

REVIEW ARTICLE

Understanding the resilience and mental health impacts of natural disasters in India: A narrative review

Sangram Kishor Patel^{1*}, Gopal Agrawal², Bincy Mathew³

¹Population Council, Zone 5A, India Habitat Center, Lodi Road, New Delhi, India

²Office of Registrar General and Census Commissioner of India, New Delhi, India

³George Institute for Global Health, New Delhi, India

ARTICLE INFO

Received: February 16, 2020

Accepted: April 3, 2020

Published: April 12, 2020

*CORRESPONDING AUTHOR

Dr. Sangram Kishor Patel,
Senior Program Officer,
Poverty, Gender and Youth
Program, Population Council,
Zone 5A, IHC, Lodi Road,
New Delhi - 110 003, India.
sangramkishor@gmail.com

CITATION

Patel SK, Agrawal G,
Mathew B. (2020).
Understanding the resilience
and mental health impacts of
natural disasters in India: A
narrative review. *International
Journal of Population Studies*,
6(1):82-98.
doi: [10.18063/ijps.v6i1.1183](https://doi.org/10.18063/ijps.v6i1.1183)

Copyright: © 2020 Patel, *et al.*

This is an Open Access article
distributed under the terms
of the Creative Commons
Attribution-Non Commercial
4.0 International License
([http://creativecommons.org/
licenses/by-nc/4.0/](http://creativecommons.org/licenses/by-nc/4.0/)), permitting
all noncommercial use,
distribution, and reproduction
in any medium, provided the
original work is properly cited.

Abstract: The purpose of this study is to understand the linkages between natural disasters and their impact on the mental health of people as well as associated resilience mechanisms in India. Natural disasters affect not only the physical environment but also the economy, social life, and well-being of the population. In addition to the loss of precious lives and economic losses, disasters affect the natural growth and mental health of the affected populations to a great extent. It is extremely challenging to quantify the true scale of damage caused by a disaster because physical damage is visible, but hidden impacts could be much more severe and have catastrophic effects on the socioeconomic growth of the affected families and areas. Against this background and with the limited available evidence, this study has tried to understand how disasters lead to poor mental health among the affected populations around the globe and tried to conceptualize this in the Indian context. Our review documents the different pathways for disasters to adversely affect mental health, particularly among vulnerable populations. The review also highlights how an increased frequency of disasters with climate change can lead to a post-traumatic stress disorder, adjustment disorder, and depression. Changes in climate and global warming may require populations to migrate, which can lead to acculturation stress. It can also lead to increased rates of physical illnesses, which secondarily would be associated with psychological distress. This research is an initial step in bringing this important issue forward in the context of Sustainable Development Goals and outlining that better policies need to be designed for prevention, services, and psychological counseling of mental health problems due to disasters. This study also suggests for more longitudinal research to understand the development of disaster-related mental health problems and to develop adequate mitigation strategies.

Keywords: Climate change; Natural disasters; Resilience; Post-traumatic stress disorder; Psychological distress; Mental health; India

This article belongs to the *Special Issue: Environment and Population Dynamics in South Asia*

1. Introduction

Disasters are the most prominent catastrophes which severely hinder the growth and pace of development of a country. In 2016, the world witnessed 191 natural catastrophes. Nearly 11,000 people died or went missing, and the profound economic loss from these disasters was estimated to be USD175 billion, the highest since 2012 (Swiss Re, 2016). Since 1970, the number of disasters worldwide has quadrupled to around 400 a year. Natural disasters increased by 13.9% in 2015 over the previous year (Guha-Sapir, Hoyois, and Below, 2016). Scientists believe that the increase in hydrometeorological disasters is due to a combination of natural and man-made factors. Global warming is continuously

increasing the temperature of the Earth's oceans and atmosphere, leading to more intense storms of all types, including hurricanes. However, natural disasters are deadlier and costlier than man-made disasters. In 2015, 6994 people were killed in man-made disasters, while 19,365 lives were lost to natural disasters. The economic losses incurred due to natural and man-made disasters in 2015 were USD80 billion and USD12 billion, respectively (Swiss Re, 2016).

Natural disasters have had multifarious ruinous impacts, invariably affecting the rich and the poor, the developed countries, and developing countries. However, natural disasters are more hazardous to low-income countries in particular, as they lead to long-term damages and resources are heavily diverted for reconstruction purposes (Johnson, 2006). Furthermore, low-income countries are more vulnerable as a higher proportion of people stay in areas that have poor infrastructure, and the lack of access to basic facilities heightens their exposure to disasters. Between 1994 and 2013, the Asian continent had the highest frequency of natural disasters and the greatest number of lives lost due to disasters. This is primarily due to the large and varied landmass in Asia – multiple river basins, flood plains, mountains, and active seismic and volcanic zones that are at high risk from natural hazards along with high population densities in disaster-prone areas. Nearly 48% of all disasters worldwide occurred in Asia in 2014 and 85% of lives lost were also in the same continent (CRED, 2015).

Natural disasters affect millions of people every year and leave residents and communities devastated and completely decimated. However, their impact is disproportionately more severe on the poor, farmers, and other marginalized groups of the population. Natural disasters brutally affect the agricultural sector, impacting livelihoods, and food production. With an approximate loss of USD80 billion owing to fall in crop production between 2003 and 2013, efforts toward hunger eradication have been hindered as a consequence of disasters that have impacted livelihoods and food security of over one-third of the developing countries (FAO, 2015). Statistics tend to count the lives lost and economic devastation of these events, but it is not easy to quantify the psychological impacts of a disaster.

The people left in the wake of these events have lost their homes, loved ones, and sometimes an entire way of life. For people already experiencing a mental illness, such a traumatic event makes symptoms even worse. For others, a natural disaster can lead to depression, extreme stress, generalized anxiety, eating and food issues, obsessive-compulsion, and a host of other problems. People are resilient – they begin to pick up the pieces of their lives and rebuild, but that does not mean the effects of a natural disaster do not linger. Studies have drawn out the mental health effects of natural disasters (McMichael, Woodruff, and Hales, 2006; Nahar, Blomstedt, Wu, *et al.*, 2014). Evidence suggests that the psychological impact of disasters is not restricted only to the people who have experienced it but also people involved in roles or occupations that require them to respond to disasters, for example, people involved in rescue operations and relief work; they are also susceptible to different psychological and mental stresses (Thormar, Gersons, Juen, *et al.*, 2010; Brooks, Dunn, Amlôt, *et al.*, 2016).

1.1. Rationale

Climate change is one of the greatest challenges of our time. The consequences of climate change on exposed biological subjects, as well as on vulnerable societies, are a concern for the entire scientific community. Rising temperatures, heat waves, floods, tornadoes, hurricanes, droughts, fires, loss of forests, and glaciers, along with the disappearance of rivers and desertification, can directly and indirectly cause human pathologies that are both physical and mental (Cianconi, Betrò, and Janiri, 2020). However, there is a clear lack in psychiatric studies on mental disorders linked to climate change. India has also been significantly affected by natural disasters over the years. Between 1994 and 2013, in terms of the cumulative number of people affected by natural disasters, India figured among the top countries (CRED, 2015). India also figured among the top five most disaster-hit countries in the past 10 years (Guha-Sapir, Hoyois, and Below, 2016). While a bound volume of evidence is documented on impacts of disasters on physical health, livelihood, food security, water and sanitation, and other socioeconomic dimensions in India, there is a dearth of studies on the impact of disasters on the mental health of the population in the country. With the above scenarios, this review article primarily aims to explore the pathways through which different natural disasters, which include heat waves, droughts, floods, cyclones, earthquakes, and landslides, impact the mental health of disaster affected-exposed people in India. We also aim to investigate the coping and adaptation mechanism of communities, as well as government strategies for tackling mental health impacts due to natural disasters, to suggest some future policy recommendations for better and effective disaster management in the country. To understand the pathways through which different natural disasters impact the mental health of people in India, we conducted a short review on theme.

2. Natural Disasters and Pathways to Mental Health

The expanding research literature on inter-linkages between climate change, natural disasters, and mental health includes increasing evidence that extreme weather events – which are more frequent, intense, and complex under a changing

climate – can trigger post-traumatic stress disorder (PTSD), major depressive disorder (MDD), anxiety, depression, complicated grief, survivor guilt, vicarious trauma, recovery fatigue, substance abuse, and suicidal ideation. Incremental climate change, such as rising temperatures, rising sea levels, and episodic drought, can change natural landscapes, disrupt food and water resources, change agricultural conditions, change land use and habitation, weaken infrastructure, and give rise to financial and relationship stress, increase risks of violence and aggression, and result in displacement of entire communities (Hayes, Blashki, Wiseman, *et al.*, 2018; Solanki, 2016; Wind and Komproe, 2018).

Berry *et al.* (2010) described the putative direct and indirect relationships among factors which have both direct and indirect effects on mental health, as illustrated in Figure 1. This figure serves as a guide to bridge disciplines and to comprehend key concepts related to inter-linkages between climate change, natural disasters, and mental health of affected populations. The link between extreme anxiety reactions (such as PTSD) and acute weather disasters, such as floods (the most common disasters at the global level), forest fires, heat waves, and cyclones, can be direct and indirect. Climate change/natural disasters may affect mental health directly by exposing people to the psychological trauma associated with higher frequency, intensity, and duration of climate-related disasters, including extreme heat exposure, and also by destroying landscapes, which diminishes the sense of belonging and solace that people derive from their connectedness to the land. In addition, indirect effects to mental health may occur via two pathways. Climate change-induced disasters may affect (1) physical health, through increased heat stress, injury, disease, and disruption to food supply and (2) community well-being, through damage to the economic and, consequently, the social fabric of communities (Kjellstrom, Holmer, and Lemke, 2009; Berry, Bowen, and Kjellstrom, 2010).

