V. Earthquake in West Sumatra, Indonesia in 2009

September 2016

Preface

Whilst Asia is ranked as the most disaster-prone region in the world in terms of both natural and man-made disasters, research and training in the Asia-Pacific region is limited. Better understanding of the disaster epidemiological profile and human health impact will enhance response, preparedness and mitigation of the adverse human impacts of disaster. The concept of case-teaching method has been used extensively in research and teaching of disasters and humanitarian studies at schools of public health around the world, including Harvard School of Public Health, Johns Hopkins Bloomberg School of Public Health and London School of Hygiene and Tropical Medicine. Through the existing partners and networks of The Jockey Club School of Public Health and Primary Care, the Public Health Humanitarian Initiatives of The Chinese University of Hong Kong, and the Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC), this disaster and humanitarian relief monograph series composed of eight case study reports has been developed using a standardised analytical and reporting framework. Methods for case study including literature reviews, stakeholder interviews and retrospective data analyses have been employed.

The main objective of this 2009 West Sumatra Indonesia earthquake disaster case study is to highlight the key lessons learnt in disaster medical and public health response in the region. The goal is to develop Asia-specific teaching materials for public health and medicine in disaster and humanitarian response.

The "Guidelines for Reports on Health Crises and Critical Health Events" framework has been adopted as a reference for the literature search and the identification of key areas for analysis (1). We acknowledge that disaster management is a multidisciplinary area and involves much more than health issues, but we believe that the public health impact of all interventions should be appreciated across all disciplines.

This report is developed from a research conducted by Emily Ying Yang CHAN, Polly Po Yi LEE, Cecilia CHOI and Kevin Kei Ching HUNG in 2011. Ms Choi was then Graduate Fellow and Dr Hung

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Executive Summary

Whilst Asia is ranked as the most disaster prone region of the world in both natural and man-made disasters, research in the Asia-Pacific region is limited. This study is part of a 24 months, multi-country, multidisciplinary partner based project that aims to develop a series of disaster medical and public health case study in the Asia pacific region. Using an internationally standardized disaster incident reporting template developed by Kulling et al , this specific project aims to document the disastrous event and evaluate the health implications of West Sumatra Earthquake in Indonesia on 30 September 2009 (1).

A literature search was conducted using multiple search engines and databases using the key terms "West Sumatra earthquake" and "2009 West Sumatra earthquake. Information provided from multi stakeholders, including National Disaster Management Agency (BNPB), Provincial Disaster Management Agency (BPBD), UN agencies, and independent organisations were studied.

The structure of the report based on the guidelines for health crises includes pre-event status, health crises and critical health events, relief and recovery response, development, discussion, lessons learnt, and conclusions. The disaster affected more than 2.5 million people and killed over a thousand people. The emergency phase was declared over within one month. The Cluster Approach led by OCHA was activated within 48 hours.

The project provides a comprehensive documentation of 2009 West Sumatra Earthquake using public health approach. Regardless the limitations in the policy and regulations, the inter-agency collaboration shown in this disaster were praised for the effective response.

1. Introduction/Material/Methodology

1.1 Introduction

A 7.6 magnitude Richter-scale earthquake hit West Sumatra Province, Indonesia, on 30 September 2009. It was followed by two major aftershocks and subsequent landslides. The earthquake caused

more than 1,000 deaths, injured more than 3,000 people, and damaged nearly 400,000 buildings. Thirteen districts were affected and even neighbour countries were threatened. Housing, agriculture, and water supplies were mostly destroyed. Injuries, acute respiratory infections, and diarrhoea were the most common presentations identified.

Earthquake is one of the most common natural disasters occurred in Indonesia. As a country situated in the Ring of Fire, Indonesia is well known for its massive geophysical disasters. The local people are aware of the risk but yet they are unprepared when disaster happened. The government has established a national agency to build the community resilience towards disaster. In this earthquake, government welcomed the international assistance, thus the Cluster Approach led by OCHA was established. The Government of Indonesia, UN organisations, NGOs and different bilateral agencies had worked together on the immediate relief and long-term recovery work. The inter-agency collaboration shown in this disaster was praised as one of the success stories in providing rapid needs assessment and relief support. This study aims to document the key lessons learnt from the Cluster Approach applied in this disaster.

1.2 Material

Information on West Sumatra Earthquake was taken from various online databases that are publicly available. The databases were provided by national government, UN agencies, and independent organisations.

Publicly available information written in English or Indonesia was obtained from the online sources. The relevant literature was analysed and description of the health impacts and relief activities at the time of disater were identified. The following databases were searched: PUBMED, national government, local government, national agency for disaster management, UN organizations, and other independent organizations. The key terms “West Sumatra earthquake” and “2009 West Sumatra earthquake” were used to find the relevant literature.

Inclusion criteria

Articles were included in the review if they were: (i) written either in English or in Indonesia; (ii) published from September 2009 to January 2014, and (iii) describing the experiences, health activities, and Cluster Approach, at the time of the disaster.

Exclusion criteria

Articles were excluded if they were published neither English nor Indonesia. The case study is written using the guidelines for health crises proposed by Kulling et al., with the following structure: pre-disaster (disaster preparedness, hazard, risk, vulnerability, resilience), disaster (physical health impact, mental health impact, social impact), post-disaster (Cluster Approach using the five basic human health needs), discussion, lessons learnt, and conclusion (1). The activities in each of phase in disaster cycle are discussed accordingly. In addition, the impact of disaster is described using the WHO definition of health, and the discussion of Cluster Approach in this case will only covered the five basic human health needs.

1.3 Methodology and a theoretical framework for an earthquake case study

To achieve a systematic examination of the case, major public health principles of disaster response and the disaster cycle model will form the theoretical framework for this analysis.

I. *Public health principles of disaster response*

According to the *Oxford Handbook of Public Health Practice*, the three main principles of public health response to disasters include securing basic human needs required to maintain health, determining the current and the likely health threats to the affected community, and acquiring and providing the resources to address the two issues above (2). The discussion in this case study will focus on the five basic human health needs.

The five basic requirements for health include food, health services, information, water and sanitation, as well as shelter and clothing. The access to these basic needs is often disrupted after a disaster.

Compared with other major natural disasters, the short-term effects of earthquakes include a higher death toll, an overwhelming number of severe injuries requiring extensive medical care, and a relatively small increase in the risk of communicable diseases, while food scarcity or major population displacements are comparatively rare (3). Securing the access to the basic needs is considered the main goal of the emergency relief.

As a global effort in setting the standard for emergency relief, the international Sphere Project hosted by the International Council of Voluntary Agencies (ICVA) in Geneva is "a voluntary initiative that brings a wide range of humanitarian agencies together around a common aim - to improve the quality of humanitarian assistance and the accountability of humanitarian actors to their constituents, donors and affected populations." The Sphere Handbook, *Humanitarian Charter and Minimum Standards in Humanitarian Response*, provides a level of standard that has been agreed upon by a multitude of front line agencies (4). It contains the minimum standards for most aspects of the basic requirements for health, specifically water supply, sanitation and hygiene promotion; food security and nutrition; shelter, settlement and non-food items; and health action. For each specific sector, it has distinct indicators to measure whether the minimum standards are being achieved.

