POPULATION EXPOSED TO NATURAL HAZARDS

a Study Based on the 2010 Population Census

BNPB

UNFPA

BADAN PUSAT STATISTIK

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Joint Foreword

Partnership is a very positive step to synergize resources from various parties. The National Disaster Management Agency (BNPB) and Statistics Indonesia (BPS), under the auspices of UNFPA, the United Nations Population Fund heve colaborated in a partnership to develop this thematic study, “Populations Exposed to Natural Hazards”. a study based on the 2010 population census in Indonesia and BNPB’s 2011 Disaster Risk Assessment.

The study is expected to provide readers with impotant information as well as provide policy-makers with reference material to support evidence-based policy-making on disaster management and development planning.

BNPB and BPS believe this study is very important in providing relevant information on the threats of the disasters towards the population in Indonesia, particularly vulnerable groups. These groups comprise young children (under-five children), the elderly and people with disabilities.

BNPB and BPS, again with the support of UNFPA, have previously integrated population data into the Indonesian Disaster Data and Information system. Further collaboration with government ministries and agencies will hopefully lead to the development of national guidelines on using data for disaster management programmes.

We wish to express our deep appreciation for UNFPA’s facilitation in making this collaboration possible. We look forward to making the most of the results of this thematic study, as we seek to bring our respective strengths to the important task of responding to natural disaster hazards in Indonesia.

Head of Center for Data, Information and Public Relations, BNPB

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Preface

One important achievement of the cooperation between the National Disaster Management Agency (BNPB) and BPS-Statistics Indonesia has been the successful integration of population data into the Indonesian Disaster Data and Information (DIBI) system, with technical support from UNFPA, the United Nations Population Fund. UNFPA is committed to continue providing technical support for the further integration and use of population data for disaster management in Indonesia.

The integration of population and disaster data has enabled BNPB to assess the numbers of vulnerable groups and populations in disaster-prone areas. One useful product of this integration has been the compilation of this book, with a focus on populations exposed to the hazards of natural disasters.

This book, titled Populations Exposed to Natural Hazards, a study based on the 2010 population census in Indonesia contains the results of a study on the numbers of vulnerable groups and populations that are exposed to six types of high and medium level hazards in each of Indonesia's 33 provinces. The types of hazards assessed include earthquakes, tsunamis, landslides, volcanic eruptions, floods, extreme waves and erosion. The groups and populations identified as vulnerable to disasters include under-five children, the elderly (60+), and persons with disabilities.

The study in this book shows that more than 97% of Indonesia's total population live in disaster-prone areas. Of the six types of hazards discussed in the book, earthquakes pose a high or medium level hazard to the greatest number of people, at more than 148 million people, or 62.4% of Indonesia's total population.

UNFPA is proud to have contributed to the preparation of this book by providing technical assistance to BNPB for the calculation of the numbers of vulnerable groups and populations that are exposed to natural hazards.

I hope this book can provide timely and accurate information on vulnerable groups and populations exposed to natural hazards so that it can be used as a reference by all humanitarian actors, including both government and non-government actors, in policy making and programme activities for disaster risk management.

Jakarta, June 2015

Jose Ferraris
UNFPA Representative in Indonesia

Executive Summary

The Indonesian archipelago is located in a region that is very prone to the threat of natural disasters. The country with a population of over 237 million people counted in the 2010 Population Cencus, is subject to devastation from geological and hydro-meteorological hazards caused by its position and geographic conditions.

Acknowledging this background, the National Disaster Management Agency (BNPB), Statistics Indonesia (BPS), and UNFPA, the United Nations Population Fund, have collaborated to publish this handbook in an effort to enrich the study of disaster relief in Indonesia. This study will improve public knowledge regarding exposure to the hazards as well as encouraging a more comprehensive understanding of disaster related development planning at the local level.

This study has drawn on the data from BNPB's 2011 Disaster Risks Assesment and BPS's 2010 Population Census. The threats include the geological hazards earthquake, tsunami, and volcanic eruption, and hydro-meteorological hazards floods, landslides, storms, and extreme waves and abrasion. BNPB categorizes the hazards in low, medium, and high levels, however, only the medium and high categories are used in this study.