3. Key Findings

3.1. Heat Waves and Mental Health

Heat waves pose a serious policy challenge as temperatures soar and heat wave mortality rates mount with every passing year. The year 2016 has been the warmest in the world till date – it was 1.1°C higher than pre-industrial levels (WMO, 2019). India has high exposure to heat waves, and with inadequate adaptive ability, the effect of heightened heat waves might turn acute. In terms of the number of deaths due to natural disasters in 2015, heat waves caused the third-highest number of deaths in India at 2248 (Murari, Daly, Patwardhan, *et al.*, 2015). Heat waves not only account for mounting mortality rates but also have multiple life-altering impacts on populations and severely affect their employment, food availability, and basic life sources. Occupational health risks are likely to increase with a rise in heat exposure and thus

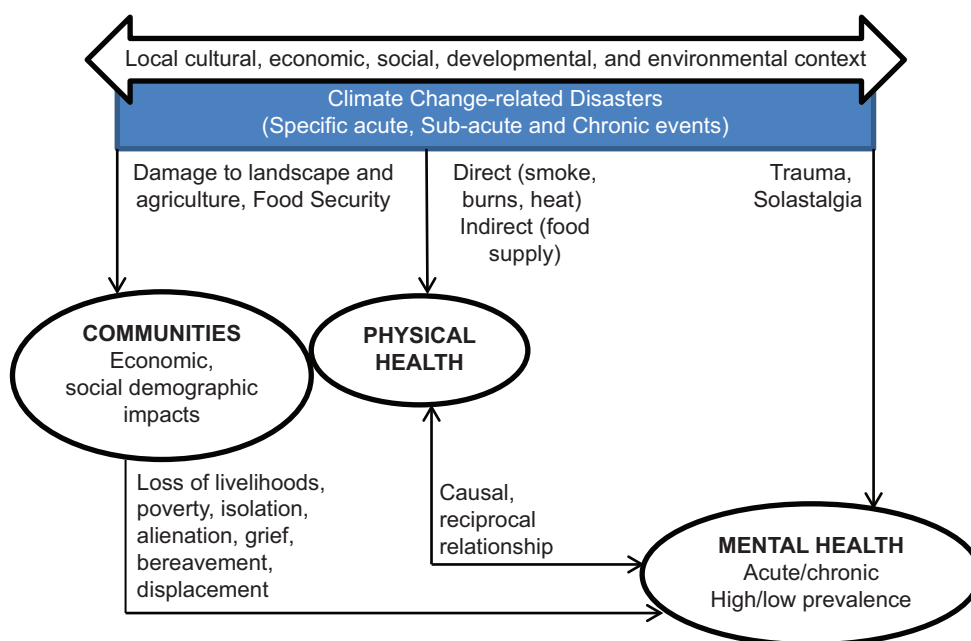


Figure 1. Natural disasters and pathways to mental health. Source: Referred from Berry *et al.* (2010).

adversely affect the productivity of workers (Kjellstrom, Holmer, and Lemke, 2009). Evidence shows that daily wage workers are not able to work continuously during heat waves, which affects their earning. People are forced to go out for work as they have no other choice. Vegetable vendors, construction workers, auto repair mechanics, rickshaw pullers, roadside kiosk operators, and other weaker sections in India have to work in the heat, thereby making them susceptible to the adverse impacts of heat waves such as dehydration, sun-strokes, and other health risks (NDMA, 2009b).

Exposure to heat waves also affects the mental health of populations. Evidence suggests that extreme heat exposure made people susceptible to symptomatic mental disorders, dementia, mood (affective) disorders, neurotic, stress-related, and somatoform disorders, disorders of psychological development, and other mental health consequences, for which admissions to hospitals rose during heat waves. At the same time, hospital admissions increased more among men, the elderly, and people in rural areas (Hansen, Nitschke, Ryan, *et al.*, 2008; Trang, Rocklöv, Giang, *et al.*, 2016). People also suffer psychologically and feel depressed when they are unemployed. People with low incomes have a higher likelihood to be afflicted by a chronic disease or other ailments such as mental illness or obesity due to heat waves (Kovats and Hajat, 2008).

In India, very limited evidence is available on how natural disasters affect the mental health of the affected populations. Heat waves are known to cause physiological and psychological stresses and even lead to death. It is known as a silent disaster as it develops gradually and harms both human beings and animals in the country. Global warming has resulted in increased heat wave conditions in India, consequently resulting in increased deaths due to heat waves in different parts of India, particularly in the north-western, southern, and south-eastern regions (Akhtar, 2007). Sudden increases are recorded in deaths arising due to mental and behavioral disorders during heat waves, especially among older persons (Solanki, 2016; Shukla, 2013). In Odisha, India, the increase in the frequency of extreme weather events has had an impact on the mental health of the people. The study conducted in Odisha showed that due to the extreme heat, water scarcity, and unavailability of labor force, majority of people suffered from a drought-like situation. They lost scope of agricultural productivity because of heat waves and scarcity of water. Many people migrated to other areas to work at low wages, which disturbed their financial condition. Loss of livelihood and income sources caused psychological stress. People became depressed as they had to struggle incessantly to meet their income needs, family commitments, and food requirements (Patel, 2018a).

3.2. Droughts and Mental Health

Drought has long been documented as one of the most insidious natural disasters and causes of human misery. Like other natural disasters, droughts often have significant health effects, typically mediated through complex environmental, economic, and social pathways. The catalog of harmful health effects associated with drought is still being assembled. Water scarcity also affects the functioning of public institutions such as schools and public health centers. Some of the health impacts owing to shortage of water include diarrhea, which occurs due to the consumption of contaminated water, while inadequate water intake can lead to dehydration. These factors are also a leading cause of infant mortality. Other health impacts of droughts include water-related diseases such as *Escherichia coli* and cholera, airborne, and dust-related diseases, vector-borne diseases such as malaria and West Nile virus, and mental health ailments (Stanke, Kerac, Prudhomme, *et al.*, 2013). Women, children, and infants constitute the most vulnerable sections of the population in the event of a drought. Previous studies have shown that drought not only affects people physically but also psychologically. There was a high degree of concordance among the identified literature, leaving a strong impression of increased risk for adverse mental health impacts associated with drought. Studies have highlighted how droughts have affected the mental health of people in terms of emotional stress and anxiety (Dean and Stalin, 2010; Hart, Berry, and Tonna, 2011).

Along with the western US, China, eastern and southern Africa, and the Mediterranean region, India featured among the areas that were most drought-prone between 1984 and 2013 (FAO, 2015). In India, droughts are projected to exacerbate the levels of poverty and affect the means of livelihood sustainability. Most major droughts in India have been followed by a recession. It leads to a shortage of raw material supplies for agro-based industries and it also reduces the demand for industrial products owing to the low purchasing capacity of rural consumers. Losses in agriculture affect the livelihood of farmers as small- and medium-sized farmers turn into agricultural laborers (NDMA, 2009b; Singh, Bantilan, and Byjesh, 2014).

Defining health outcomes associated with drought is also challenging, particularly in the area of mental health. Interpretations of mental health outcomes vary across studies, and often outcomes are not explicitly defined. Although mental health concepts are complex and vary with social, cultural, and familial norms and values, categorization of adverse mental health outcomes is a prerequisite of further study. We considered mental health to be more than just the absence of a mental illness or disorder and determined by a host of socioeconomic, biological, and environmental

factors. Our review suggests a high degree of concordance among the identified literature, leaving a strong impression of increased risk for adverse mental health impacts associated with drought. Indian farmers continue to suffer regularly from drought, a frequent natural disaster that has profound effects both individually and collectively. Successive droughts and low agricultural productivity are a blow to the regular income sources of farmers. This has caused many farmers in recent decades to take the extreme step of ending their lives. Farmer suicides, due to droughts and related consequences, have emerged as an important area of concern in recent decades in India (Kalamkar and Shroff, 2011; Bharti, 2011).

Drought affects employment and income of farmers and leads to indebtedness, and is counted as one of the major reasons for suicides (Udmale, Ichikawa, Manandhar, *et al.*, 2014; Patel, Mathew, Nanda, *et al.*, 2019). In 2014, around 5650 farmers committed suicide in India, of which 20.6% was due to indebtedness and 16.8% due to the failure of crops. Crop loss, chit funds, debt burden, property disputes, daughter's marriage, and illness of family members are among the reasons for farmer suicides in Karnataka (Deshpande, 2002). One of the reasons for reduced yield/profitability among cotton farmers in Vidarbha that had increased suicides post-1995 was the shortage of water (Mishra, 2006). In Karnataka, farmers have to grapple with drought conditions and paucity of rain, and a high number of suicide victims had rain-fed lands (Deshpande, 2002). Here, it is important to understand the cycle which farmers affected by droughts go through and eventually decide to end their lives. Undoubtedly, they were depressed, psychotic, and impulsive, accompanied by a pervasive sense of suffering and hopelessness, as well as a desire to escape from the situation that has arisen due to successive droughts and indebtedness. The study conducted in Odisha showed that besides the impact of droughts on livelihoods, food security, and physical health, the mental health of people was also impacted in the process. People are under tremendous mental pressure to meet the basic requirements of the family (Patel, 2018b).

