and coping strategy to environmental disaster in Kedarnath valley, Uttarakhand, Indian Himalayan Region. *International Journal of Disaster Risk Reduction*, *25*, 111–124. doi:10.1016/j.ijdrr.2017.09.002

Malik, Z. A., Pandey, R., & Bhatt, A. B. (2016). Anthropogenic disturbances and their impact on vegetation in Western Himalaya, India. *Journal of Mountain Science*, *13*(1), 69–82. doi:10.1007/s11629-015-3533-7

Mallick, B., Ahmed, B., & Vogt, J. (2017). Living with the risks of cyclone disasters in the south-western coastal region of Bangladesh. *Environments*, *4*(1), 13. doi:10.3390/environments4010013

Managi, S., & Guan, D. (2017). Multiple disasters management: Lessons from the Fukushima triple events. *Economic Analysis and Policy*, *53*, 114–122. doi:10.1016/j.eap.2016.12.002

Manning, M., Lawrence, J., King, D. N., & Chapman, R. (2015). Dealing with changing risks: A New Zealand perspective on climate change adaptation. *Regional Environmental Change*, *15*(4), 581–594. doi:10.1007/s10113-014-0673-1

Matyas, D., & Pelling, M. (2015). Positioning resilience for 2015: The role of resistance, incremental adjustment and transformation in disaster risk management policy. *Disasters*, *39*(s1), s1–s18. doi:10.1111/disa.12107 PMID:25494954

McKinnon, S., Gorman-Murray, A., & Dominey-Howes, D. (2016). 'The greatest loss was a loss of our history': Natural disasters, marginalised identities and sites of memory. *Social & Cultural Geography*, *17*(8), 1120–1139. doi:10.1080/14649365.2016.1153137

Mechler, R., & Bouwer, L. M. (2015). Understanding trends and projections of disaster losses and climate change: Is vulnerability the missing link? *Climatic Change*, *133*(1), 23–35. doi:10.1007/s10584-014-1141-0

Mehta, M., Dobhal, D. P., Shukla, T., & Gupta, A. K. (2016). Instability Processes Triggered by Heavy Rain in the Garhwal Region, Uttarakhand, India. In *Climate Change, Glacier Response, and Vegetation Dynamics in the Himalaya* (pp. 219–234). Cham: Springer. doi:10.1007/978-3-319-28977-9_12

Misanya, D., & Øyhus, A. O. (2015). How communities' perceptions of disasters influence disaster response: Managing landslides on Mount Elgon, Uganda. *Disasters*, *39*(2), 389–405. doi:10.1111/disa.12099 PMID:25440695

Mishra, A., Appadurai, A. N., Choudhury, D., Regmi, B. R., Kelkar, U., Alam, M., & Fu, C. (2019). Adaptation to climate change in the Hindu Kush Himalaya: Stronger action urgently needed. In The Hindu Kush Himalaya Assessment (pp. 457-490). Springer.

Nappi, M. M. L., & Souza, J. C. (2015). Disaster management: Hierarchical structuring criteria for selection and location of temporary shelters. *Natural Hazards*, *75*(3), 2421–2436. doi:10.1007/s11069-014-1437-4

Noy, I. (2015). Comparing the direct human impact of natural disasters for two cases in 2011: The Christchurch earthquake and the Bangkok flood. *International Journal of Disaster Risk Reduction*, *13*, 61–65. doi:10.1016/j.ijdrr.2015.03.009

Oken, B. S., Chamine, I., & Wakeland, W. (2015). A systems approach to stress, stressors and resilience in humans. *Behavioural Brain Research*, *282*, 144–154. doi:10.1016/j.bbr.2014.12.047 PMID:25549855

Older, M. (2015). When is too much money worse than too little? Giving, Aid, and Impact after the Indian Ocean Tsunami of 2004. In *Recovery from the Indian Ocean Tsunami* (pp. 121–137). Tokyo: Springer. doi:10.1007/978-4-431-55117-1_9

Ostadtaghizadeh, A., Ardalan, A., Paton, D., Khankeh, H., & Jabbari, H. (2016). Community disaster resilience: A qualitative study on Iranian concepts and indicators. *Natural Hazards*, *83*(3), 1843–1861.