To develop the modeling on the population exposed to these risks, the study used geographic information systems and grid analysis techniques. The grid analysis displays spatial data in several cells with certain sizes. Each of these cells contains numbers that represent a value, and the parameters in the analysis use the number of population exposed based on gender and vulnerable groups. The parameters refer to the definitions used by BPS; that is, gender refers to men and women, and vulnerable groups refer to under five children, the elderly, and persons with disability.

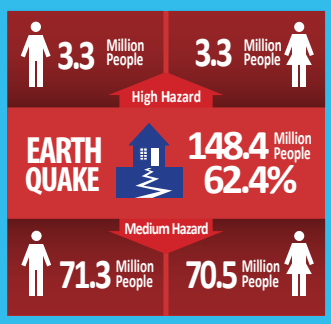
The study of population exposed to the danger of natural disasters shows that over 97% of inhabitants of Indonesia are living in the areas prone to disasters. Out of the six types of disasters, earthquake is the hazard with the largest population exposed in the high- and medium level categories. The total population exposed is over 148 million or 62.4% of the total population of Indonesia. This is a large number considering that 92.2 million hectares or 48.5% of the total area of Indonesia is exposed high and medium levels of earthquake. Population exposure to other hazards includes tsunamis (4.2 million people), volcanic activity (3.9 million), floods (63.7 million), landslides (40.8 million), and extreme waves and abrasion (11.1 million).

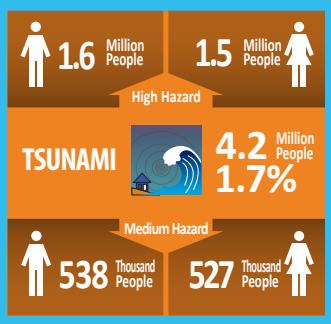
In comparison to the total population exposed to the different hazards, tsunami and volcanic eruption show the lowest number, but data shows these disasters have significantly high impacts. Based on Indonesia Disaster Data and Information (DIBI)figures, the number of casualties due to tsunami during the period of 2000 - 2013 was 167,000 with the largest number being the event in Aceh in 2004. Volcanic eruption led to as many as 403 deaths during the same period, with the most casualties resulting from the Mount Merapi eruption in Central Java and Yogyakarta in 2010.

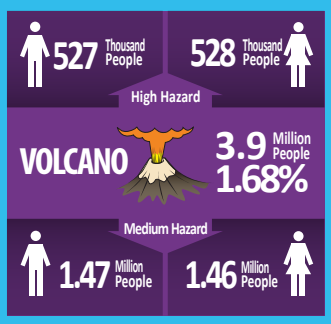
Other disasters that often strike in Indonesia are flood and landslides. More than 1,000 incidents are recorded in the period of 2000 - 2013, and large numbers of people have been exposed to both types of disasters. The percentages of population exposed to high and medium level floods and landslides are 26.8% and 17.2% of the total population of Indonesia, respectively.

Efforts of mainstreaming disaster risk reduction are very important in every step of development both in the national and local levels. At the national level, Ministry of National Development Planning (BAPPENAS) and BNPB have incorporated disaster risk reduction into the Medium Term National Development Plan 2015-2019. This study shows the areas and the number of population exposed to risks from hazards and natural disaster. It is important for people who live in particular ares prone to these risks to be aware of the environment around their residing place. They must be capable of adapting to any potential hazards that might occur. The results of this study may help to the information on exposure to disasters to assist in informing the wider public about these risks, and assist stakeholders at all levels in planning for disaster risk reduction and response.