3.3. Floods and Mental Health

Floods are the most commonly occurring natural disasters globally. It is not unusual then that among all-natural disasters, floods have affected the largest number of countries. In the post-2005 period, 47% of weather-related disasters globally were caused by floods, thereby affecting 2.3 billion people. In Asia and the Pacific region, 3.35 billion people were affected by floods between 1970 and 2013, which is higher than other natural disasters in the region. The economic losses caused by floods amounted to USD 370 billion, which is the second highest in the region after a combined loss of USD 472 billion caused by earthquakes and tsunamis (UNESCAP, 2015). In addition to economic losses, detrimental short-, medium-, and long-term effects on well-being, relationships, and physical and mental health are common. While most people who are involved in disasters recover with the support of their families, friends, and colleagues, the effects on some people's health, relationships, and welfare can be extensive and sustained.

Flooding can lead to substantial social and mental health problems that may continue over extended periods of time. Flooding can challenge the psychosocial resilience of the hardest of people who are affected. It is important to understand the effects of being separated from family and friends, disruption to family life and daily routine, the loss of pets and possessions, and moving to temporary accommodation, all of which can have an effect on the mental health of children. Symptoms can include separation anxiety; irregular sleeping patterns/nightmares; behavioral problems such as becoming withdrawn, increased aggression, bedwetting; and development of habit-forming behaviors such as routines/rituals about washing; and academic performance may suffer. Across the world, numerous studies have demonstrated that floods have impacted people psychologically. Floods have a range of impacts on physical and mental health. Women suffered from malnutrition due to food shortages after floods in Bangladesh. They were also subjected to mental torture, verbal abuse, domestic violence, and sexual harassment. Their vulnerability was increased due to the paucity of clothing and fuelwood (Azad, Hossain, and Nasreen, 2013). Flooding can lead to bereavement, behavioral issues in children, substance misuse, and even worsen mental health status (Stanke, Murray, Amlôt, *et al.*, 2012; Lock, Rubin, Murray, *et al.*, 2012). An epidemiological review by Health Protection Agency indicates that children and the elderly exhibit higher vulnerability to mental diseases as they depend on people of working age in terms of how they cope with floods. A study done in England indicates that people who were relocated due to floods and people with low earnings have a higher likelihood of severe mental health deterioration such as flashbacks, increased anger, and sleeplessness (Lamond, Joseph, and Proverbs, 2015). Another study indicates that there is a higher likelihood of developing anxiety and PTSD among people who are displaced after flooding (odds ratio for depression 2.0 [95% confidence interval 1.3-2.9], for anxiety 1.7 [1.1-2.5], and for PTSD 1.7 [1.2-2.5]) than people who were not displaced (Munro, Kovats, Rubin, *et al.*, 2017).

Floods in India ranked seventh in terms of the number of deaths and economic damage caused in 2015, and the second-highest number of victims at 13.71 million people (Guha-Sapir, Hoyois, and Below, 2016). More than 40 million hectares or nearly 12% of land in India is prone to floods and river erosion (NDMA, 2009b). Multiple factors that affect key aspects of the lives of people also cause mental stress. Several studies have highlighted the impact of floods on the

mental health of people in India. For example, studies in Kashmir have noted the mental health consequences of floods among people in terms of trauma, depression, stress, and anxiety (Fatima and Maqbool, 2017; Hassan, Singh, and Sekar, 2018; Dar, Iqbal, Prakash, *et al.*, 2018). Some studies have documented the mental health impact of floods on people in Bihar. Livelihood concerns were among the main reasons for developing symptoms of depression. A study showed that the elderly are more susceptible to developing PTSD and depression following the floods in Bihar (scored high PTSD at $p < 0.05$ compared to all other age-groups) (Telles, Singh, and Joshi, 2009; Telles, Singh, Joshi, *et al.*, 2010). Another study showed the psychological impact in the form of sleep disturbance and flashbacks among the elderly survivors of the Uttarakhand floods. At least 16.1% of the sample experienced recurrent flashbacks following the disaster and mostly had difficulty in maintaining sleep (14.5%). At least 12.9% found themselves thinking about the disaster and its recurrence even when they did not want to, and experienced intrusive memories regarding the same. At least 6.5% experienced a loss of their sense of safety and security following the disaster, and many contemplated relocating to other relatively safer parts of the state. At least 21.0% experienced restlessness and increased physiological arousal, contingent with any stimuli associated with the disaster, while 1.6% experienced increased irritability and anger at minor instances. At least 3.2% of them experienced vague bodily complaints non-attributable to any specific reason, following the occurrence of the disaster and significant worry regarding the future. At least 19.4% attempt to avoid reminders of the disaster (Chandran, Roopesh, Raj, *et al.*, 2015).

A study among high school students showed that, of all the adolescents aged 13-16 years, about one-third continued to suffer from trauma-related stress disorder even after 3 months of the flood in Uttarakhand in 2013 (Nisha, Kiran, and Joseph, 2014). The study shows that people struggle with psychosocial problems due to floods. They suffer psychologically because of the continuous loss of crops caused by floods. Farmers are always under immense mental pressure to sustain their families (Patel, 2018c). Due to erosion of the social, environmental, and material context, the recurrent floods have large negative impacts on the mental health outcomes and psychological and physical functioning of people in Northern India (Wind, Joshi, Kleber, *et al.*, 2013).

The review indicates that flooding affects people of all ages, can exacerbate or provoke mental health problems, and highlights the importance of secondary stressors in prolonging the psychosocial impacts of flooding. The distressing events experienced by the majority of the people, transiently or for longer periods after disasters, may be difficult to distinguish from the symptoms of common mental disorders. However, there are a number of methodological challenges that arise when conducting research and analyzing and comparing data on the psychosocial and mental health impacts of floods. Most of the studies employed cross-sectional design without a control group. There is a lack of studies that report evidence from the monitoring of the mental health of the flood-affected populations. Studies were conducted during the 1st year, with no medium- to long-term follow-up. This is important because acute stress-related response, if not addressed properly, can evolve to more severe disorders such as depression.

3.4. Cyclones and Mental Health

Even as cyclones become a regular occurrence in the range of disasters worldwide, they continue to leave behind a trail of destruction. During 1980-2009, 412,644 people died worldwide from cyclones (Doocy, Daniels, Packer, *et al.*, 2013). Several studies show that cyclones result in the destruction of property and infrastructure. They also indicate the damage wrought by cyclones on power supply and related infrastructure (Yuvaraj, Dharanirajan, Narshimulu, *et al.*, 2015). In recent years, cyclones have resulted in the displacement of people in higher numbers compared to other disasters. In 2013, Typhoon “Haiyan” caused the maximum number of displacements of people in the Philippines at 4,095,000. Similarly, in 2014, Typhoon “Rammason” in the Philippines caused the displacement of 2,994,100 people. In the last century, cyclones have affected populations worldwide. As for the biggest windstorm disasters between 1900 and 2005, Typhoon “Talim” was the third biggest disaster, affecting 19.6 million people in China (CRED, 2005). High levels of mental illness, PTSD, and suicidal attempts were reported among Hurricane Katrina affected people in New Orleans, USA (Sastri and VanLandingham, 2009).

This global trend of evidence-based research has also been seen in India. It has been acknowledged that India has traditionally been vulnerable to many natural disasters, including cyclones and tsunamis, on account of its unique geo-climatic conditions. Recent major cyclones in India include the Andhra Pradesh cyclone (1996), the super cyclone in Orissa (1999), and the tsunami in Tamil Nadu (2004). Cyclones have caused large-scale displacement and devastation in India. In terms of the biggest windstorm disasters between 1900 and 2005, India featured in the fifth position, while it had the second-highest number of major tropical cyclones. The super cyclone in Odisha in 1999 was the eighth biggest disaster in this period affecting 11 million people (CRED, 2005). In 2013, India ranked sixth in terms of the number of displacements, with Cyclone “Phailin” displacing 1,000,000 people. Cyclones also affect water and sanitation and impact health in the process.

While an event like a cyclone could serve as a catalyst for the occurrence of a disaster, the precise roots of mental health problems lie in the socially induced vulnerability associated with places and populations. In addition to the public health and medical consequences of these disasters, the social, cultural, and psychological impact of cyclones and tsunamis have an enormous and long-lasting impact throughout the world and a direct effect upon human development in general. The impact of gender, caste, socioeconomic status, and social network was apparent at virtually every stage of cyclone “Thane” in Puducherry, showing the salience of inequality and differential vulnerability in society (Parida, 2014). Cyclones have had a grave impact on water, sanitation, and health. Displaced people have a higher likelihood of suffering under outbreaks of waterborne and flood-borne diseases along with mental shocks (Chhotray and Few, 2012; Bhunia and Ghosh, 2011).

A growing body of research has pointed to linkages between mental health and environmental stressors exacerbated by climate change, including tropical cyclones. A study conducted 1 year after the super cyclone in India in 1999, found that a large number of children had post-traumatic symptoms. Another study showed that about 80.4% people had a probable psychiatric disorder, while 57.5% people had an anxiety disorder, and 52.7% had depression (Kar, Mohapatra, Nayak, *et al.*, 2007). Cases of anxiety and abnormal behavior patterns were also reported (Patra, Tripathy, and Jena, 2013). After cyclone Thane, a number of people were uprooted from their homes and lost their livelihoods in Puducherry, India. They experienced trauma, acute anxiety, depression, and suicidal thoughts (Parida, 2014).