II. *Definition of health*

Health is a state of complete physical, mental and social well-being instead of the mere absence of disease or infirmity (5). Specifically, public health is defined as "[t]he science and art of preventing disease, prolonging life and promoting health through the organised efforts of society", according to Sir Donald Acheson (6).

III. *The disaster cycle model*

Apart from the general public health principles, it is important to recognise the different actions required during the various phases of disasters. The disaster cycle model helps highlight the key stages in post-disaster emergency response. It can serve as a useful reference for different parties to take actions during disaster management.

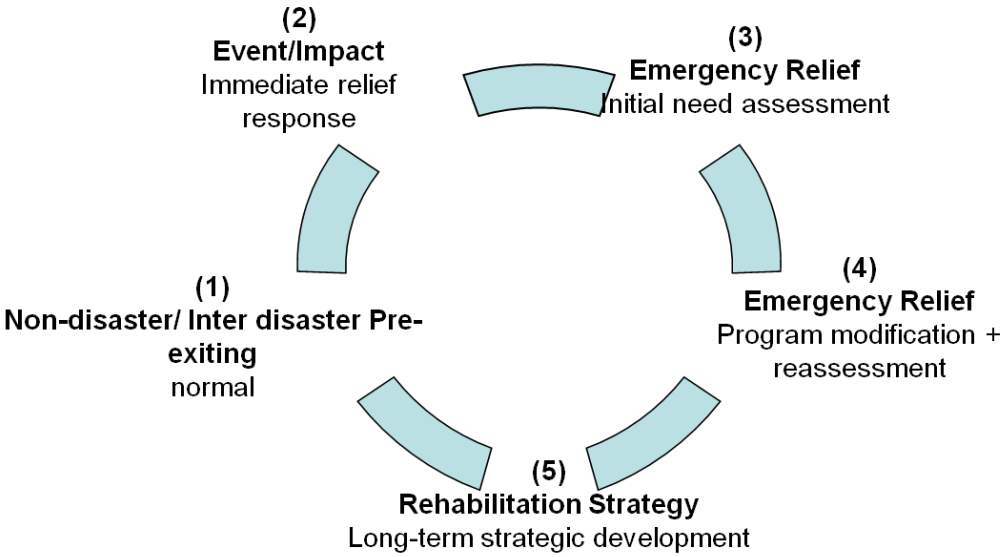

Figure 1 Disaster cycle

Source: Chan EYY, Sondorp E. Natural disaster medical intervention: missed opportunity to deal with chronic medical needs? An analytical framework. Asia Pacific Journal of Public Health. October 2007;19(Special Issue):45-51.

This case study report will examine the health impact of the 2009 West Sumatra Indonesia earthquake, using the disaster cycle, assessing the non-disaster (pre-disaster), event/impact, and emergency relief.

2. Pre-event Status

2.1 Background

Indonesia is an archipelago country, comprised of about 17,500 islands between Asia and Australia. Situated in South East Asia, most islands are low coastal lowlands with more than 80% of territory being covered with water. There are 5 major islands, which are Sumatra, Java, Kalimantan, Sulawesi, and Papua. The capital city is Jakarta, located in Java Island. Indonesia ranked number four as the largest population in the world with more than 245 million people. It has a size of about 2 million km^2 and is the world's 16^{th} largest country in terms of land area. The national average density is 109 people per km^2 and approximately 118 million people (52% of the population) live in urban areas, with about 86% of the total population is Muslims (7).

Indonesia's GDP is $1.03 trillion (in US dollars), with only 5.5% of GDP spending on health services. The country is governed by a republic government. It is divided into 33 provinces and each province is subdivided into districts and sub districts (8).

Indonesia is also well-known to be the high risk country of natural disasters. Earthquake, volcano eruption, floods are the most common natural disasters occurred in Indonesia. Located in the Pacific Ring of Fire, Indonesia is very prone to all geophysical disasters. Figure 1 below shows the earthquake hazard map of Indonesia (9).

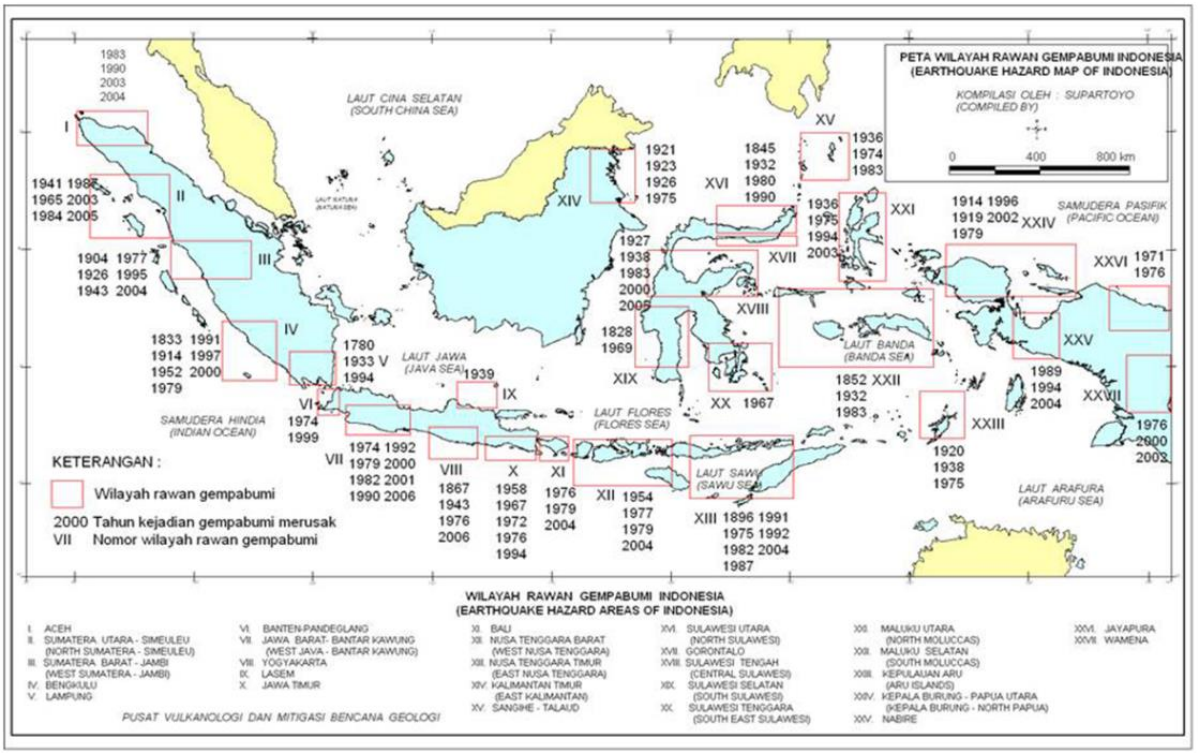

Figure 1 Earthquake Hazard Map of Indonesia

West Sumatra is a province located in the west coast of the Sumatra Island, Indonesia. It covers an area of 50,939 km^2 with population of about 4.76 million people, accounting for 2.08% of total population in Indonesia. The province comprises of 12 regencies and 7 cities. Regency is a rural, large

area; while city is an urban area, with limited agricultural activities. The capital city of West Sumatra Province is Padang, with total population 900,000 people (10).

