DESTRUCTIONS IN LOCAL COMMUNITIES CAUSED BY NATURAL DISASTERS

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ABSTRAK

Natural disasters are devastating events resulting unexpectedly from natural processes such as floods, hurricanes, landslides, tsunamis, and earthquakes. These disasters in turn result in losses of life, suffering among the victims, property damages, environmental destruction and adversely impacting the economy. Damages due to natural disasters can significantly affect the economy and social life of local communities especially in developing countries. As such, knowledge on environmental conservation is very important in disaster management both before and after a disaster. This paper discusses some of the natural disasters that caused major destructions on affected communities such as the 2004 tsunami in Aceh, the 2011 tsunami in Tohoku, the 2011 earthquake in Christchurch, the 2013 hurricane in Tacloban, Anak Krakatau volcanic eruption in 2018 and the 2014 Yellow Flood in Kelantan, Malaysia. Impacts from disasters discussed in this paper should provide lessons to be learnt and guiding insights for capacity building among local stakeholders especially in the communities. Effective preparedness and mitigation measures must be planned so that the impacts of future disasters can be lessened.

Kata Kunci : *Disasters, natural disasters, disaster impacts, disaster damages, community*

Introduction

Natural disasters result from the onset of natural events such as climatological events (wildfires, drought and extreme temperatures), hydrological events (avalanches and floods), meteorological events (cyclones and storms) and geophysical (earthquakes, landslides, tsunamis and volcanic activity) that occur in an area where a vulnerable population is present (Wisner, 2004). Throughout the past decade, there has been an increase in the frequency of natural disasters globally caused by earthquakes, tsunami, volcanic activity, storms, typhoons, and other climatological events which brought about droughts or forest fires (Insurance Information Institute, 2019). In 2019 alone, 193 out of 292 disaster events recorded were natural disasters that accounted for USD50 billion in losses and claiming the lives of 11,000 people (Insurance Information Institute, 2019). Disaster, particularly those caused by extreme natural events affect all aspects of a developed community such as the economy, environment, health, and livelihood of local communities.

Over the last few decades, many large-scale disasters have struck developed and developing countries worldwide, with some affecting multiple countries in a single event. These disasters caused loss of lives, damages to properties and infrastructure as well as affecting the environment. Recovery from disasters especially among local communities are challenging as their livelihood both physically and mentally are impacted. As can be observed from large scale disasters throughout the human history, regardless of whether a country is well-prepared or not, all of the affected countries still faced loss of lives and substantial setback to their development. Several notable disasters that have struck mainly Asian and Oceania countries include earthquakes, tsunamis, floods and typhoon namely the Indian Ocean tsunami in December 2004, the Christchurch earthquake in 2011, the Great East Japan earthquake, tsunami and nuclear disaster in 2011, typhoon Haiyan in 2013, the Malaysian flood from December 2014 to January 2015, and more recently the Sunda Strait tsunami in 2018. These disasters are examined, and the impacts are discussed in this paper.

2004 Indian Ocean Tsunami

On 26 December 2004, an unexpected tsunami struck Banda Aceh, claiming thousands of lives and causing severe damages to the infrastructures and the environment. The tsunami, which was recorded as one of the largest tsunamis in history, affected all countries around the Bay of Bengal and the Indian Ocean. It was triggered by a magnitude 9.1 earthquake off Sumatra with waves as high as 50 meters in west Sumatra (NGDC, 2014). The earthquake occurred 250 km southwest of the Northern tip of Sumatra, Indonesia and subsequently generated a tsunami claiming more than 200,000 human lives and severely impacted coastal communities in several countries including Indonesia, Thailand, Sri Lanka, India, Malaysia, Maldives and Somalia (Fritz et al., 2006). Indonesia's west and north coast experienced severe damage as they were closest to the epicentre of the earthquake (Borrero, 2005) as well as Sri Lanka which was 1600km from the epicentre (Liu et al., 2005). Subsequently, Maldives was affected by the tsunami an hour after Sri Lanka (2500 km from the epicentre) (Fritz et al., 2006) followed by Somalia at 5000km from the epicentre (Fritz and Borrero, 2006). The number of casualties was very high as the tsunami was unexpected by countries in the Indian Ocean region. There was no early warning system in place, and no preparedness measures put in place by local governments, communities and tourists who lacked knowledge on tsunamis with Indonesia being the first country to be severely affected by the tsunami within 30 minutes of the earthquake specifically Banda Aceh with a total of 166 thousand people reported missing or dead (Satake, 2014).