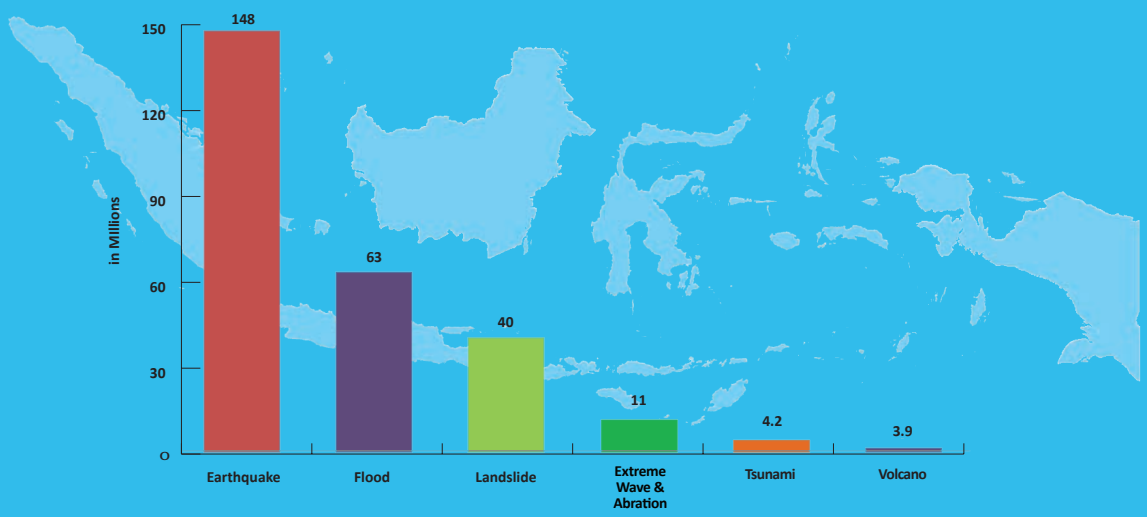
POPULATION EXPOSED TO NATURAL HAZARDS



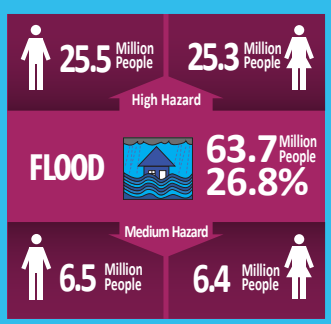


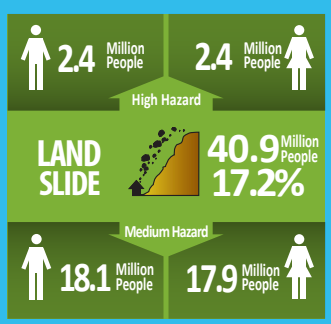


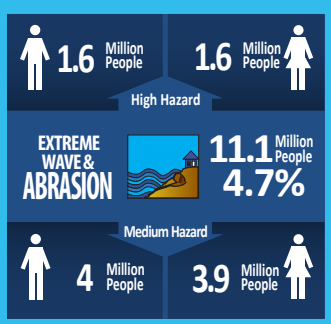
Population Exposed to Natural Disaster Hazards in Indonesia



Source: Adapted from the 2010 Population Census, BPS and 2011 Disaster Risks Assessment, BNPB.

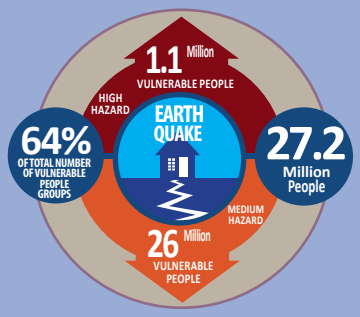


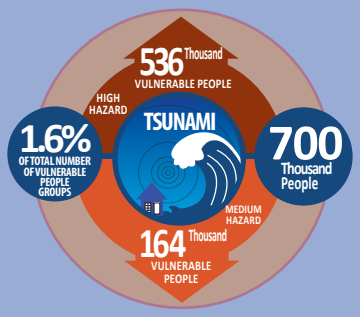


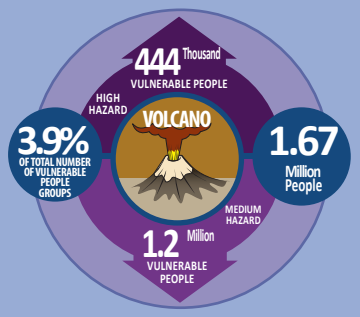


Percentages are of total population in Indonesia
(2010 Population Census, BPS)