In fact, acceptance of the existence of psychological impacts of natural disasters and the need for focused services for the survivors became much clearer only after the cyclone. A study done more than 4 years after the tsunami struck India in 2004 showed the continued prevalence of psychiatric morbidity among a high percentage of survivors (Kar, Krishnaraaj, and Rameshraj, 2013). In the wake of the 2004 tsunami, some of the problems faced by children in India included sleep disorder and separation anxiety from parents, anxiety, and helplessness. Adults had to grapple with hypervigilance, hyperarousal, depersonalization, and panic attacks (Becker, 2007). The review of some of the qualitative studies reveals that the mental health of people is severely affected in the event of disasters alongside the destruction of livelihoods and agriculture. Many people were in mental trauma or grappled with post-traumatic disorders after the 1999 cyclone, some people were not even able to recognize their family members (Patel, 2018c).

3.5. Earthquakes and Mental Health

Earthquakes are the deadliest natural disasters worldwide. In the period between 1994 and 2013, earthquakes accounted for 55% of total deaths caused by natural disasters, more lives were lost in earthquakes than from any other natural hazard, and earthquakes were the third most frequently occurring disasters in this period. Studies have highlighted the economic damages (Cavallo, Powell, and Becerra, 2010) and infrastructural damages caused by earthquakes (Parker and Steenkamp, 2012; Kobayashi, 2014). Large-scale seismic damage was caused to engineering infrastructure, and structural damage was caused to non-engineered reinforced concrete buildings due to the earthquake in Sumatra in 2005; main arteries and small streets were destroyed, thereby affecting the transportation system and hindering relief efforts (Saatcioglu, Ghobarah, and Nistor, 2005).

Earthquakes, as a natural disaster, not only causes deaths, physical disease, damage to infrastructure, and economic loss, they also have long-lasting mental health effects on individuals involved. A study highlighted that older people had higher levels of post-traumatic stress symptoms after an earthquake (Ticehurst, Webster, Carr, *et al.*, 1996). As per the Government of Nepal (2018), half of the people reported physiological stress on the day of the earthquake in Nepal, and far more women had psychosocial problems than men. About 40% of consultations in the aftermath of the 2005 earthquake in Pakistan were for trauma. PTSD, anxiety, and depression were prevalent among people 8 weeks after being affected by the earthquake in Thailand (Griensven, Chakkraband, Thienkrua, *et al.*, 2006). About 58% people had severe mental health issues after the Bam earthquake in Iran in 2003, which was thrice the psychological distress in the general population (Montazeri, Baradaran, Omidvari, *et al.*, 2005). A study showed that the middle-age group was more psychologically vulnerable and had a poorer capacity to cope with the earthquake in China due to their responsibility toward their family (Xu and He, 2012). A number of survivors of the earthquake in Wenchuan reported high levels of PTSD, anxiety, and depression. The prevalence rates of probable PTSD, anxiety, and depression were 26.3%, 49.8%, and 49.6%, respectively (Zhang, Shi, Wang, *et al.*, 2011).

There are very few studies which capture the adverse effects of earthquakes on mental health in India. Mental health problems were seen among people in Andaman and Nicobar Islands following the earthquake and tsunami that struck the Indian subcontinent in 2004. The study also showed that people suffered from depression, adjustment disorders, anxiety disorder, panic disorder, and PTSD and that displaced survivors had higher levels of psychiatric morbidity than non-displaced people. Following the early phase of the disaster, 5-8% of the population were suffering from significant mental health problems which were expected to increase in the aftermath of the early relief phase. Psychiatric morbidity is expected to be around 25-30% in the disillusionment phase (Math, Girimaji, Benegal, *et al.*, 2006).

A study done on children and adolescents in displaced populations showed the prevalence of adjustment disorder, schizophrenia, PTSD, and other disorders, in Andaman and Nicobar Islands. The most common psychiatric morbidities observed among the primary and secondary survivors were adjustment disorder (13.5%), depression (13.5%), panic disorder (10.8%), post-traumatic stress disorder (10.8%), schizophrenia (2.7), and other disorders (43.2%). Subclinical syndrome was present in the majority of the primary and secondary survivors. Few tertiary survivors had subsyndromal symptoms (Math, Girimaji, Benegal, *et al.*, 2008). Studies have observed the increase in mental health problems among survivors after the Gujarat earthquake in 2001 (Sharma, 2002). After the earthquake, psychosocial problems were reported, and some of the women who had suffered psychosocial shock even experienced premature delivery. A study showed that some of the people whose houses were ravaged during the earthquake in Kashmir in 2005, experienced adjustment disorders, depression, other stress reactions, and PTSD or PTSD-like symptoms. Some people lost their family members and/or injured physically (Chadda, Malhotra, Kaw, *et al.*, 2007). A study showed that children had psychological stress following an earthquake in Sikkim in 2011. Sleeplessness, night-awakenings, and excessive crying were observed among these children (Mondal, Sarkar, Banerjee, *et al.*, 2013).

The Marathwada earthquake in 1993 in India was one of the worst human tragedies of modern times, which captured global attention because of the massive impact it had in terms of loss of life and property. Moderate increase in psychiatric morbidity was observed in the medium term among the disaster-affected group, which for the most part, had subsided by the follow-up stage 5 years post-disaster. Differential distribution of cases was noticed in the affected villages paralleling the gradient of disaster losses. There was a clustering of cases within families (Shah, Parhee, Kumar, *et al.*, 2005; Kar, 2010). The above review has summarized the current status of information on mental disorders caused by experiencing or witnessing a severe, life-threatening earthquake. Each earthquake phase has different mental health problems. The review suggests that common mental disorders due to earthquakes include depression, cognitive function disorders, PTSD, and schizotypal personality.

3.6. Landslides and Mental Health

Landslides are among the most significant disasters across the globe, primarily affecting hilly regions. Landslides adversely affect the economy and cause damage to property (NIUA, 2016). Roads, bridges, schools, irrigation canals, temples, and cremation sites are damaged as a consequence of landslides (Van der Geest and Schindler, 2016). The impact on lifeline systems (water systems, hospitals, health centers, energy, and lines of communication) present in the path of the landslide is massive. They can be severely damaged or destroyed. Indirect effects can include loss of property value, livestock and crops, and increasing the vulnerability of the population, reducing their coping and caring capacities. The psychosocial well-being and mental health of rescue workers and their families are also at risk during and after landslides.

In a case report on providing support after landslides, Clifford (1999) described the psychological support services provided after the Thredbo landslide in New South Wales, Australia, which resulted in 18 fatalities (including a member of the New South Wales Fire Brigade). The labor-intensive and hazardous emergency response was complicated by a number of stressors, including fatigue, frustration, fear for personal safety, personal knowledge of the victims, and media exposure. Catapano *et al.* (2001) reported a controlled prevalence study among the survivors of the landslide in Sarno, Italy, in 1998. Survivors were more than 20 times more likely than members of a control group to suffer from PTSD, with 27.6% of survivors meeting the diagnostic criteria for PTSD compared to 1.4% in the control group. Typhoon "Morakot" in 2009 was one of the most severe typhoons to hit Taiwan. Nearly all inhabitants of the steep mountainside communities in southern Taiwan were at risk of landslides. Female gender, being injured during the landslide, and bereavement as a result of the disaster were all associated with increased risk of PTSD (Yang, Yen, Tang, *et al.*, 2011). People suffered mental stress and emotional trauma after the landslide in Nepal (Van der Geest and Schindler, 2016). Psychological well-being of children stood threatened as a consequence of floods and landslides in Myanmar (Government of Myanmar, 2015).

In India, the Himalayas are prone to landslides, particularly during the monsoon season from June to October. Various types of landslides occur in the Himalayas, including block slumping, debris flow, debris slide, rock falls, rotational slip, and translational slides. Studies show that more than 12% of the land area in the country is susceptible to landslides. The major landslide-prone areas in India include the Western Ghats and Konkan Hills (Tamil Nadu, Kerala, Karnataka, Goa, and Maharashtra), Eastern Ghats (Araku region in Andhra Pradesh), North-East Himalayas (Darjeeling and Sikkim), and North-West Himalayas (Uttarakhand, Himachal Pradesh, and Jammu and Kashmir). Landslides cause damage to private and government property, infrastructure, and heritage (NDMA, 2009a). Landslides in Darjeeling in 2015 led to several deaths and people were rendered homeless. Piles of debris were strewn across Darjeeling leading to disruption of communication, as roads were disconnected, and it took over a month to clear the debris (Sumantra and Raghunath

2016). Each year landslides lead to road blockages in Ladakh (Hodgkins). Landslides affect socioeconomically vulnerable people, severely affecting their livelihood and food security in India (NDMA, 2009a), and making daily life a struggle as key aspects of life get affected. This has potential mental health consequences for disaster-affected people.