Banda Aceh's environment was severely impacted by the tsunami such as the beaches, coral reefs, river channels, coastal forests and the mangroves (Srinivas and Nakagawa, 2008) with an estimated 90% damage to mangroves (Chen et al., 2005). Industries such as aquaculture, fishing and small to medium enterprises (SMEs) was severely damaged that resulted in damage to 9000 ha of aquaculture farms and fishing equipment and facilities (Athukorala & Resosudarmo, 2006; Nafesa et al., 2018). Sand barriers that protect lagoons or river mouths were also found to be completely eroded with a widening of river channels (Paris et al., 2010). Even though most beaches were rebuilt 13 months after the tsunami, agriculture ponds still showed signs of erosion (Liew et al., 2010). Damage to the agricultural and fishing industry also caused loss of traditional knowledge among fishing communities especially the elder fishermen or also known as Panglima

Laot who were elected among senior fishermen to enforce traditional fishing regulations and resolve disputes among the fishermen (Wilson and Linkie, 2012). The loss of knowledge, income and equipment was a major setback to the survivors as they needed to rebuild their livelihoods. Handlers and traders who depended on fishermen were also affected as the latter were unable to resume their fishing activities (Wilson and Linkie, 2012).

Buildings in the localities were severely damaged by the tsunami as they were non-engineered buildings that were either made of burned brick or timber frames which were inadequately constructed with poor quality of materials and workmanship (Boen, 2006). Consequently, the tsunami affected many sectors of the economy such as the public sector, health and educational facilities, as well roads, seaports, airports and bridges (Nafesa et al., 2018). Local communities who survived the tsunami also faced health related diseases such as asthma, emphysema, aspiration pneumonia and infections due to contaminated soil or water as well as exposure due to hazardous material during the recovery phase (Keim, 2006). Additionally, survivors of the tsunami also experienced severe significant distress as the result of loss of family members, properties and displacement.

2011 Christchurch, New Zealand Earthquake

In the early morning of 4 September 2010, the Canterbury region in New Zealand was shaken by a Mw 7.1 earthquake, also referred to as the Darfield earthquake, that caused severe damages to buildings and properties, though no lives were lost. While New Zealand is no stranger to earthquakes, the Darfield earthquake was the first since 1931 to have occurred at a highly populated region of the country (Berryman et al., 2020). The earthquake was then followed by thousands of aftershocks between December 2010 to June 2011 with most measuring less than Mw 3.0. The strongest of the aftershocks, considered an earthquake by itself, struck the Central Business District (CBD) of Christchurch on 22 February 2011. The Mw 6.2 – 6.3 Christchurch earthquake, which had an epicentre 5 km deep and within 10 km away from the bustling city, occurred at approximately 12:51 PM and resulted in 185 deaths while injuring many others (GNS Science, 2011). Out of those that died, a majority was located in the city centre area, while only 12 others were in the suburban area. In terms of injured victims, there were at least 7,171 injured victims which was three times as many injuries reported compared to the Darfield earthquake in 2010, mainly due to collapsing buildings (Potter et al., 2015). Some suffered paralysis (partial and full), while some others had their limbs amputated. Aside from these more serious injuries, thousands of others reported minor bruises, cuts, and broken bones (Ministry for Culture and Heritage, 2016).