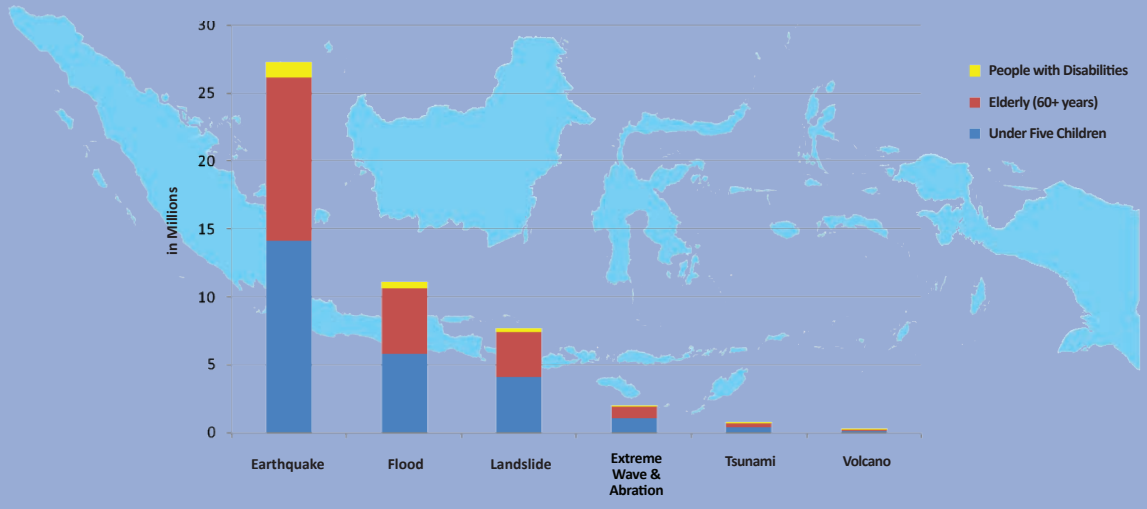
VULNERABLE PEOPLE EXPOSED TO NATURAL HAZARDS



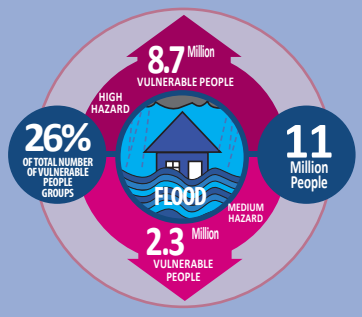


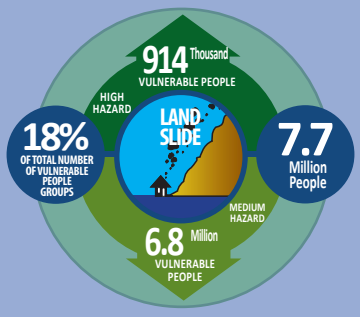


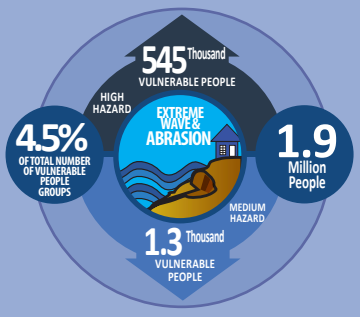
Number of Vulnerable Groups Exposed to Natural Hazards in Indonesia



Source: Adapted from 2010 Population Census, BPS and 2011 Disaster Risks Assessment, BNPB.