While there is a large body of literature on the engineering and geological aspects of landslides, the mortality and morbidity caused by landslides are not as well documented. We could find a small number of relevant studies, as the documentation of the health impacts of landslides has been very limited. Mental health impacts were better documented, though some of the studies are now quite old. According to a study, the Himalayan landslides resulted in the loss of shelter and playing space and were associated with psychological distress, insecurity, grief, helplessness, and uncertainty in children (Aneelraj, Kumar, Somanathan, *et al.*, 2016). Studies showed that psychological morbidity was higher among people in the immediate phase following floods and landslides, as compared to other disasters in Uttarakhand (Nisha, Kiran, and Joseph, 2014; Srivastava, Goel, Semwal, *et al.*, 2015). People suffered from post-traumatic stress disorder, severe levels of depression, stress, and anxiety, and it was higher for those with lower levels of education (Sharma, 2016). A large number of people with severe mental disorders were seen wandering in the villages and near-religious places. Some of the shortcomings in disaster management with respect to mental health treatment included the absence and lack of availability of anti-psychotics, anti-depressants, anti-epileptics, and mood stabilizers in the district hospitals (Channaveerachari, Raj, Joshi, *et al.*, 2015). Landslides in Udhampur, Jammu and Kashmir, India, led to deaths and loss of livelihood and mental illness (Sharma, 2016).

4. Mental Health Resilience to Natural Disaster

4.1. Coping and Adaptation

Risk management includes both coping and adapting, and the two concepts are central for adaptation to climate change in both research and practice. Understanding local strategies used in preparing for, responding to, and recovering from climate-related disasters will help to define the capacity to adapt to disasters and climate-related events. This approach has been widely recognized and adopted within the field of climate change adaptation across developing countries as a part of their response. This section describes a number of mechanisms that are adopted by people to cope with different types of disasters and, at the same time, to reduce their mental health problems due to natural disasters.

In Banda Aceh, Indonesia, after the December 2004 tsunami, victims were eager to return to normalcy, while external medical relief workers were still arriving in large numbers. A study showed that while youth feel stressed due to drought in Botswana, some of the coping mechanisms they adopt include taking up work in the capital city, engaging in sexual activities, and accepting that drought is an important characteristic of the climate in the country and the best method to cope is to train themselves to live with it (Babugura, 2008). Highly exposed survivors resorted to problem-avoidance, fantasy, self-blame, and sought assistance to cope with the Sichuan earthquake in 2008 (Xu and He, 2012). During power failures in Australia, elderly clients had often coped better with heat waves than younger people with neurological conditions, probably because of heat preservation techniques learned during the pre-air conditioning period. Some of the elderly people pretended to be ill, so they could seek refuge in air-conditioned hospitals (Hansen, Nitschke, Pisaniello, *et al.*, 2011).

Numerous studies indicate the relevance of community support in helping people cope with disasters. A primary coping mechanism undertaken by people following the 2005 earthquake was to take up refuge with relatives in areas that either suffered less damage or those that were quickly stabilized (Hamilton and Halvorson, 2007). A factor that played a major role in avoiding negative mental health outcomes following floods was a rise in social cohesion such that people shared food with each other as there was a breakdown of caste barriers. While <1% people visited the traditional quack for mental health issues, drinking and dancing were taken up to deal with stress (Crabtree, 2013).

A study in Odisha, India, showed that people who were emotionally attached to the place, that is, genealogical rootedness, had strong emotional bonds and respect for ancestors, were alert to disasters that could potentially wreak havoc on their ancestral houses. People also helped their poor neighbors in reconstructing their houses after the cyclone. After cyclone "Phailin," people gave support and priority to the elderly, people with disabilities, and pregnant women in cyclone shelters (UNDP, 2015). Several factors helped people cope with the tsunami in 2004 in the Andaman and Nicobar Islands, including cohesive community, social support, altruistic behavior of the community leaders, and religious faith and spirituality. This was helpful in mobilizing people to help one another. In contrast to many disaster situations in South Asia, that show how women find it difficult to cope after natural disasters, this study showed that women were given priority with respect to social status, their safety, and security among the Nicobarese tribals (Math, Tandon, Girimaji, *et al.*, 2008).

Some studies have observed the significance of mind-body practices in reducing the effect of mental stress. A study showed that mind-body practices (which include Tai Chi and Qigong, meditation-relaxation, mindfulness-based stress

reduction, and deep breathing) had positive effects on PTSD and depression (Kim, Schneider, Kravitz, *et al.*, 2013). Another study showed that yoga proved useful in reducing sadness for victims of the Bihar floods (Telles, Singh, Joshi, *et al.*, 2010). A study conducted on the survivors of the 2010 floods in Ladakh showed that only a handful had PTSD or MDD, and this was largely attributed to the social background and temperamental characteristics of the Tibetan culture (Ishikawa, Yamamoto, Yamanaka, *et al.*, 2013).

4.2. Governmental Measures

Disaster preparedness prevents a surge in the local problems that health services normally handle. The immediate emergency response is provided under a highly political and emotional climate, and the responsibilities of the national or local health authorities are significant. The governments of various countries have introduced policies and programs for disaster management. The federal government in Brazil arranged for psychological assistance after a landslide in Rio-de-Janeiro (Pereira, Morales, Cardoso, *et al.*, 2013). The Mental Health Support for Drought-Affected Communities initiative in Australia aims to provide crisis counseling to distressed individuals in rural areas that are drought-declared, in addition to training for clinicians and community leaders. It also aims to improve the capacity of communities to respond to psychological trauma resulting from droughts (Government of Australia, 2007). The Humanitarian Country Team assisted the Sri Lankan government in the provision of psychosocial support to children and teachers in schools, and women, to restore normalcy after floods. Other measures to restore normalcy besides mental health care support include improving access to food, water, and sanitation for victims (UNRCO, 2017).

Initiatives as part of the recovery and reconstruction plan after landslides included rebuilding of damaged health facilities and provision of psychosocial support. Priority activities encompassed early recovery psychosocial services (Government of Myanmar, 2015). In 2006, Substance Abuse and Mental Health Services Administration of the Health and Human Services department of the US government conducted 91,000 counseling sessions for victims of Hurricane Katrina. Catholic Charities USA, a charity which received over USD 146 million in donations, provided hurricane victims with food, housing, and mental health counseling (Wang, Gruber, Powers, *et al.*, 2007).

The National Disaster Management Authority (NDMA) guidelines in India provide for emergency psychosocial first aid and evacuation of acute mentally ill persons that could be followed by activation of the Psychosocial Support and Mental Health Services response plan (NDMA, 2009b). Mental health experts were roped in by the administration to conduct counseling for survivors and relatives of victims affected by the landslide in Adivare, Maharashtra (Isalkar and Dastanel, 2014). Some studies have shown the usefulness of interventions providing mental health care support to survivors of natural disasters in India. A study done after the 2004 tsunami showed that people in Chennai, India, who received mental health support from trained volunteers, showed lower levels of depressive symptoms and psychological distress in contrast to people who did not get similar support (Vijayakumar and Kumar, 2008). An intervention that was initiated by NIMHANS in the wake of the 2004 tsunami was the stationing of teams of psychiatrists, social workers, and nurses, to provide support to survivors in Nagappattinam and Cuddalore in Tamil Nadu. This was done by providing training to local health-care providers and teachers who, in turn, trained 1200 community level workers who provided mental health care support to people. The study further advocated improvement in infrastructure and training with regard to the provision of psychosocial care (Becker, 2007).

5. Discussion

The widespread effects of natural disasters are well known. They affect not only the physical aspects of the environment but also the economy, social life, and well-being of populations (Gu, 2020). In addition to the loss of precious lives and economic losses, disasters affect the natural growth and mental health of the inhabitants to a great extent. It is often difficult to estimate the true scale of a disaster because physical damage is visible, but hidden damages could be much higher and affect the socioeconomic growth of the affected families and areas badly. There are some definite patterns that emerge in the aftermath of every disaster, which, if studied and understood well, can serve as an important pointer for the future. There is a growing need for public health practitioners and researchers to understand the health impacts of natural disasters. Our review critically documents several pathways for disasters to adversely affect mental health, particularly among vulnerable populations. As there is limited evidence available, we reviewed the literature on how disasters lead to poor mental health among the affected populations around the globe and try to conceptualize this in the Indian context. The review documents how increased frequency of disasters with climate change can lead to PTSD, adjustment disorder, and depression. Changes in climate and global warming may require populations to migrate, which can lead to acculturation stress. It can also lead to increased rates of physical illnesses, which secondarily would be

associated with psychological distress (Padhy, Sarkar, Panigrahi, *et al.*, 2015). There is some evidence that individuals may suffer from post-traumatic stress through the impact of the disaster on their community, even if not individually impacted (Wind and Komproe, 2018).

Disasters affect the economy of countries as substantial damage is caused to infrastructure and the cost of recovery is high, given the increasing frequency of some natural hazards. People are uprooted from their homes and lose their livelihoods, and end up grappling with trauma, acute anxiety, depression, and suicidal thoughts (Parida, 2014). The review shows that with the wrecking of livelihoods, people find it difficult to secure alternate employment and the inability to cope with disasters and adapt, adversely affects their mental health. Natural disasters, especially heat waves, lead to an increase in morbidity, exacerbate physical illnesses, and cause heatstroke, making it difficult for informal sector workers to work during extreme heat wave conditions. Livelihood concerns were among the main reasons for developing symptoms of depression (Crabtree, 2013). Farmer suicides in recent decades are an important area of concern in the mental health arena. Given the increasing unviability of agriculture as an occupation and psychological problems that have emerged in recent years due to the livelihood impact of floods/cyclones, it is imperative to assess and further study the mental health impact of natural disasters on agriculture and other climate-sensitive livelihoods. It is also essential to improve infrastructure and facilities for mental health care besides strengthening programs for livelihood regeneration to avert suicides arising from indebtedness and loss of income sources.