Given that the city was still recovering from damages caused by the September 2010 earthquake, the subsequent damages and disruptions to lifeline systems such as healthcare infrastructures, electrical supply, gas distribution system, road network, as well as water and sanitation system were considered severe. However, the impacts were to some extent reduced by risk reduction measures put in place by the government and local lifelines group in particular through the Civil Defence and Emergency Management Act 2002, “lifelines culture” and support for Lifelines Engineering (Giovinazzi et al., 2011). The largest hospital in Canterbury region, the Christchurch Hospital, suffered both structural and non-structural damages in both clinical and non-clinical buildings in its premise causing short-term healthcare capacity and functionality losses. Due to this, some of its services and functionality were subsequently supported by other less severely damaged hospitals in the region throughout the response and recovery phases

(McIntosh et al., 2012). In addition to the earthquake, the city's eastern and southern suburbs also experienced landslide and liquefaction due to the higher shaking intensity and shallow ground water level depth (0 – 2 meters from ground surface) (Yamada et al., 2011). Most of the significant damages from the disaster were attributed to soil liquefaction, which in turn caused settlement, lateral spreading, sand boils, water ponding and silt mud ejection (Giovinazzi et al., 2011). Four more damaging and distinct types of ground failure were also observed as a result of the ground shaking, namely rock-fall (boulder roll), rock-fall (cliff collapse), incipient large landslides (characterised by tension cracks and vertical displacement in the head-scarp area), and widespread retaining wall failures (Dellow et al., 2011).

From the initial 2010 Darfield earthquake until the 2011 Canterbury earthquake, a total of 167,500 claims for damaged dwellings were made, out of which 24,200 were for serious claims, while 8,061 properties were re-classified as being in red zones. Affected populations with pre-disaster vulnerabilities e.g. low-income group, disabled, Māori and other ethnic minorities, reported to have faced difficulties in dealing with insurance issues, forced to live in temporary or damaged accommodations, as well as facing other financial burdens (Morgan et al., 2015). These compounding effects were reported to adversely affect their family wellbeing and increased risk of psychological distresses particularly in the form of acute stress, depression and anxiety symptoms (Dorahy and Kannis-Dymand, 2012; CERA, 2015). One of the many responses to these issues was the establishment of meeting houses or 'Marae' by local Māori groups to accommodate displaced victims as well as other recovery support needs (Kenney et al., 2015). Economically, businesses within the CBD area of Christchurch were significantly affected, with a majority having to close for a duration of 16 days on average (Stevenson et al., 2012). Some businesses were also found to have relocated to safer areas as a response (Bowden, 2011). Taking into consideration that many buildings in the CBD were identified as unsafe following the disaster and thus requiring repair, retrofit or even demolition (at least 627 commercial buildings to be demolished), the associated costs were estimated at a total of NZ$7 billion (Parker and Steenkamp, 2012; Chang et al., 2014).

2011 Great East Japan Earthquake, Tsunami & Nuclear Disaster

The event also referred to as "san-ten-ichi-ichi" or 3.11 by the Japanese began as a magnitude 9.0 earthquake with an epicentre 130km offshore from the city of Sendai in Miyagi prefecture, which then triggered a tsunami with waves reaching nearly 40m high in some places (Dunbar et al., 2011). 2,000km of coastline was affected and over 400 km2 of land was inundated in Japan (Mori et al., 2011). 345 fires were reported across 12 prefectures, caused by the earthquake and/or the tsunami (Mimura et al., 2011). Subsequently, the tsunami caused damages to nuclear power plants located along the eastern coast of Fukushima, leading to a nuclear accident that is regarded as the second worst after Chernobyl in 1986. Up until November 2013, casualties recorded from the disaster was 18,571 dead, 2,651 missing and over 6,000 others injured (Ranghieri and Ishiwatari, 2014). Based on autopsies done on bodies found in Iwate, Miyagi and Fukushima prefectures, over 90% was found to have died from being drowned by the tsunami (National Police Agency, 2011). Approximately 470,000 people were evacuated immediately following the event, with over 280,000 of them remaining as evacuees by October 2013. Despite many structural and non-structural measures put in place given Japan's extensive experience in facing devastating hydrogeological disasters, nearly 650 km of the Sanriku coastline was ravaged by the tsunami, resulting in more than 836,000 houses either damaged or completely demolished, seawalls breached, roads were closed, and more than 20,000 hectares of agricultural land flooded and crops destroyed (Suppasri et al., 2013; Ranghieri and Ishiwatari, 2014). Total economic damages in Japan were estimated at nearly JPY17.7 trillion or USD210 billion spent for response and recovery, while JPY2.9 trillion was documented for insurance pay-outs (Kajitani et al., 2013).