The economy of West Sumatra Province is heavily relied on agriculture, followed by transportation and trading. Compared to other provinces, West Sumatra is considerably well-developed and is positioned in the fourth national deciles of poverty line (tenth is the poorest). However, there are great disparities among districts with the percentage of people under poverty line are ranging from 2.3% in Sawahlunto City to 17.9% in Pasaman Regency. The unemployment rate in West Sumatra (9.7%) is higher than the national average of 8.5%. (10)

West Sumatra is also renowned as earthquake prone area. As the Governor of West Sumatra, Gamawan Fauzi, mentioned, "West Sumatra is a supermarket for disasters, earthquakes, and tsunamis" (11). Figure 2 below shows the seismic activity zone in West Sumatra Province (12).

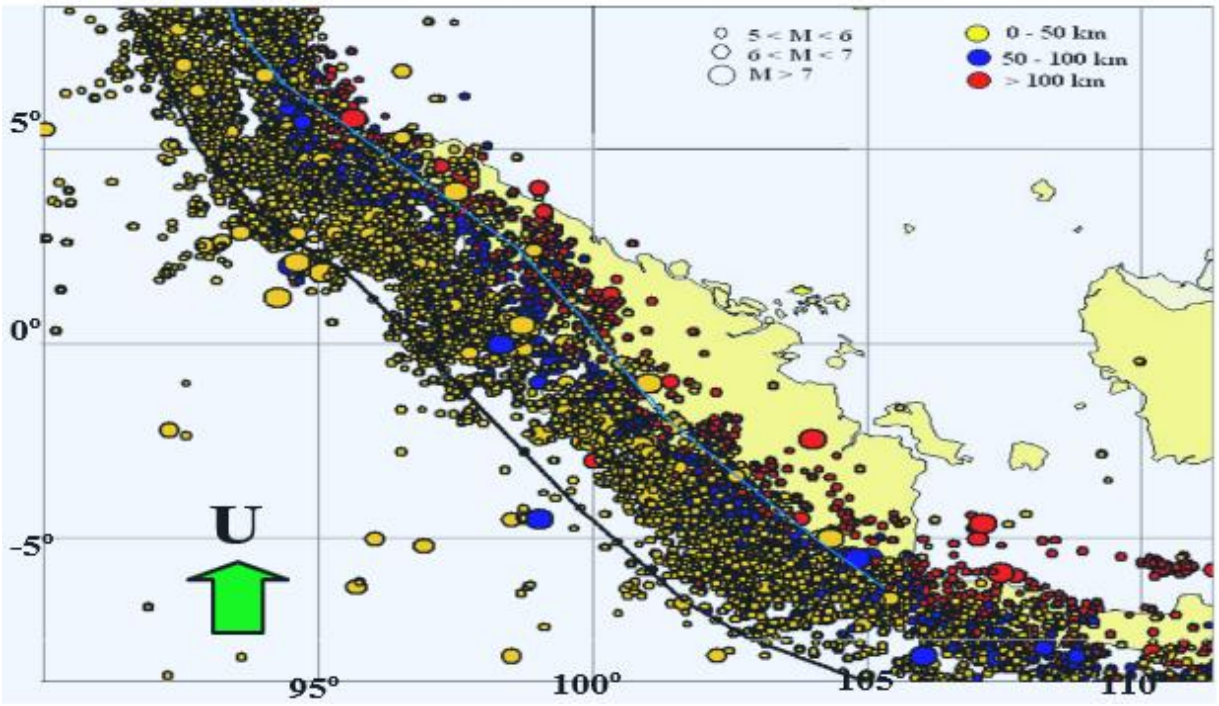

Figure 2 Earthquake Zone Map of West Sumatra in 1900-2007

2.2 Preparedness

Disaster preparedness is defined as the disaster knowledge and capacities developed to anticipate, respond to and recover from, the impacts of hazard events or conditions (13).

I. *Health Crisis Centre*

In 1991, Ministry of Health established the Health Crisis Centre to manage health problems due to disease outbreak and disasters. However, it was in 2007 that sub regional Health Crisis Centre established in West Sumatra Province. It aims to reduce the health impact of disaster and humanitarian crisis. It serves as a central database and training centre during pre-disaster phase and operation control centre during disaster phase (14).

II. *Provincial Agency for Disaster Management (BPBD)*

The concept of having national disaster management agency existed since 1945, but it was legalised as coordinating agency in 1979. The activities of national agency were being recognised since the devastating tsunami disaster in 2004 (15). The Provincial Agency for Disaster Management (BPBD) itself was established in February 2009, few months before the major earthquake struck the land. BPBD developed a general policy for disaster prevention, emergency relief, rehabilitation and reconstruction of the city (16).

III. *UN Clusters Approach*

The Cluster Approach is a system for coordinating humanitarian actors by sector aimed at improving the effectiveness, predictability, and accountability of humanitarian response (17). It was launched in 2005 by the Inter-Agency Standing Committee (IASC). A cluster is a group of organizations in a specific sector of humanitarian response that works together to coordinate operational activities (18). BNPB issued the Guideline on the Role of the International Organisations and Foreign Non-Governmental Organisations in Emergency and adopted the Cluster Approach since 2010. But even before the enactment of the regulation, the Cluster Approach has been implemented in West Sumatra earthquake. The government has been actively participated in the cluster-based coordination of

humanitarian activities (17). United Nations Office for the Coordination of Humanitarian Affairs (OCHA) facilitates the inter-cluster coordination to develop common approach among stakeholders. Ten clusters (Agriculture, Education, Health, Nutrition, Emergency Shelter, Early Recovery, Emergency Telecommunications, Food and Nutrition, Logistics, Protection, WASH) are well established to address the gaps in the humanitarian response (19).

IV. *Early Warning System*

The disastrous Indian Ocean tsunami in 2004 led the development of tsunami early warning system in Indonesia. The National Agency for Meteorology, Climatology, and Geophysics (BMKG) is responsible to monitor the seismic activities and send out earthquake information and warning of potential tsunami to the local authorities (20).

2.3 Hazard

Hazard is defined as a dangerous phenomenon, substance, human activity or condition that may cause adverse health impacts, property or environmental damage, social and economic disruption etc.[4] West Sumatra is prone to seismic activity and is one of the most frequent earthquake-stricken zones in Indonesia. It is located between the confluence of two major continental plates (Eurasian and Indo-Australian plate) and Great Sumatran Fault. A micro-zoning map produced by The Volcanological Survey of Indonesia had shown that most areas in the western coast of Sumatra Island, e.g. Padang and Pariaman city, are located in high to very high amplification zones (10).