The study clearly shows the psychosocial impacts of natural disasters, including sleep disturbances, flashbacks, helplessness insecurity, grief, uncertainty, depression, stress, PTSD, psychiatric disorders, trauma-related stress disorders, adjustment disorders, anxiety disorders, panic disorders, and abnormal behavioral patterns. Mental disorders that result from disasters are major challenges for public health and development (Stanke, Murray, Amlôt, *et al.*, 2012). The fact that disasters have continued to affect countries severely shows that even though policies on climate change and disaster management have been introduced, they have not been entirely successful in curbing the severe effects of disasters. Some studies have observed the significance of mind-body practices in reducing the effect of mental stress (Kim, Schneider, Kravitz, *et al.*, 2013; Telles, Singh, Joshi, *et al.*, 2010). There is evidence which highlights inadequate facilities for mental health care (Channaveerachari, Raj, Joshi, *et al.*, 2015), and the significance of interventions made to provide mental health care support in the aftermath of disasters (Vijayakumar and Kumar, 2008; Becker, 2007). Community mental health preparedness is important to find the most appropriate tool which will enable a suitable response when facing disasters. However, there is a lack of mental health preparedness in a majority of the countries; valid and reliable tools and context-bound programs should be developed based on the experiences and perceptions of the community (Roudini, Khankeh, and Witruk, 2017). There is a great need for long-term prospective studies on the effects of disasters and more interventional studies to find out the effectiveness of supportive measures provided to the victims. It is imperative to inculcate a mental health support system in the disaster response strategies in India (Kar, 2010).

The review shows that despite measures introduced by the government, mental health continues to be affected by disasters, and stronger measures need to be taken up. Boosting public education with regard to effects and aftereffects of disasters, mentally preparing people for natural outcomes, and improving public health surveillance to detect diseases and complications will add value to existing efforts. Giving special attention to mental health and post-disaster psychosocial rehabilitation will be an investment worth making. While rescue efforts are worthy of praise, recurrent disasters will warrant attention and care for all survivors well into the future. Psychological counseling needs to be facilitated in shelters/camps. Psychological and psychiatric care needs to be provided both in the immediate aftermath of disasters as well as for the long-term. Psychological first aid can be provided by field workers, including health workers, teachers, or trained volunteers, and does not always need mental health professionals. However, psychosocial teams (psychiatrist, psychologists, and psychosocial worker) may be needed for rapid psychosocial assessments and community-based psychosocial care and referral services in affected communities.

Post-disaster, rebuilding of an area, especially in relation to mental health, requires building emotional health of survivors through self-care; strengthening of families; supporting anganwadis, schools, colleges, and workplaces, to become places to promote mental health; creating caring communities from the Panchayat level; building resilience at the community level for long-term preparedness; and most importantly, to sensitize the administrative mechanisms toward the importance of mental health aspects, and coordination with the local authorities and policymakers (Chadda, 2018; Murthy, 2018). It is also important to understand that the psychological and mental health services and interventions are very much country- and culture-specific; therefore, any tailor-made intervention in one country may not be applicable in a similar disaster in other countries. For example, similar magnitudes of earthquakes in India and Iran would be two different contexts altogether; therefore, mental health and psychosocial services would certainly vary, although the core recovery

objectives and principles may remain similar and constant in both the countries. However, good intervention practices in one country may be adapted for the specific needs of another country's disaster-affected populations (Satapathy, 2012).

6. Conclusions

Given the current situation affecting most of the countries across the globe, and increasing concerns over the association between climate change and natural disasters, the linkages between natural disasters and mental health also becomes increasingly important. Globally, the prevalence of mental health issues is extremely high even without considering the added mental health consequences of a changing climate. While public awareness of the health implications of climate change and natural disasters continues to grow, the topic of mental health is frequently absent from this discourse. In some ways, this reflects the global discourse, where, in comparison to physical health, mental health, in general, has been neglected. There is a substantial body of literature on the topic that allows for the identification of several distinct and interrelated pathways by which disasters can adversely impact mental health, as well as several coping and adaptation strategies. Most of these relationships are mediated through environmental or socioeconomic pathways, and the outcomes most closely studied are PTSDs and, to a lesser degree, intimate partner violence and suicide. The associations between disaster exposure and adverse mental health outcomes have had large socioeconomic impacts. The mental health effects of climate change can be multifarious, direct or indirect, and short-term or long-term. Acute disaster events can act through mechanisms similar to that of traumatic stress, leading to well-understood psychopathological patterns.

This research is an initial step in bringing this important issue forward in the context of Sustainable Development Goals and outlining that better programs/guidelines need to be designed for prevention, services, and psychological counseling of mental health problems due to disasters. Longitudinal research will further help us understand the development of disaster-related mental health problems and develop adequate mitigation strategies to confront the increasing numbers of disaster-affected individuals with mental health problems. Moreover, an important step can also be to focus on social capital mechanisms, which can intentionally be promoted with beneficial effects on disaster mental health outcomes. Psychosocial interventions should be culturally applied to local survivors. In addition, the national mental health program should be integrated or linked to other government programs and departments, such as health programs, disaster mitigation programs, revenue department, and other allied programs so that the affected people can benefit and receive the services immediately without delay and live a dignified life free of mental health issues.

Disclaimer

The views and geographic names or definitions expressed in this article solely reflect those of the authors and do not reflect those of the organizations the authors are affiliated to nor the publisher nor those of the editorial office and the editorial board of the Journal.

Acknowledgments

The authors are grateful to the colleagues of Population Council for providing the necessary inputs for writing this paper.

Authors' Contributions

Conceived, designed, and taken lead: Sangram Kishor Patel. Review of literature: Sangram Kishor Patel, Gopal Agrawal, and Bincy Mathew. Contributed to tools/materials/references: Sangram Kishor Patel and Gopal Agrawal. Drafted, reviewed, and wrote the manuscript: Sangram Kishor Patel, Gopal Agrawal, and Bincy Mathew.

Conflicts of Interest

No conflicts of interest were reported by the authors.

Ethical Approval

Not applicable.

Availability of Supporting Data

Open data sources.

Availability of Data and Materials

Not applicable.

Funding

None.

References

- Akhtar, R. (2007). Climate Change and Health and Heat Wave Mortality in India. *Global Environ Res*, 11:51-7.
- Aneelraj D, Kumar CN, Somanathan R, et al. (2016). Uttarakhand Disaster 2013: A Report on Psychosocial Adversities Experienced by Children and Adolescents. *The Indian Journal of Pediatrics*, 83(4):316-21.
- Azad AK, Hossain KM, and Nasreen M. (2013). Flood-Induced Vulnerabilities and Problems Encountered by Women in Northern Bangladesh. *The International Journal of Disaster Risk Science*, 4:190-9.
- Babugura AA. (2008). Vulnerability of Children and Youth in Drought Disasters: A Case Study of Botswana. *Children Youth and Environments*, 18(1):126-57.
- Becker SM. (2007). Psychosocial care for adult and child survivors of the tsunami disaster in India. *Journal of Child and Adolescent Psychiatric Nursing*, 20(3):148-55.
- Berry HL, Bowen K, and Kjellstrom T. (2010). Climate Change and Mental Health: A Causal Pathways Framework. *International Journal of Public Health*, 55(2):123-32.
- Bharti V. (2011). Indebtedness and Suicides: Field Notes on Agricultural Labourers of Punjab. *Economic and Political Weekly*, 46(14):35-40.
- Bhunia R and Ghosh S. (2011). Waterborne Cholera Outbreak Following Cyclone Aila in Sundarban Area of West Bengal, India, 2009. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 105(4):214-9.
- Brooks SK, Dunn R, Amlôt R, et al. (2016). Social and Occupational Factors Associated with Psychological Distress and Disorder among Disaster Responders: A Systematic Review. *BMC Psychology*, 4(1):18.
- Catapano F, Malafronte R, Lepre F, et al. (2001). Psychological consequences of the 1998 landslide in Sarno, Italy: A community study. *Acta Psychiatrica Scandinavica*, 104(6):438-42.
- Cavallo E, Powell A, and Becerra O. (2010). Estimating the Direct Economic Damages of the Earthquake in Haiti. *The Economic Journal*, 120(546):298-8.
- Chadda RK, Malhotra A, Kaw N, et al. Mental Health Problems Following the 2005 Earthquake in Kashmir: Findings of Community-run Clinics. *Prehospital and Disaster Medicine*, 22(6):541-5.
- Chadda RK. (2018). Mental Health Services in Disaster-Affected Population in Low-Resource Settings. *Indian Journal of Social Psychiatry*, 34:7-10.
- Chandran D, Roopesh N, Raj A, et al. (2015). Psychosocial Impact of the Uttarakhand Flood Disaster on Elderly Survivors. *Indian Journal of Gerontology*, 29(1):62-76.
- Channaveerachari NK, Raj A, Joshi PP, et al. (2015). Psychiatric and Medical Disorders in the after Math of the Uttarakhand Disaster: Assessment, Approach, and Future Challenges. *Indian Journal of Psychological Medicine*, 37(2):138.
- Chhotray V and Few R. (2012). Post-disaster Recovery and Ongoing Vulnerability: Ten Years after the Super-Cyclone of 1999 in Orissa, India. *Global Environmental Change*, 22(3):695-702.
- Cianconi P, Betrò S, and Janiri L. (2020). The Impact of Climate Change on Mental Health: A Systematic Descriptive Review. *Frontiers in Psychiatry*, 11:74.
- Clifford B. (1999). The New South Wales Fire Brigades' Critical Incident Stress Management Response to the Thredbo Landslide. *International Journal of Emergency Mental Health*, 1(2):127-33.
- Crabtree A. (2013). Questioning Psychosocial Resilience after Flooding and the Consequences for Disaster Risk Reduction. *Social Indicators Research*, 113(2):711-28.
- CRED. (2005). *Disaster Data: A Balanced Perspective*. Brussels, Belgium: Centre for Research on the Epidemiology of Disasters,

CREAD.