Based on studies of past earthquakes occurring near Miyagi prefecture, the average gap between major earthquakes measuring over 7.0 magnitude is 37 years. Considering the preceding major earthquake to the 2011 event was in 1978, local government of Sendai city was indeed expecting similarly significant earthquake (Suppasri et al., 2013). Despite this expectation and mitigation measures in place (which included a Guinness world record holder for deepest breakwater at 63m near Kamaishi city's shore), cities in Japan still suffered major damages, albeit relatively less severe in some places due to better protective measures. As an addition to breakwaters, tsunami sluice gates constructed at the river mouth in some areas were able to prevent significant tsunami damage such as in Fudai village in Iwate prefecture. The 15.5m high tsunami gate successfully protected the village beyond from tsunami waves of up to 20m high that flowed only a few hundred meters past the gate and thus leaving the village minimally damaged (EEFIT, 2011).

Another significant impact of the earthquake and tsunami was the nuclear incident in Fukushima, and the resulting decline in usage of nuclear energy in Japan. Due to the nuclear plant failure and nuclear emergency, radioactive contamination from the leaked radionuclides rendered soil, food, plants and water near Fukushima as unsafe based on the sampling done schools and cities in the area. By the third week of March 2011, increased rates of radioactivity were detected in the atmosphere, rainwater and grass samples due to transported radionuclides in South Korea, France and Greece, though the rate remained relatively low and thus did not necessitate any emergency responses (Manolopoulou et al., 2011; Kim et al., 2012; Perrot et al., 2012). In Japan, damages and physical health impacts from the radiation were low in part due to fast responses by the general affected population and the authority. Based on health survey and estimates by health experts in Japan, there was no acute radiation syndrome (ARS) detected and relatively low risk for related illnesses such as cancer or thyroids to develop among the victims, save for a small number of emergency workers who were exposed to more than 100mSv following response and evacuation operations (Brumfie, 2013; Hasegawa et al., 2015).

In contrast, various levels of psychosocial impacts were more observable following the triple disaster event. These impacts include mental distress due to public discrimination especially among emergency and nuclear power plant workers, discordance in families and communities, and self-stigma among victims (Hasegawa et al. 2015). Psychological impacts are also found to have increased in particular due to a shift in risk perception among adults, which in turn is related to the fear and concerns for radiation exposure similar to the Chernobyl disaster in 1986 (Bromet, 2012; Yabe et al., 2014). Fukushima Health Management Survey noted a significantly higher persistence of mild to moderate mental distress among adult Fukushima evacuees than other affected parts of the country (Yabe et al. 2014). The same survey also found evidence of higher potential or developed psychological symptoms among child evacuees aged 4 – 12 years old such as hyperactivity, conduct problems or peer issues. Lack of knowledge contributed to rising stigma among young female victims regarding the effects of radiation on future pregnancy or other hereditary complications, which is exacerbated and reinforced by ignorant, public stigma (Los Angeles Times, 2012; Save the Children, 2012). Furthermore, change in lifestyle, diet and personal habits following the disaster and evacuation, compounded with the observed mental-related problems and sleeping difficulties, raised concerns for increased risk of cardiovascular diseases as evident based on increased prevalence of hypertension, diabetes and dyslipidaemia among evacuated residents (Ohira et al., 2014; Satoh et al., 2015). With regards to evacuation, facility-specific evacuation patterns, care quality and conditions of evacuation sites were suggested to have affected evacuees' psychological state and in turn affected their physical health conditions and increased mortality risks especially among vulnerable populations such as the elderly and hospital inpatients (Nomura et al., 2013; Yasumura, 2014).