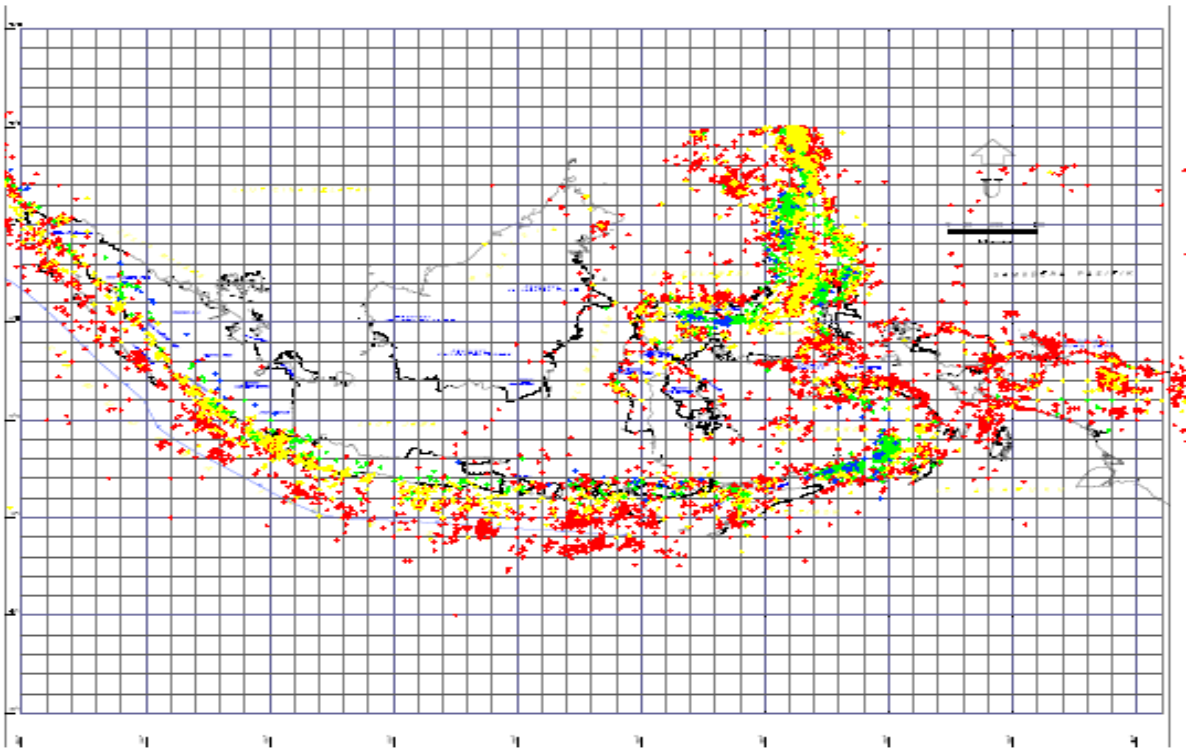

Figure 3 Distribution of earthquake epicentres. Kertapati (1999), as referred to by Center for Disaster Mitigation, ITB (2009) (10)

2.4 Risk

Risk is defined as the combination of the probability of an event and its negative consequences (10). Being named as the "Ring of Fire", Indonesia is actually a place very prone to different kinds of natural disaster. During the period of 1900-2011, Indonesia had experienced 98 times of earthquake (ground shaking) and 9 tsunamis, causing more than 200 thousands deaths, 9 million people affected and costing US$ 11 billion damage in total (19). Sumatra itself had experienced with major earthquakes in the previous years, e.g. 6.9 magnitude Richter-scale on April 2005, 6.5 magnitude on the Richter scale on March 2007, 7.9 magnitude on the Richter scale on September 2007.

2.5 Vulnerability

Vulnerability is the characteristics and circumstances of a community, system or asset that make the population or organization susceptible to the damaging effects of a hazard (13).

I. *Housing*

The earthquake resistant building code has been introduced since 1970. Using the 1987 standard, Indonesian region was divided into six seismic zones (zone 1 is the highest seismic hazard) and Padang city is classified as zone 2. In 2002, the code has been updated to the earthquake resistant design standard (21). However, the enforcement of building codes and the quality assurance of construction is lacking in Padang. The poor quality of building that improperly constructed made them vulnerable to earthquakes. These also include government buildings and health facilities (21).

II. *Maternal and child health*

High rate of maternal and infant mortality, along with under-nutrition were the health problems encountered in the West Sumatra Province. In 2008, the maternal mortality ratio (MMR) was 215.9 deaths per 100,000 live births, and the infant mortality rate was 47 per 1,000 live births. In Padang city, the capital of the province, the MMR was 95.6 deaths per 100,000 live births in the same year (22).

2.6 Resilience

Resilience is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner (9). After 2004 tsunami in Aceh, disaster risk reduction programs have been widely promoted. A large number of mock drills, discussions, and simulations on earthquake and tsunami have been conducted in the community. People were trained to run a kilometre or more to a higher ground. Schoolchildren were prepared with mock disaster drills and local motivators were trained to understand the process of natural disasters. Moreover, they were also prepared with basic medical and rescue procedures (11)(23).

3. Health Crisis and Critical Health Events

3.1 Primary event

On 30 September 2009 at 17:16 local time, a massive earthquake struck West Sumatra, measured 7.6 magnitudes on the Richter-scale with an epicentre at coordination of 0.84°S, 99.65°E and a depth of 71 km under the sea level at a distance of 57 kilometres north-west of the city of Padang (24)(25).

Thirteen districts in West Sumatra province were affected by the earthquake and six districts were accounted as the most hit area, i.e. Padang city, Pariaman city, Pasaman Barat regency, Agam regency, Padang Pariaman regency, and Pesisir Selatan regency, with population density ranging from 70 to 1,214 people in one square-kilometre (10). The earthquake was also felt by the surrounding areas, such as Riau, North Sumatra Province, Singapore, Malaysia and even Jakarta which located 922 kilometres away, with low intensity (10)(26). (Figure 4)