- CREAD. (2015). *The Human Cost of Natural Disasters 2015: A Global Perspective*. Brussels, Belgium: Centre for Research on the Epidemiology of Disasters, CREAD.
- Dar KA, Iqbal N, Prakash A, et al. (2018). PTSD and Depression in Adult Survivors of Flood Fury in Kashmir: The Payoffs of Social Support. *Psychiatry Research*, 261:449-45.
- Dean JG and Stain HJ. (2010). Mental Health Impact for Adolescents Living with Prolonged Drought. *Australian Journal of Rural Health*, 18(1):32-7.
- Deshpande RS. (2002). Suicide by Farmers in Karnataka: Agrarian Distress and Possible Alleviatory Steps. *Economic and Political Weekly*, 37(26):2601-10.
- Doocy S, Daniels A, Packer C, et al. (2013). The Human Impact of Earthquakes: A Historical Review of Events 1980-2009 and Systematic Literature Review. *PLoS Currents*, 5:833.
- FAO. (2015). *The Impact of Disasters on Agriculture and Food Security*. Rome, Italy: Food and Agriculture Organization. Accessed from: <http://www.fao.org/3/a-i5128e.pdf>. [Last accessed on 2020 Jun 03].
- Fatima Z and Maqbool S. (2017). Trauma, Depression and Stress among Individuals Living in Flood Affected and Unaffected Areas. *International Journal of Education and Psychological Research*, 6(1):7-11.
- Government of Australia. (2007). *Mental Health Increased Mental Health Services for Drought-Affected Communities*. Australia: Government of Australia.
- Government of Myanmar. (2015). *Myanmar Post-Disaster Needs Assessment of Floods and landslides, July-September 2015*. Myanmar: Government of Myanmar.
- Government of Nepal. (2018). *Nepal Disaster Report, 2017: The Road to Sendai*. Kathmandu: Government of Nepal.
- Griensven VF, Chakkraband MS, Thienkrua W, et al. (2006). Mental Health Problems among Adults in Tsunami-Affected Areas in Southern Thailand. *JAMA*, 296(5):537-48.
- Gu, D. (2019). *Exposure and Vulnerability to Natural Disasters for World's Cities*. United Nations, New York, USA: Department of Economics and Social Affairs, Population Division, Technical Paper No. 4.
- Guha-Sapir D, Hoyois P, and Below R. (2016). *Annual Disaster Statistical Review 2015. The Numbers and Trends*. Belgium: CRED.
- Hamilton JP and Halvorson SJ. (2007). The 2005 Kashmir Earthquake: A Perspective on Women's Experiences. *Mountain Research and Development*, 27(4):296-301.
- Hansen A, Nitschke M, Pisaniello D, et al. (2011). Perceptions of Heat-Susceptibility in Older Persons: Barriers to Adaptation. *International Journal of Environmental Research and Public Health*, 8(12):4714-28.
- Hansen A, Nitschke M, Ryan P, et al. (2008). The Effect of Heat Waves on Mental Health in a Temperate Australian City. *Environmental Health Perspectives*, 116(10):1369.
- Hart CR, Berry HL, and Tonna M. (2011). Improving the Mental Health of Rural New South Wales Communities Facing Drought and Other Adversities. *Australian Journal of Rural Health*, 19(5):231-8.
- Hassan FU, Singh G, and Sekar K. (2018). Children's Reactions to Flood Disaster in Kashmir. *Indian Journal of Psychological Medicine*, 40:414-9.
- Hayes K, Blashki G, Wiseman J, et al. Climate Change and Mental Health: Risks, Impacts and Priority Actions. *International Journal of Mental Health Systems*, 12:28.
- Ishikawa M, Yamamoto N, Yamanaka G, et al. (2013). Disaster-Related Psychiatric Disorders among Survivors of Flooding in Ladakh, India. *International Journal of Social Psychiatry*, 59(5):468-73.
- Johnson JD. (2006). *Natural Disaster and Vulnerability*. Policy Brief No. 29 OECD Development Center. OECD Development Center, Policy Brief No. 29.
- Kalamkar SS and Shroff S. (2011). Impact of Rehabilitation Package in Suicide-Prone Districts of Vidarbha. *Economic and Political Weekly*, 46(5):10-3.
- Kar N, Krishnaraaj R, and Rameshraj K. (2013). Long-Term Mental Health Outcomes Following the 2004 Asian Tsunami Disaster: A Comparative Study on Direct and Indirect Exposure. *Disaster Health*, 1(2):1-11.
-

- Kar N, Mohapatra PK, Nayak KC, *et al.* (2007). Post-Traumatic Stress Disorder in Children and Adolescents One Year after a Super-Cyclone in Orissa, India: Exploring Cross-Cultural Validity and Vulnerability Factors. *BMC Psychiatry*, 7:8.
- Kar N. (2010). Indian Research on Disaster and Mental Health. *Indian Journal of Psychiatry*, 52(Suppl 1):S286-90.
- Kim SH, Schneider SM, Kravitz L, *et al.* (2013). Mind-body Practices for Posttraumatic Stress Disorder. *Journal of Investigative Medicine*, 61(5):827-34.
- Kjellstrom T, Holmer I, and Lemke B. (2009). Workplace Heat Stress, Health and Productivity an Increasing Challenge for Low and Middle-Income Countries during Climate Change. *Global Health Action*, 2(1):2047.
- Kobayashi M. (2014). Experience of Infrastructure Damage Caused by the Great East Japan Earthquake and Countermeasures against Future Disasters. *IEEE Communications Magazine*, 52(3):23-9.
- Kovats RS and Hajat S. (2008). Heat Stress and Public Health: A Critical Review. *Annual Review of Public Health*, 29:41-55.
- Lamond JE, Joseph RD, and Proverbs DG. (2015). An Exploration of Factors Affecting the Long Term Psychological Impact and Deterioration of Mental Health in Flooded Households. *Environmental Research*, 140:325-34.
- Lock S, Rubin GJ, Murray V, *et al.* (2012). Secondary Stressors and Extreme Events and Disasters: A Systematic Review of Primary Research from 2010-2011. *PLoS Currents*, 4:24.
- Math SB, Girimaji SC, Benegal V, *et al.* (2006). Tsunami: Psychosocial Aspects of Andaman and Nicobar Islands. Assessments and Intervention in the Early Phase. *International Review of Psychiatry*, 18(3):233-9.
- Math SB, Tandon S, Girimaji SC, *et al.* (2008). Psychological Impact of the Tsunami on Children and Adolescents from the Andaman and Nicobar Islands. *Primary Care Companion to the Journal of Clinical Psychiatry*, 10(1):31.
- McMichael AJ, Woodruff RE, and Hales S. (2006). Climate Change and Human Health: Present and Future Risks. *The Lancet*, 367(9513):859-69.
- Mishra S. (2006). Farmers' Suicides in Maharashtra. *Economic and Political Weekly*, 41(16):1538-45.
- Mondal R, Sarkar S, Banerjee I, *et al.* (2013). Acute Stress-Related Psychological Impact in Children Following Devastating Natural Disaster, the Sikkim Earthquake (2011), India. *Journal of Neurosciences in Rural Practice*, 4(Suppl 1):S19.
- Montazeri A, Baradaran H, Omidvari S, *et al.* (2005). Psychological Distress among Bam Earthquake Survivors in Iran: A Population-based Study. *BMC Public Health*, 5(1):4.
- Munro A, Kovats RS, Rubin GJ, *et al.* (2017). Effect of Evacuation and Displacement on the Association between Flooding and Mental Health Outcomes: A Cross-sectional Analysis of UK Survey Data. *Lancet Planet Health*, 1(4):e134-41.
- Murari KK, Ghosh S, Patwardhan A, *et al.* (2015). Intensification of Future Severe Heat Waves in India and their Effect on Heat Stress and Mortality. *Regional Environmental Change*, 15:569-79.
- Murthy RS. (2018). Disaster Mental Health and Social Psychiatry: Challenges and Opportunities. *Indian Journal of Social Psychiatry*, 34:323-7.
- Nahar N, Blomstedt Y, Wu B, *et al.* (2014). Increasing the Provision of Mental Health Care for Vulnerable, Disaster-Affected People in Bangladesh. *BMC Public Health*, 14(1):708.
- NDMA. (2009a). *National Disaster Management Guidelines Management of Landslides and Snow Avalanches, 2009*. New Delhi: A Publication of the National Disaster Management Authority, Government of India.
- NDMA. (2009b). *National Disaster Management Guidelines: Psycho-Social Support and Mental Health Services in Disasters, 2009*. New Delhi: A Publication of the National Disaster Management Authority, Government of India.
- Nisha C, Kiran P, and Joseph B. (2014). Assessment of Post-Traumatic Stress Disorder among Disaster Affected Children in a High School in Uttarkashi District, Uttarakhand, India. *International Journal of Health System and Disaster Management*, 2(4):237.
- NIUA. (2016). *Landslides India Urban Climate Change Fact Sheets*. New Delhi: National Institute of Urban Affairs.
- Padhy SK, Sarkar S, Panigrahi M, *et al.* (2015). Mental Health Effects of Climate Change. *Indian Journal of Occupational and Environmental Medicine*, 19(1):3-7.
- Parida PK. (2014). We are Living with Daily Disasters: A Study of Mental Health Consequences of Cyclone Thane. *Sociological Bulletin*, 63(1):77-94.
- Parker M and Steenkamp D. (2012). The Economic Impact of the Canterbury Earthquakes. *Reserve Bank of New Zealand Bulletin*,

75(3):13-25.