2013 Typhoon Haiyan

The Philippines is a country that is frequently exposed to various types of natural disasters such as volcanic eruptions, landslides, floods, droughts, and earthquakes as it is within the Pacific Ring of Fire. In 2013, the country was struck by the deadly Typhoon Haiyan which mainly affected Tacloban city leaving 6,300 dead, 26,689 injured and a total of 1,061 missing (Lagmay et al., 2015). Even though several areas were affected by the typhoon, which was named as the most intense tropical cyclone in the world by the Joint Typhoon Warning Center, Tacloban City was more vulnerable to damages as its location amplifies storm surges. Additionally, it's vulnerable coastal areas that are populated by those living in poverty suffered the highest number of casualties in the whole country (Su and Le De, 2020). Reports approximated USD56.6 million in damages to infrastructure in Tacloban, which accounts for 38.7% of the total amount of damage while storm surges up to 7.5 meters high resulted in deadly floods (NASA, 2013). Additionally, the typhoon caused several landslides to occur across Eastern Visayas, which washed away houses in its path and heavily damaged the Tacloban Airport due to strong winds and storm surges as high as 6 meters. Subsequently, damages to infrastructure was also due to stranded ships on land mainly in the Anibong area as well as the vulnerability of the structure since the materials used for construction were lightweight and not engineered appropriately (Mas et al., 2015). Besides infrastructure, the environment was also severely damaged by Haiyan such as the mangroves with an approximate of 868 hectare of mangrove which accounts for 3.5% of the total mangrove area in the Philippines (Long, Giri, Primavera and Trivedi, 2016).

Subsequently, the livelihood of local residents was also affected due to the typhoon as those affected lived in coastal areas and were fishermen. Equipment such as stationary fishing gears were severely damaged which impacted their fishing operations (Montecarlo et al., 2018). Survivors exhibited symptoms associated with mental issues, as many experienced sleep disturbance (insomnia) and psychological distress even 30 months after the disaster struck (Labarda and Chan, 2018). A study reported an increase in violence against women and girls after the disaster primarily due to stress, though it was also noted that it is not specifically a result of the disaster, but also due to gender inequalities in the social environment prior to the disaster (Nguyen, 2018).

In terms of preparedness, several localities took pre-emptive actions in order to prepare for the typhoon by placing response teams on standby, prepositioned medicinal supplies, evacuated residents with readily packed food, and had rescue boats on standby (Lagmay et al., 2015). Some others chose to undermine warnings issued by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and did not evacuate promptly (Mas et al., 2015). The warnings were neglected due to assumptions made based on their previous experiences, which were not as serious as Typhoon Haiyan. Some residents also chose not to evacuate to higher grounds in order to protect their assets and properties (Mas et al., 2015).

2014 Malaysian Flood

Floods in Malaysia has been occurring over the last few decades which are mostly due to monsoonal flood affecting a few states namely Kelantan, Terengganu and Sabah resulting in at least a few hundred deaths, thousands displaced and millions in damages (Chan, 2012; Aini et al., 2016). In 2014, flood was occurring in several countries in the Southeast Asia region namely Peninsular Malaysia, Indonesia and Southern Thailand due to the northeast monsoon. Out of all the countries, Malaysia had the highest number of evacuees compared to the other countries and it was the worst flood experienced in recent history. The flood affected five states in Peninsular Malaysia such as Kelantan, Terengganu, Perak, Pahang, Johor with Kelantan being the most affected state. A total of 66,500 people were evacuated and 21 deaths were reported with an estimated RM 2.58 billion in damages (Hai, Samah, Chenoli, Subramaniam, & Ahmad Mazuki, 2017). Damages to homes and agricultural land were caused by uprooted trees, abandoned logs and eroded subsoil (Shamshuddin et al., 2016).

The main cause of this flood was due to extreme rainfall events as a result of the north-east monsoon and the presence of the Madden Julian Oscillation (MJO) and mild effects from the El-Nino Southern Oscillation (ENSO) (Nor Eliza et al., 2020). Early warning systems have already been placed prior to the flood however a study by Nor Eliza et al. (2018) among the evacuees of the 2014 flood in Kelantan found that more than half of the respondents were not aware of the early warning system by the Department of Irrigation and Drainage Malaysia (DID). While awareness was lacking among the respondents, half of the respondents did received warning mostly through television and public dissemination. Despite early warning by the local authority, most of the victims only evacuated when the flood water level to rose to a dangerous level resulting in challenges for the responder to rescue the victims as they were already incapacitated due to inaccessible roads and inadequate equipment (Ahmad Sobri and Mohamad Syafiq, 2018).