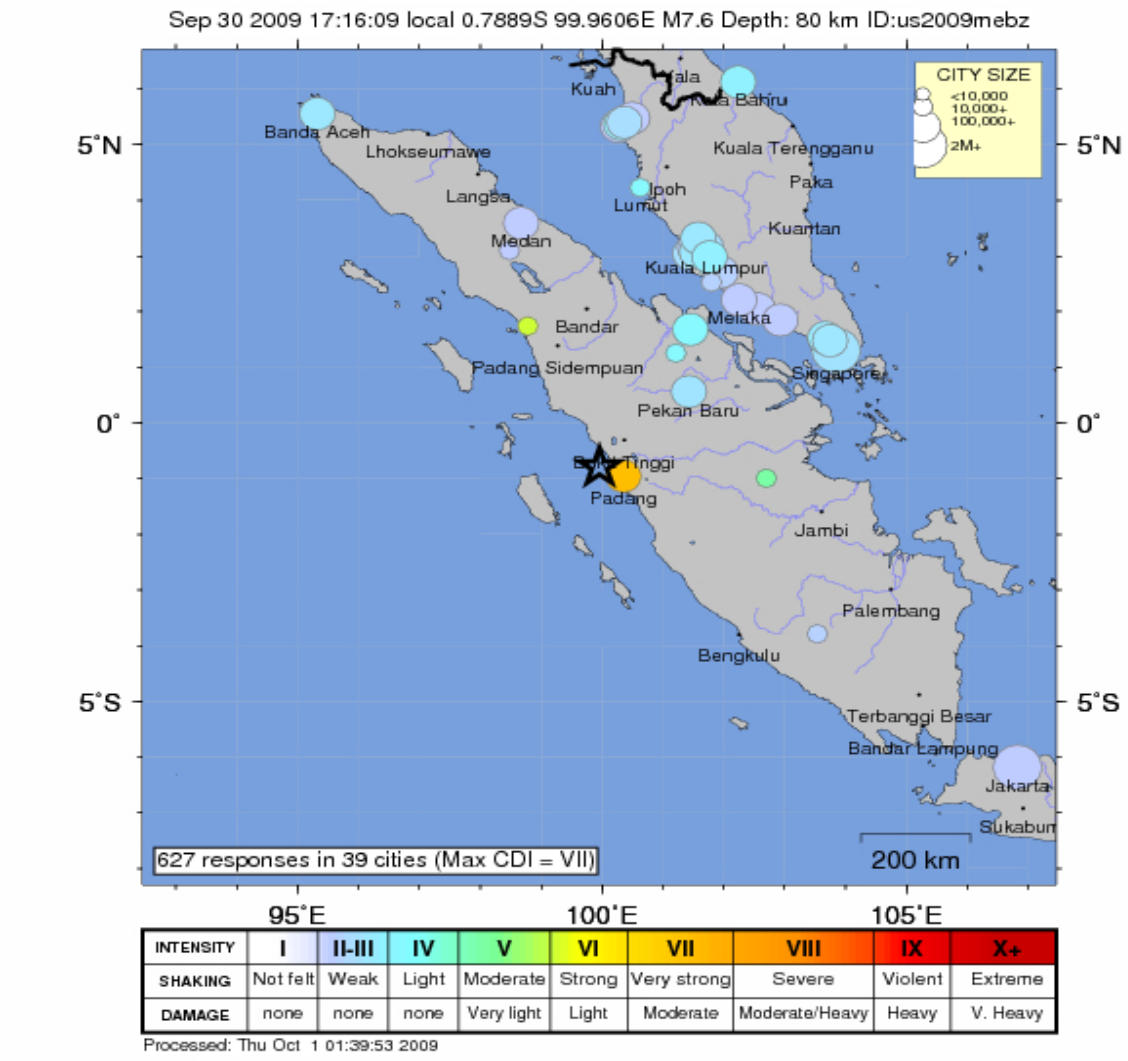

Figure 4 Padang and the surrounding affected areas (27)

3.2 Secondary events

It was followed by two major aftershocks and landslides which brought more destruction to the area. The second one (aftershock) of 6.2 Richter-scale struck the coast 22 minutes later, at 17:38 with an epicentre at depth 110 kilometres and located at 0.72°S and 99.94°E (10)(26)(28)(17). BMKG issued the earthquake information and sent it within five minutes to the local authorities. The tsunami warning was not issued because the location of the quake would not initiate tsunami. However, the information was not disseminated publicly until 30 minutes after the earthquake through the announcement in radio by the mayor. If a tsunami had happened, it would have been too late to evacuate people (29).

4. Damage & Consequences of Damage

West Sumatra earthquake has caused unexpected damage to infrastructure, livelihoods, and economy of the province. Over 2.5 million people had been affected and more than 1,000 deaths and 3,000 injuries identified after the earthquake. About 200 people were reported missing while more than 600 buried by the earthquake-triggered landslides in four villages. Housing, agricultural land, educational and health facilities, communication network, water piping system had severely damaged. An estimation of IDR 21.58 trillion (≈ US$ 2.2 billion) economic damage cost had been incurred (30)(31).

4.1 Damage and disturbances (human)

I. *Human toll*

The death toll reached 1,117 people, while 788 people suffered major injuries and 2,727 for minor ones (32). There were 565 people treated in the hospital and 33,521 outpatients due to illnesses/injuries from the disaster.

II. *Injuries*

Among the injuries, bruises (41%) and bone fracture and/or dislocation (39%) were the most predominant (24). Deaths and injuries are commonly found in the earthquake disasters, and most injuries are associated with the increase risk of disability, which can affect the quality of life (4)(24).

Table 1 Death toll and number of injured in West Sumatra Earthquake

District / Municipality	Dead	Major Injury	Minor Injury	Missing	IDP
Kota Padang	313	412	1,690	2	-
Kab. Agam	80	82	40	-	-
Kab. Pesisir Selatan	9	8	5	-	-
Kab. Pasaman	-	-	23	-	-
Kota Pariaman	32	102	-	-	-
Kab Padang Pariaman	675	175	540	-	-
Kab. Solok	-	1	-	-	-
Kota Solok	3	-	4	-	-
Kota Padang Panjang	-	-	15	-	-
Kota Bukit Tinggi	-	4	-	-	-
Kab. Pasaman Barat	5	4	410	-	-
Kab. Tanah Datar	-	-	-	-	-
Kab. Kepuluan Mentawai	-	-	-	-	-
Total	1,117	788	2,727	2	0

III. *Sickness*

Based on the type of diseases, upper respiratory infections and diarrhoea were dominated among the affected population, with 32,745 cases and 6,169 cases respectively, of which about one-third of the disease cases were from Padang city (27). (Table 1)

IV. *Mental Health*

A study by Musa et al reported that disaster victims in West Sumatra were at risk to develop psychological impact, such as depression (18%), anxiety (51%) and stress (25%) (33). The study also identified that younger age group were more vulnerable for adverse psychological implication in post-disaster areas, especially the school-going children (33). Single individuals also had higher scores of depression and stress than married individuals (33).

4.2 Damage and disturbances (environment)

I. *Health services*

The earthquake collapsed 10 hospitals, 53 community health centre, 137 supporting community health centres, 15 village clinics, and 2 pharmaceutical warehouses (27). The destruction of health infrastructures made impacts on the delivery of health services. There were high demands for health staff to replace those who had fallen victims in the disaster, medical supplies and support for their mobility. Additionally, essential equipment for vaccination was not accessible nor destroyed due to the rubble. The earthquake also disturbed the maternal and child health services.

II. *Infrastructure*

The total damage and loss accumulated during West Sumatra earthquake was estimated to reach US$ 2.2 billion. Housing shared the largest amount with nearly 80% of the total damage, followed by productive sectors (11%) (34). Table 2 shows the number of units damaged by the earthquake.