- Patel SK, Mathew B, Nanda A, et al. (2019). A Review on Extreme Weather Events and Livelihood in Odisha, India. *Mausam*, 70(3):551-60.
- Patel SK. (2018a). *A Qualitative Community Level Assessment of Heatwaves in Odisha: Impacts, Resilience and Policy Implications, Policy Brief*. New Delhi: Population Council.
- Patel SK. (2018b). *A Qualitative Community Level Assessment of Droughts in Odisha: Impacts, Resilience and Policy Implications, Policy Brief*. New Delhi: Population Council.
- Patel SK. (2018c). *A Qualitative Community Level Assessment of Floods and Cyclones in Odisha: Impacts, Resilience and Policy Implications, Policy Brief*. New Delhi: Population Council.
- Patra M, Tripathy S, and Jena I. (2013). Health Hazards by Sea Cyclones in Odisha, the Supercyclone and the Phailin. *Odisha Review*, 70(4):30-7.
- Pereira BM, Morales W, Cardoso RG, et al. (2013). Lessons Learned from a Landslide Catastrophe in Rio de Janeiro, Brazil. *American Journal of Disaster Medicine*, 8(4):253-8.
- Roudini J, Khankeh HR, and Witruk E. (2017). Disaster Mental Health Preparedness in the Community: A Systematic Review Study. *Health Psychology Open*, 4:307.
- Saatcioglu M, Ghobarah A, and Nistor I. (2005). Effects of the December 26, 2004 Sumatra Earthquake and Tsunami on Physical Infrastructure. *ISET Journal of Earthquake Technology*, 42(4):79-94.
- Sastry N and VanLandingham M. (2009). One Year Later: Mental Illness Prevalence and Disparities among New Orleans Residents Displaced by Hurricane Katrina. *American Journal of Public Health*, 99(3):S725-31.
- Satapathy S. (2012). Mental health impacts of disasters in India: Ex-ante and Ex-post analysis. In: Sawada Y and Oum S editors. *Economic and Welfare Impacts of Disasters in East Asia and Policy Responses*. ERIA Research Project Report 2011-8, Jakarta: ERIA. p425-461.
- Shah B, Parhee R, Kumar N, et al. (2005). *Mental Health Research in India (Technical Monograph on ICMR Mental Health Studies)*. New Delhi: Indian Council of Medical Research.
- Sharma A. (2016). *Risk of Landslides Drives Migration and Mental Health Worries*. Canary Wharf, London: Reuters.
- Sharma R. (2002). Gujarat Earthquake Causes Major Mental Health Problems. *BMJ British Medical Journal*, 324(7332):259.
- Shukla J. (2013). Extreme Weather Events and Mental Health: Tackling the Psychosocial Challenge. *International Scholarly Research Notices*, 2013:127365.
- Singh NP, Bantilan C, and Byjesh K. (2014). Vulnerability and Policy Relevance to Drought in the Semi-arid Tropics of Asia A Retrospective Analysis. *Weather and Climate Extremes*, 3:54-61.
- Solanki R. (2016). Effect of Climate Change on Mental Health. *International Journal of Indian Psychology*, 3(4):304.
- Srivastava M, Goel D, Semwal J, Gupta R and Dhyani M. (2015). Posttraumatic Stress Disorder Symptoms in the Population of Uttarkashi, Tehri, and Pauri Garhwal India in Reference to Uttarakhand Flood-June 2013. *International Journal of Health System and Disaster Management*, 3(5):37.
- Stanke C, Kerac M, Prudhomme C, et al. (2013). Health Effects of Drought: A Systematic Review of the Evidence. *PLoS Currents*, 5:1-4.
- Stanke C, Murray V, Amlôt R, et al. (2012). The Effects of Flooding on Mental Health: Outcomes and Recommendations from a Review of the Literature. *PLoS Currents*, 4:e4f9f1fa9c3cae.
- Sumantra SB and Raghunath P. (2016). Causes of Landslides in Darjeeling Himalayas during June-July, 2015. *Journal of Geography and Natural Disasters*, 6:173.
- Swiss Re. (2016). *Natural Catastrophes and Man-made Disasters in 2015: Asia Suffer Substantial Losses*. Sigma No. 1, Switzerland. Available from: http://www.re.indiaenvironmentportal.org.in/files/file/sigma_2016_en.pdf. [Last accessed on 2020 Jan 26].
- Telles S, Singh N, and Joshi M. (2009). Risk of Posttraumatic Stress Disorder and Depression in Survivors of the Floods in Bihar, India. *Indian Journal of Medical Sciences*, 63(8):330.
- Telles S, Singh N, Joshi M, et al. (2010). Post-Traumatic Stress Symptoms and Heart Rate Variability in Bihar Flood Survivors

- Following Yoga: A Randomized Controlled Study. *BMC Psychiatry*, 10(1):18.
- Thormar SB, Gersons BP, Juen B, *et al.* (2010). The Mental Health Impact of Volunteering in a Disaster Setting: A Review. *The Journal of Nervous and Mental Disease*, 198(8):529-38.
- Ticehurst S, Webster RA, Carr VJ, *et al.* (1996). The Psychosocial Impact of an Earthquake on the Elderly. *International Journal of Geriatric Psychiatry*, 11(11):943-951.
- Trang PM, Rocklöv J, Giang KB, *et al.* (2016). Heatwaves and Hospital Admissions for Mental Disorders in Northern Vietnam. *PLoS One*, 11(5):e0155609.
- Udmale P, Ichikawa Y, Manandhar S, *et al.* (2014). Farmers' Perception of Drought Impacts, Local Adaptation and Administrative Mitigation Measures in Maharashtra State, India. *International Journal of Disaster Risk Reduction*, 10(A):250-269.
- UNDP. (2015). *Preparing for Disaster: Lessons from Phailin Response*. New Delhi, India: UNDP.
- UNESCAP. (2015). *Overview of Natural Disasters and their Impacts in Asia and the Pacific, 1970-2014*. Bangkok, Thailand: United Nations Economic and Social Commission for Asia and the Pacific.
- UNRCO. (2017). *Sri Lanka: Floods and Landslides Emergency Response Plan (June October 2017)*. India: UNRCO.
- Van der Geest K and Schindler M. (2016). *Case Study Report: Loss and Damage from a Catastrophic Landslide in Sindhupalchok District, Nepal. Report No. 17*. Bonn: United Nations University Institute for Environment and Human Security.
- Vijayakumar L and Kumar MS. (2008). Trained Volunteer-Delivered Mental Health Support to Those Bereaved by Asian Tsunami an Evaluation. *International Journal of Social Psychiatry*, 54(4):293-302.
- Wang PS, Gruber MJ, Powers RE, *et al.* (2007). Mental Health Service use among Hurricane Katrina Survivors in the Eight Months after the Disaster. *Psychiatric Services (Washington, DC)*, 58(11):1403-11.
- Wind TR and Komprou IH. (2018). Closing the Gap between Disaster Mental Health Research and Practice: Evidence for Socio-Ecological Mental Health Interventions through Multilevel Research. *Intervention*, 16(1):5-13.
- Wind TR, Joshi PC, Kleber RJ, *et al.* (2013). The Impact of Recurrent Disasters on Mental Health: A Study on Seasonal Floods in Northern India. *Prehospital and Disaster Medicine*, 28(3):1-7.
- WMO. (2019). *WMO Confirms 2019 as Second Hottest Year on Record*. World Meteorological Organization, Press Release dated 6 February, 2019. Available from: <https://www.public.wmo.int/en/media/press-release/wmo-confirms-past-4-years-were-warmest-record>. [Last accessed on 2020 Jun 25].
- Xu J and He Y. (2012). Psychological Health and Coping Strategy among Survivors in the Year Following the 2008 Wenchuan Earthquake. *Psychiatry and Clinical Neurosciences*, 66(3):210-9.
- Yang P, Yen CF, Tang TC, *et al.* (2011). Post-Traumatic Stress Disorder in Adolescents after Typhoon Morakot-Associated Mudslides. *Journal of Anxiety Disorders*, 25(3):362-368.
- Yuvaraj E, Dharanirajan K, Narshimulu S, *et al.* (2015). Post-Disaster Assessment of Impact of Cyclone Lehar in South Andaman Island. *Current Science*, 108(1):85-90.
- Zhang Z, Shi Z, Wang L, *et al.* (2011). One Year Later: Mental Health Problems among Survivors in Hard-Hit Areas of the Wenchuan Earthquake. *Public Health*, 125(5):293-300.