The 2014 flood also caused damages to commercial infrastructure and residential properties that also functions as agricultural land resulting in loss of crops and livestock (Chan, Ku Ruhana and Mohd Zaini, 2018). Additionally, the flood also affected the environment as the well waters in the Kelantan River Basin was contaminated by the flood water and was unsafe for drinking (Hariz, Noor, Azzmer and Tengku, 2018). Subsequently, the flood also affected the health of the victims as there was an increase in purchase of prescription medications (Sharifa Ezat et al., 2018) and admission in the pediatric ward in victims younger than two years old as they experienced diarrhea due to unsanitary conditions in the shelter (Zaharah et al, 2016).

2018 Sunda Strait Tsunami

The collapse of Krakatau Island in one of the most globally well-known volcanic eruptions in 1883. In June 1927, a new cone called Anak Krakatau formed at the site of the collapse and emerged from the sea surface. Up until 2011, the volcano erupted over 100 times, alternating between eruptive phases and relatively quiet phases that lasted for a few years throughout. Following intermittent eruptions of ash plumes and lava flows in the past decade, and a quiet period of 15 months between March 2017 to mid-June 2018, the volcano's activities resumed with increased seismicity, lava flows, Strombolian eruptions and more frequent explosions beginning 18 June 2018 (Global Volcanism Program, 2018). A partial flank collapse on 22 December 2018 again significantly altered the volcano island's morphology, and triggered a tsunami that caused 437 deaths, 31,943 others injured, 16,198 displaced, and 10 considered as missing (BNPB, 2019).

Observation approximately 47km away on 22 December noted that eruptions started at about 2:29 PM local time, increased in intensity at 5:00 PM with more frequents eruptions accompanied by volcanic lightning, ejection of incandescent blocks and ash at around 6:30 PM, and a massive eruption recorded at 9:03 PM. By 9:03 PM, view of the volcano was completely obscured by ash plume, and the first tsunami wave arrived at 9:23 PM in West Java (Global Volcanism Program, 2018). Due to the triggering mechanism and the time of the event, local government and communities were caught by the tsunami unprepared (Syamsidik et al., 2020). Neighbouring coastal regions of Lampung in Sumatra and Banten in West Java suffered most of damages and losses due to the tsunami, while coastal areas of the islands in the volcano's immediate vicinity were stripped bare of their previously dense vegetation (Borrero et al., 2020). In Banten, the most affected districts were Pandeglang, which is a tourist and residential area, and Serang, which is known as a tourism destination and for its industrial area. In Lampung, areas populated by farmers and fishermen namely South Lampung (Kalianda and Rajabasa) and Tanggamus reported damages and casualties.

While initially unclear, analyses of local, regional and teleseismic seismic station records in addition to satellite radar images provided evidence of a sector collapse causing a long-period landslide movement, which preceded intense eruption activities, that triggered the tsunami (Muhari et al., 2019; Walter et al., 2019). Whether the landslide was caused by slope instability, seismic activities and/or the volcano's eruptive activities remain to be determined. On the two Indonesian mainland, the western coasts of Banten reportedly experienced more severe damages compared to southern Lampung to the west of the volcano. Tsunami wave depths in Banten measured up to 3.75 m in Serang district, and up to 6.6 m in Pandeglang. Relatively high casualties were reported at Tanjung Lesung Resort in Pandeglang, as a gathering and music performance were taking place when nearly 5 m tall tsunami waves arrived at the premise (Syamsidik et al. 2020). Similarly, 70 casualties were reported at a resort on Carita Beach as the walls were completely destroyed and washed away by the tsunami (Borrero et al., 2020). At Labuan, wave of about 1 meter high reached a crowded fish market, though damage was only reported at 10 m inland. A multi-storey vertical evacuation building was available but remained unused and appeared abandoned in the area. In Sumur, buildings within 100 m of the lagoon's shoreline were destroyed while inundation was limited to 155 m inland. The area was also completely cut off from the other sub-districts due to the extensive damages on roads and bridges connecting Sumur to the other sub-districts (Borrero et al., 2020; Syamsidik et al. 2020). In Lampung, Rajabasa sustained the worst damages as waves up to 4.5 m high damaged village houses, an elementary school and a shrimp hatchery. In Waykiayi and Wayurang, houses along the coastline were completedly destroyed (Syamsidik et al., 2019). Meanwhile in Tanggamus, the highest recorded inundation height was 1.84 m at the Bandung Jaya village. Overall, compared to damages from earthquake, soil liquefaction and tsunami in Palu on three months prior, lower probabilities for complete damages were identified in this event (Syamsidik et al., 2020).