Table 2 Number of damage recorded post-earthquake 30 September 2009 (35)

Infrastructures	**Number of units**
Lightly damaged houses	67,838
Moderately damaged houses	67,198
Heavily damaged houses	114,797
Damaged educational facilities	4,748
Damaged health facilities	153
Damaged places of worship	2,851
Damaged markets	58
Damaged bridges	68

The destruction was occurred in urban areas, flat rural areas, and mountainous rural areas. It is the man-made structures that are responsible for most of the damage and injuries in the earthquake

situation. In urban areas, most of the building collapsed were often first story, and more prevalent in the building constructed prior to about 2002 before the revision of building code seismic design (21). While in rural areas, the housing structures were almost flat due to landslides triggered by earthquake. In addition, many people lived in unsafe shelter made from the ruins and stayed nearby their collapsed houses, exposing them to the risk of injuries (36).

III. *Water Supply and Sanitation*

During the first week, more than half of public facilities did not have any water supply. Even after one year, 15% of the facilities still left without reliable water supply (32). There were no electricity in nearly half of the facilities in the first week, and it recovered at the end of the third month (32). The telephone network was less damaged compare to other facilities. Sanitation was also disturbed because there were not enough water supplies. The disruption of water supplies and sanitation could increase the risk of communicable diseases.

IV. *Livelihoods*

Agricultural land, irrigation system, roads, bridges, market, hotels were severely damaged, while people in West Sumatra were mostly relied on agriculture, trading, and tourism. More than 70% of hotels and many small enterprises had severely damaged. According to BNPB survey, many people intended to leave agriculture and trade sector and seek for new employment in other sector. The economy condition of the province slowed down significantly and it was projected that the annual income would be 2% lower than the previous year and the poverty level increased by 1.5%. However, the earthquake did not pose any major impact to the national stability as West Sumatra contributed less than 2% of national GDP (37).

5. Reponses

5.1 Relief responses

Within the first 24 hours, the Governor of West Sumatra (under the approval from BNPB) invited OCHA as counterpart in coordinating the humanitarian response from international organisations,

while BNPB managed the activities organised by government and local NGOs (35). President of Indonesia, Susilo Bambang Yudhoyono, welcomed the international assistance to help West Sumatra earthquake (26). Initially, BNPB announced the emergency response would take place for two months, but later it was changed into one month (26). A joint mission from United Nations, led by OCHA, was deployed to Padang within the first 18 hours and humanitarian clusters were activated within 48 hours, involving local and international actors. (Table 3) At the same time, various local and international NGOs sent their team to conduct joint needs assessment (38).

Table 3 Humanitarian clusters activated during West Sumatra Earthquake 2009 (31)

Cluster	**Lead Agencies**	**Governmental Institutions**
Agriculture	FAO	Office of Governor, Provincial and District Agricultural, Fisheries, and Forestry Agency, Agency for Food Security, Ministry of Agriculture, Ministry of Marine Affairs and Fisheries;
Coordination and safety	UNDP	BAPPEDA West Sumatra
Education	UNICEF, Save the Children	Ministry of Education, Ministry of Social Affairs, Ministry of Religious Affairs, Public Works (Housing).
Food and nutrition	WFP and UNICEF	Local government
Health	WHO	Ministry of Health, Provincial Health Office, Provincial BKKBN, District/Municipality Health Office;
Logistic and telecommunications	WFP	BNPB and local government
Protection	UNICEF, UNFPA	Ministry of Social Affairs, Ministry of Education, Local Department of Social

		affairs and Education; Ministry of Justice and Human Rights, National Police, National Department of Land matters, Bappenas, Governor office of West Sumatra, Local Police Department,
Shelter	IFRC	Ministry of Public Works; Ministry of Social Affairs; BAPPENAS, Ministry of Public Works, Ministry of Housing, district agencies
Water, sanitation, and hygiene (WASH)	UNICEF	Municipal water authorities PDAM, Department of Education;
Early recovery	UNDP	Offices of the Governor, BAPPEDA, Ministry of Manpower and Transmigration, Ministry of Social Affairs

I. *Search and Rescue*

Search and rescue (SAR) operations were activated within the first 48 hours, and 21 teams conducted their operations within the first week (39). On 6 October 2009, BNPB and BPBD West Sumatra declared the end of SAR operations. The relief efforts were elaborated into ten clusters (Table 3). This case study will summarise the response of clusters related to basic health needs as mentioned in SPHERE standard: Health, Food and Nutrition, WASH, Shelter, and information.

II. *Health Cluster*

The health cluster was led by the WHO and the Ministry of Health. In the early stage 3,000 health workers were deployed and 5 field hospitals was set up. WHO South East Asia regional office immediately released USD$ 175,000 from its health emergency fund to set up the operations. Fifty-three organisations participated in 5 sub cluster areas: immunisation, psychosocial and mental health,

mobile clinic, injury surveillance and rehabilitation, nutrition, maternal and child health, health facility support, and environmental health (32). The cluster managed to respond the emergency situation in a timely manner and was able to coordinate with nearly all (90%) of the partners in the field. The affected population was able to reach the basic health services and the health facilities were functionally restored within two weeks. The cluster members, UNFPA (United Nations Population Fund) and provincial BKKBN (Provincial Family Planning Coordination Board), distributed 2060 hygiene kits, 740 pregnant mother kits, 681 post-delivery kits, and 612 baby kits at five affected districts. They worked closely with Indonesian Army, thus the kits were able to be delivered to remote areas using helicopters. Fifteen maternal health posts were established at the areas where community health centres were affected. Within one month, they had provided 535 antenatal services, 222 delivery assistances, and 760 family planning services. Based on the data compiled by UNFPA, there were no significant difference of antenatal coverage before and after the earthquake, and the coverage reached 95.6% for first antenatal care visit and 87% for complete visit in December 2009 (40).

III. *Food and Nutrition Cluster*

UNICEF and WFP coordinated the provision of food and nutritional needs during the emergency situation. The cluster distributed the supplementary foods through 62 community health centres and 698 primary schools to reach 114,873 children under-five, 42,340 pregnant and lactating women, 111,577 students and 5,697 teachers in six districts. In total, WFP had disseminated 1,090 metric tons of fortified foods and noodles. The local government coordinated the distribution of staple foods and provided emergency public kitchens. In order to control the distribution of breast milk substitutes, all donated infant formula were stored in the provincial health warehouses. Vitamin A was also distributed to children 6-59 months, along with the immunisation campaign. At the end of emergency period, no severe cases of under nutrition identified and it appears that the cluster had fulfilled their objectives (40).

IV. *Water, Sanitation, and Hygiene (WASH) Cluster*

UNICEF, along with Public Work Department and PDAM Water Company, coordinated the cluster to

prevent the water and sanitation related diseases. The initial response of WASH cluster was to distribute water storage, hygiene kits, water purification units, water bladders, and water trucking, particularly in Padang, Pariaman, and Agam cities. In the beginning of 2010, 69,992 hygiene kits, 36,495 jerry cans, 43 water treatment plans, 196 public water points, 4 pipe systems, and 37 wells were managed to reach 90% of the affected population. There were also trainings on hygiene promotion and education to 361 facilitators and 55 teachers (40).