Ramos-Castillo, A., Castellanos, E. J., & McLean, K. G. (2017). Indigenous peoples, local communities and climate change mitigation. *Climatic Change*, *140*(1), 1–4. doi:10.1007/s10584-016-1873-0

Randle, M., & Eckersley, R. (2015). Public perceptions of future threats to humanity and different societal responses: A cross-national study. *Futures*, *72*, 4–16. doi:10.1016/j.futures.2015.06.004

Rautela, P. (2016). Lack of scientific recordkeeping of disaster incidences: A big hurdle in disaster risk reduction in India. *International Journal of Disaster Risk Reduction*, *15*, 73–79. doi:10.1016/j.ijdrr.2015.12.005

Rogers, P., Burnside-Lawry, J., Dragisic, J., & Mills, C. (2016). Collaboration and communication: Building a research agenda and way of working towards community disaster resilience. *Disaster Prevention and Management*, *25*(1), 75–90. doi:10.1108/DPM-01-2015-0013

Rumbach, A., & Follingstad, G. (2019). Urban disasters beyond the city: Environmental risk in India's fast-growing towns and villages. *International Journal of Disaster Risk Reduction*, *34*, 94–107. doi:10.1016/j.ijdrr.2018.11.008

Sahana, M., & Sajjad, H. (2017). Evaluating effectiveness of frequency ratio, fuzzy logic and logistic regression models in assessing landslide susceptibility: A case from Rudraprayag district, India. *Journal of Mountain Science*, *14*(11), 2150–2167. doi:10.1007/s11629-017-4404-1

Samaddar, S., Choi, J., Misra, B. A., & Tatano, H. (2015). Insights on social learning and collaborative action plan development for disaster risk reduction: Practicing Yonmenkaigi System Method (YSM) in flood-prone Mumbai. *Natural Hazards*, *75*(2), 1531–1554. doi:10.1007/s11069-014-1380-4

Sarwar, D., Ramachandran, M., & Hosseinian-Far, A. (2017). Disaster Management System as an Element of Risk Management for Natural Disaster Systems Using the PESTLE Framework. *Proceedings of the International Conference on Global Security, Safety, and Sustainability* (pp. 191-204). Springer.

Serfilippi, E., & Ramnath, G. (2018). Resilience measurement and conceptual frameworks: A review of the literature. *Annals of Public and Cooperative Economics*, *89*(4), 645–664. doi:10.1111/apce.12202

Shao, W. (2016). Are actual weather and perceived weather the same? Understanding perceptions of local weather and their effects on risk perceptions of global warming. *Journal of Risk Research*, *19*(6), 722–742. doi:10.1080/13669877.2014.1003956

Sharifi, A. (2016). A critical review of selected tools for assessing community resilience. *Ecological Indicators*, *69*, 629–647. doi:10.1016/j.ecolind.2016.05.023

Sharma, K., Deng, L., & Noguez, C. C. (2016). Field investigation on the performance of building structures during the April 25, 2015, Gorkha earthquake in Nepal. *Engineering Structures*, *121*, 61–74. doi:10.1016/j.engstruct.2016.04.043

Shekhar, M. S., Pattanayak, S., Mohanty, U. C., Paul, S., & Kumar, M. S. (2015). A study on the heavy rainfall event around Kedarnath area (Uttarakhand) on 16 June 2013. *Journal of Earth System Science*, *124*(7), 1531–1544. doi:10.1007/s12040-015-0621-6

Shrestha, M. S., Grabs, W. E., & Khadgi, V. R. (2015). Establishment of a regional flood information system in the Hindu Kush Himalayas: Challenges and opportunities. *International Journal of Water Resources Development*, *31*(2), 238–252. doi:10.1080/07900627.2015.1023891

Sigdel, S. R., Wang, Y., Camarero, J. J., Zhu, H., Liang, E., & Peñuelas, J. (2018). Moisture-mediated responsiveness of treeline shifts to global warming in the Himalayas. *Global Change Biology*, *24*(11), 5549–5559. doi:10.1111/gcb.14428 PMID:30153361