Despite the frequency of disasters in Indonesia, victims of the 2018 Sunda Strait tsunami exhibited symptoms of trauma and psychological issues. A study on the victims at Rajabasa identified psychological trauma on majority of the victims, which necessitated interventions and stress management support program (Sulastri et al., 2020). Another health concern raised following the tsunami was Dengue Haemorrhagic Fever (DHF) where 60 cases, a relatively high number, were recorded in Labuan, Pandeglang between December 2018 to January 2019. Entomological survey after the tsunami also found a high density of Aedes mosquitoes in several villages in Pandeglang as debris and piled up garbage such as discarded containers, water storage tanks and flowerpots provided ample breeding grounds for the mosquitoes (Rizki and Anggreni, 2020). Environmental and physical damages compounded with the psychological and health issues following the disaster also adversely impacted tourism in the affected areas. Tanjung Lesung which was designated as Special Economic Zone (SEX) for its economic and tourism potential was found to be deserted post-tsunami up until April 2019 as beaches had deteriorated, facilities damaged, and fear of possible disasters among tourists (Mulyawati et al., 2019).

Lessons learned

Once a disaster has struck, there are many lessons to be learned even though preparedness and mitigation measures have been put in place prior to the disaster. Among them are the importance of early warning systems especially for natural disasters as they can aid in predicting typhoons, floods and tsunamis. In many cases, warnings could not be disseminated effectively due to the lack of awareness and knowledge among the public. In the case of the 2004 Indian Ocean Tsunami, no early warning system was present in most countries affected. Local government and communities in the coastal areas had no knowledge on tsunamis and thus were not prepared for the tsunami (Satake, 2014).

In terms of awareness, even though local communities frequently experienced typhoons in the Philippines, they had no awareness on the implications of a storm surge (PAGASA, 2014) which resulted in delay of evacuation, injury, and loss of lives. Likewise, in Malaysia, despite frequent exposure to flood events in the states affected, many failed to evacuate to higher grounds and only evacuated once the water reached dangerous levels despite early warning that was disseminated either through village leaders or media such as television (Nor Eliza et al., 2019). In both countries, as well as in the Christchurch earthquake, search and rescue operations were halted due to inaccessible roads, inadequate equipment and responders which were also victims of the disaster (PAGASA, 2014; Ahmad Sobri and Mohamad Syafiq, 2018; Berryman et al., 2020). This highlights the importance of designing, constructing and ensuring that critical infrastructures such as electric/power supply, water distribution network, roads, and emergency response agencies' facilities take into consideration the potential for damages which would impair response capacities and operations.

Construction of buildings and houses within disaster prone areas is also one the contributing factors for damages and casualties observed in affected areas in the Philippines, Malaysia and New Zealand as the materials used were either not strong enough or the buildings were not adequately engineered. Even though Japan and to an extent New Zealand engineered buildings and structures such as a tsunami wall to withstand earthquakes and tsunami, the disaster that struck were beyond their expectation which resulted in damages and loss of lives. However, these mitigation efforts did reduce the impact and number of casualties affected by the disaster. Thus, based on the lessons learned based on the natural disasters discussed, preparedness and mitigation efforts at every level is imperative in order to reduce the impacts of the disaster. Preparedness measures such as awareness of local community, evacuation plans and drills with the mitigation measures in place such as tsunami walls and appropriately designed structures can minimize the impact of disasters, and thus resulting in less casualties and losses.

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