V. *Shelter Cluster*

During the emergency phase, IFRC led the cluster until January 2010, followed by Early Recovery Shelter Cluster Coordination Team (SCCT) and handed over to UN-HABITAT and Early Recovery Network in April 2010. The main activities in this cluster were providing temporary shelter, permanent housing support, and training and outreach to the community. The initial response of this cluster was to support temporary/transitional shelter (T-shelter) with the budget of IDR 3 million per unit to 52,000 households. Several challenges were encountered, i.e. lack of local resources (e.g. carpenters), concern on the environmental impact and sustainability, lack of understanding on government policies, and the need to coordinate the agencies to have a common method. In addition, it is reported that a large number of households were headed by females and therefore, it was important to involve females in the training and ensure the access of all assistance would reach these female headed households. In the later phase, cash stimulus was given by the government either directly or through agencies to support the construction of permanent house, IDR 15 million for new construction and IDR 10 million for house repair. By the end of April 2010, 75% (135,755 out of 181,066) of the damaged houses in 7 districts had been repaired or rebuilt with the support from government and agencies (40).

VI. *Emergency Telecommunication Cluster*

WFP led the cluster and deployed WFP Fast Telecoms deployment kit in the early days. WFP with OCHA, Telecoms Sans Frontières, and local NGOs held cluster coordination meeting in Padang. The cluster managed to establish a communication centre in Padang, VHF radio network in Padang and

Pariaman cities, hold radio communication training, and develop standard radio operating procedure. In the end of 2009, they handed over all the equipment and system to United Nations Department of Safety and Security (UNDSS) Indonesia (40).

5.2 Recovery responses

I. *Early Recovery Cluster*

The Early Recovery Cluster was established on 1 October 2009 and led by UNDP. Thirty-two organisations were involved in this cluster, even though most of them were part of other clusters. The main activities were focusing on the rapid restoration of physical and capacity of local government, safe removal of the collapsed structured, support the recovery of the affected livelihoods, and facilitation of the rehabilitation and reconstruction of permanent housing (40).

II. *Cash Transfer Program*

To support the temporary shelter program and re-establish the livelihoods, government and agencies initiated cash transfer program. The government had experienced the implementation of this program from previous disaster in 2004 Aceh Tsunami, 2006 Yogyakarta Earthquake, and 2007 West Sumatra Earthquake. It was shown that the cash would give a fast and effective purchasing power for the households to buy building materials. There were different types of cash transferring program, i.e. cash voucher, cash transfer, and cash for work. Cash voucher and cash transfer were reported to provide better solutions than cash for work. The concept of giving cash for communal work might undermine *Gotong Royong*, the local culture of doing community work voluntarily. Over 20,000 people had benefited from this program as reported from four agencies, with more than 85% of the cash was spent on building materials (41).

6. Development

BPBD, the provincial agency for disaster management, was established few months before the earthquake occurred. Learning from the disaster, national government and local authorities realised on the need of improving the community preparedness. BPBD districts were established, even though

there was different level of preparedness in the districts, e.g. BPBD in Padang Pariaman was established few months after the earthquake, while it took one year for Pesisir Selatan (42). In addition, the local government has collaborated with media to promote disaster preparedness programs. The "Build Back Better" program, which encourages the community to rebuild the house with earthquake resistant materials, has received the public attention and supported by the community and building supply storeowners (43).

7. Discussion

The case study is discussed by using the concept of disaster cycle: pre-disaster, disaster, and post-disaster. In the pre-disaster, we are discussing the preparedness from the local authorities towards disaster. In the disaster, we are looking at the emergency response. And for post-disaster, we highlight the health impact, particularly injuries, maternal and child health.

7.1 Pre-disaster: Disaster preparedness

Learnt from this disaster, the local authorities made more efforts on disaster preparedness by establishing sub district disaster management agency in Padang Pariaman and Pesisir Selatan. However, in terms of health services, it appears there were not many changes. Fuady et al. assessed the level of preparedness in nine primary health centres in Padang Pariaman district six months after disaster (44). There was only one hospital in Padang Pariaman district, thus the health services are heavily relied on primary health centre. The study found that only two primary health centres received disaster preparedness training, one primary centre for public health emergency training, all of them lacked of transportation facilities, and none of them had policies related to disaster preparedness (44). In the earthquake prone areas, like West Sumatra, it is prerequisite to set up pre-incident actions, i.e. improving the engineering and design of buildings according to earthquake resistant design standard, and developing a disaster response plan that includes training health workers and stockpiling equipment (45).

7.2 Disaster: Health impact

I. *Type of injuries*

Earthquake is one of the most devastating disasters that cause many deaths and injuries. Hospitals and health clinics are destroyed and most of health equipment, such as x-ray, dialysis machine and ventilators were dysfunctional when they are needed most. Most deaths happened in the earthquake were due to collapsed buildings and falling rubbles that caused crush injuries, extensive haemorrhage, or acute renal failures. It was recorded that more than 1,900 crush injuries had occurred due to earthquake (1988-2005) .In West Sumatra Earthquake, there was limited data on the number of victims on crush injuries, but within the first week the death toll was already reached 704 people (approximately 63% of total death) (44). Another major cause of deaths from earthquake is heavy dust produced by crumbling structures. Huge amount of dusts can fill lung and cause asphyxia or respiratory obstruction. Minor lacerations or contusions are usually the most common injuries identified in the earthquake, and it was also shown in West Sumatra Earthquake, where bruises were found to be the most predominant. The second most common injuries are simple fractures that not required operation interventions (46). This was also identified in West Sumatra, as bone fractures or dislocation were found in Mondastri et al. study. However, in the study there was no classification on the type of bone fractures (24). As with most natural disasters, chronic illnesses are found to be more prevalent because the patients cannot go to the clinic and receive regular medications or they lose the medications. Mondastri et al. study identified higher prevalence rate of hypertension (average 11%) when compared to annual rate of West Sumatra province (7.6%) (24). The increase of acute presentation of chronic illnesses was also identified in 2004 Indian Ocean Tsunami (47). To minimise the emergency health impacts, provincial health office with the help of international and local NGOs immediately established mobile clinics and set up field hospitals. Physical structures of many health facilities required long time recovery, but their functional capability were restored within two weeks, regardless of minimum water supply and electricity.