Silver, A., & Grek-Martin, J. (2015). "Now we understand what community really means": Reconceptualizing the role of sense of place in the disaster recovery process. *Journal of Environmental Psychology*, *42*, 32–41. doi:10.1016/j.jenvp.2015.01.004

Stanley, T., & Kirschbaum, D. B. (2017). A heuristic approach to global landslide susceptibility mapping. *Natural Hazards*, *87*(1), 145–164. doi:10.1007/s11069-017-2757-y

Steigenberger, N. (2016). Organizing for the big one: A review of case studies and a research agenda for multi-agency disaster response. *Journal of Contingencies and Crisis Management*, *24*(2), 60–72. doi:10.1111/1468-5973.12106

Stephan, C., Norf, C., & Fekete, A. (2017). How "Sustainable" are post-disaster measures? Lessons to be learned a decade after the 2004 tsunami in the Indian ocean. *International Journal of Disaster Risk Science*, *8*(1), 33–45. doi:10.1007/s13753-017-0113-1

Suppasri, A., Goto, K., Muhari, A., Ranasinghe, P., Riyaz, M., Affan, M., & Imamura, F. (2015). A decade after the 2004 Indian Ocean tsunami: The progress in disaster preparedness and future challenges in Indonesia, Sri Lanka, Thailand and the Maldives. *Pure and Applied Geophysics*, *172*(12), 3313–3341. doi:10.1007/s00024-015-1134-6

Tint, B. S., McWaters, V., & van Driel, R. (2015). Applied improvisation training for disaster readiness and response: Preparing humanitarian workers and communities for the unexpected. *Journal of Humanitarian Logistics and Supply Chain Management*, *5*(1), 73–94. doi:10.1108/JHLSCM-12-2013-0043

Townshend, I., Awosoga, O., Kulig, J., & Fan, H. (2015). Social cohesion and resilience across communities that have experienced a disaster. *Natural Hazards*, *76*(2), 913–938. doi:10.1007/s11069-014-1526-4

Weichselgartner, J., & Kelman, I. (2015). Geographies of resilience: Challenges and opportunities of a descriptive concept. *Progress in Human Geography*, *39*(3), 249–267. doi:10.1177/0309132513518834

Wilkin, J., Biggs, E., & Tatem, A. J. (2019). Measurement of social networks for innovation within community disaster resilience. *Sustainability*, *11*(7), 1943. doi:10.3390/su11071943

Witvorapong, N., Muttarak, R., & Pothisiri, W. (2015). Social participation and disaster risk reduction behaviors in tsunami prone areas. *PLoS One*, *10*(7), e0130862. doi:10.1371/journal.pone.0130862 PMID:26153891

Wong, M. C., Goggins, W. B., Wang, H. H., Fung, F. D., Leung, C., Wong, S. Y., & Sung, J. J. (2016). Global incidence and mortality for prostate cancer: Analysis of temporal patterns and trends in 36 countries. *European Urology*, *70*(5), 862–874. doi:10.1016/j.eururo.2016.05.043 PMID:27289567

Yoon, D. K., Kang, J. E., & Brody, S. D. (2016). A measurement of community disaster resilience in Korea. *Journal of Environmental Planning and Management*, *59*(3), 436–460. doi:10.1080/09640568.2015.1016142

You, C., Yao, T., Xu, C., & Song, L. (2017). Levoglucosan on Tibetan glaciers under different atmospheric circulations. *Atmospheric Environment*, *152*, 1–5. doi:10.1016/j.atmosenv.2016.12.021

Dilshad Sarwar is working within the area of business systems and operations as a Subject Group Leader, within the Faculty of Business and Law at the University of Northampton. Dilshad's PhD was gained from Leeds Beckett University, UK titled: "Critical Race Theory – A Phenomenological Approach to Social Inclusion of BME Non-Traditional Students". Dilshad has a Postgraduate Certificate in Research, MA in Education Management from the Open University, UK and MSc Information Systems from the University of Leeds, UK. Dilshad is a Senior Fellow of the Higher Education Academy (HEA) and a University Teaching Fellow. Dr Sarwar's current research is broadly within the Information Systems and Business Information Systems as a discipline with a focused research interests in the social influences and domains of Internet of Things and Disaster Management Systems, which entails social computing and managing information in the digital age.