II. *Maternal and child health*

West Sumatra is well known for its poor maternal and child health. High maternal mortality ratio

(215.9/100,000) and high infant mortality rate (47/1,000) was identified in 2008. Realising the need, the health cluster immediately established 15 maternal health posts and within two weeks, 60% of maternal health services were recovered. However, there was increasing trend of still birth and under-five mortality in 2011 (22). Several studies suggest psychological distress and limited access to health facilities can contribute to poor pregnancy outcomes, including pre-term birth, spontaneous abortion, low birth weight babies, retardation of foetal brain development, and reduction of breast milk (48). Furthermore, having limited access to health facilities is found to be a strong predictor for depression and anxiety for women following earthquakes (48). In the study of Djafri, Chongsuvivatwong and Greater, most respondents reported difficulties in accessing reproductive health services (ranging from 72.9% to 91.1%) compared to the access before West Sumatra Earthquake (9.2% to 21.1%). This could be attributed to these factors: severe damage of health facilities, low quality of health services, different timing of humanitarian assistance, and disruption of public facilities (such as water and power supply) (22). Reproductive health events and access to healthcare facilities are found to be significant factors contributed to depression and anxiety among women following earthquakes. Thus, psychological treatments are also required for earthquake-affected women. Ministry of Social Quick Response Team acknowledged the needs and immediately established trauma centre. However, the centre was more targeted to vulnerable groups, i.e. children, elderly, and disabilities, and less concern to women (49).

7.3 Post-Disaster

I. *Emergency Response*

West Sumatra has dealt with earthquakes many times before 2009, and yet it had not learnt enough from past experiences. In March 2007, 6.4 magnitude Richter-scale Earthquake hit West Sumatra, damaged 44,000 houses and displaced 135,000 people (50). And again, in 2009 more houses damaged because people did not build their houses using earthquake resistant design standard. However, the emergency responses shown in this disaster were relatively better, compare to West Java Earthquake that occurred in the same month. In West Java, the delivery time of aids was relatively slow (7.3 days vs. 5.8 days in West Sumatra), and less coverage area of emergency shelters (60% vs. 85%). It was

assumed that the initial government response in welcoming international assistance was one of the reasons. Both earthquakes implemented the cluster approach and collaborated with UN agencies and international organisations. During West Java Earthquake government initially did not intend to ask help from international actors, while in West Sumatra Earthquake government was directly welcoming the international assistance (34).

II. *Cluster Approach*

Cluster Approach has been introduced since December 2005. It aims to identify the gaps and enhance the quality of humanitarian action. The experience after Indian Ocean Tsunami showed the environment of competition between agencies and under coordination. The situation led Inter-Agency Standing Committee to establish the cluster system. The Indonesia has adopted the Cluster Approach since Yogyakarta Earthquake in 2006. The humanitarian response in Yogyakarta was praised as a success story despite there were still many gaps, such as lack of real-time translation that led to miscommunication, lack of participation from all agencies to the cluster system, and lack of coordination not within groups, but between government, international and local organization (51). Learnt from the previous experience, the cluster system applied in West Sumatra earthquake was considerably better. There were joint need assessment between agencies, regular meeting within the cluster, coordination meeting, and joint evaluation. Regardless of the improved coordination, the questionnaire for joint needs assessment was confusing. Some local organizations received the English version, instead of Bahasa (52). The translation facilities were still lacking in some of the clusters, which hindered the participation of local NGOs in the coordination meeting (53). This issue of translation also impeded the funding for local NGOs. Through the cluster approach, the UN agencies together with NGOs and Indonesian government produced Humanitarian Response Plan nine days after the event to appeal donors for funding, but the response was only 38% funded (53). International NGOs were encouraged to partner with the local NGOs, including the Islamic NGOs to help beyond the religion focus.

7.4 Evaluation and Limitations

The strength of this study is that it is a structured literature review discusses the health issues and responses following West Sumatra Earthquake. The guideline described by Kulling et al. is able to provide a broad picture of the whole crisis in a sequence manner. However, being a literature review, this study is dependent on the amount of studies and reports that publicly available in the internet. Some data, e.g. number of specific injuries, number of people received psychosocial interventions, are not always available and accessible. In addition, different sources could generate different results on the number of affected people. It should be noted that regardless of the inconsistency data, this study used the data from local authorities and UN agencies. Further studies should explore more the impact of earthquake on the vulnerable population and the effectiveness of health cluster which is not discussed here due to limited data. Moreover, future research is needed to extend these findings and should involve primary data collection, e.g. interview with stakeholders and the affected community.

8. Lessons Identified and Actions Recommended

Several lessons can be obtained from West Sumatra Earthquake case study. The lessons will be divided into pre-event actions and post-event actions as described below in Table 4.

Table 4 Lessons identified and actions recommended

Time	**Lessons Identified**	**Actions recommended**
Pre-event	Legislation on code building	1. Government should enforce the regulation for structural preparation, engineering, and designs according to earthquake resistant design standard 2. Government should provide training for craftsmen and education for the community, including the owners of hardware supply stores
	Disaster preparedness policy for primary health centre	1. Government should establish disaster preparedness policy for primary health centres, provide public health emergency training for health workers and emergency

		transportation, especially for primary health centres located in rural and remote area
	Early warning system	1. The local authorities should promote the use of early warning system in sub districts and establish local radio network for disseminating disaster information 2. The local authorities should promote and educate the community on early warning system
Post-event	Control and command	1. The government has shown its leadership and quick response in welcoming international assistance. It also managed to divide its responsibility with OCHA and established the cluster system in a relatively short time.
	Inter-agency collaboration	1. The cluster system managed to produce a joint needs assessment, a quick proposal to appeal donors, and joint needs evaluation. 2. Regular meetings were established to maintain the collaboration and as a platform to exchange information
	Data reporting	1. A common structure of reporting the health data is needed, particularly in the hospitals and primary health centres.
	Communication	1. Collaboration with media is required to help disseminate disaster information and provide education on building proper structures.

9. Conclusions

The West Sumatra Earthquake affected over 2.5 million people and damaged more than 200,000 buildings. Government immediately responded and the Cluster approach was adopted to provide humanitarian assistance. The emergency phase was declared over within one month, and the recovery and rehabilitation phase was continued until 2011. Regardless the well-coordinated response among different organisations, several sectors on disaster preparedness and policy legislation need to be improved. Hence, the impact of future earthquakes can be mitigated through community empowerment and better coordination.

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11. Keywords

West Sumatra, earthquake, Indonesia, Cluster Approach

12. Abbreviations

BKKBN	Provincial Family Planning Coordination Board, Indonesia
BMKG	National Agency for Meteorology, Climatology, and Geophysics, Indonesia
BNPB	National Disaster Management Agency, Indonesia
BPBD	Provincial Disaster Management Agency, Indonesia
FAO	Food and Agriculture Organization of the United Nations
IASC	Inter-Agency Standing Committee
ICVA	International Council of Voluntary Agencies
IFRC	International Federation of Red Cross and Red Crescent Societies
MMR	Maternal mortality ratio
NGO	Non-governmental Organisation
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
SCCT	Shelter Cluster Coordination Team
SAR	Search and rescue
UNDP	United Nations Development Programme
UNDSS	United Nations Department of Safety and Security
UNFPA	United Nations Population Fund
UN-HABITAT	United Nations Human Settlements Programme
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation, and Hygiene
WFP	World Food Programme
WHO	World Health Organization