Percentage of Total Number of vulnerable groups in Indonesia, 42.1 million (2010 Population Census, BPS)

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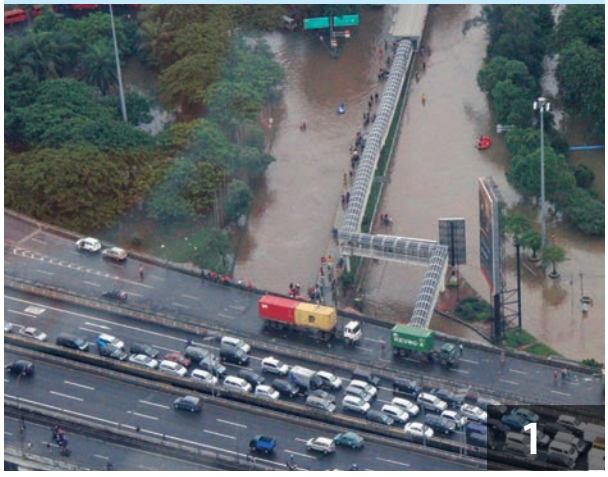
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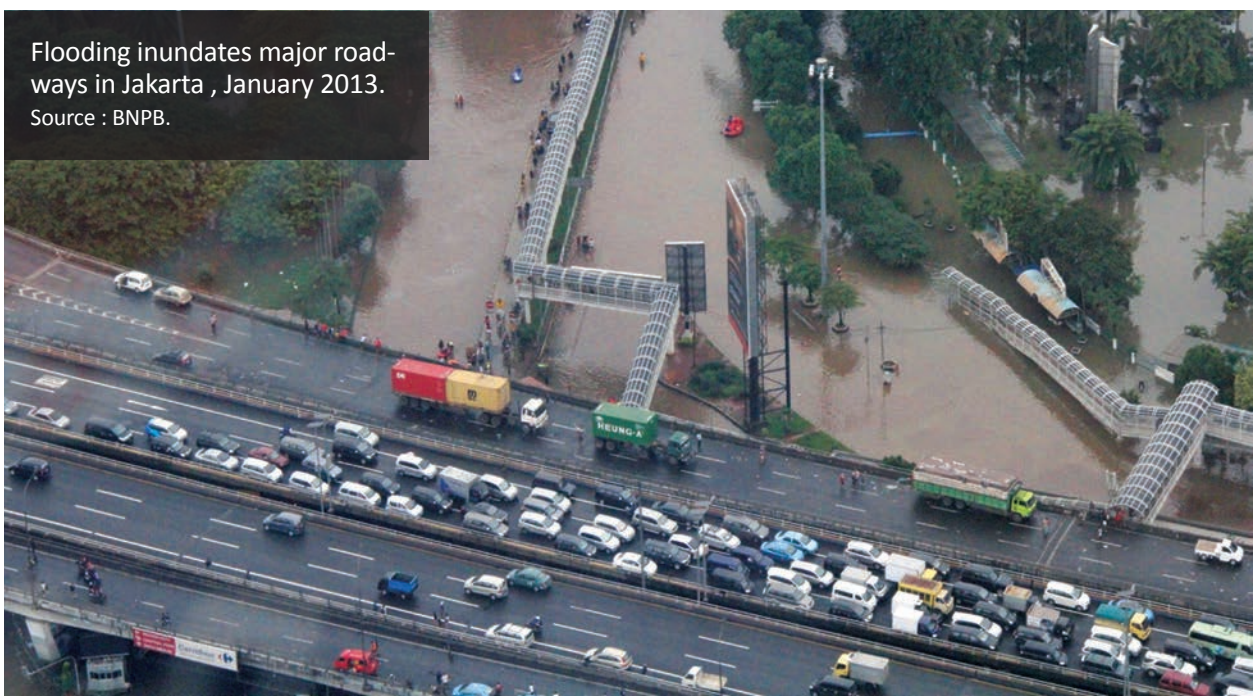
PART 1

Introduction

Background

We all know that Indonesia is a disaster-prone country. Behind its ecological beauty and richness, natural disaster hazards are all around us. The earthquake and tsunami in Aceh in 2004 is still strongly etched in our memory. The parliament and government of Indonesia promptly reacted by drafting a regulation on disaster emergency response which was then enacted as Law No. 24 of 2007 on Disaster Management. Numerous studies on disaster management and publications on natural disasters have been carried out by various parties including the government, international institutions, and academics. This shows a very serious attention to the impacts of natural disasters, in particular those disrupting the life of the community. Indonesia has recently dealt with a series of major natural disaster events after the tsunami and earthquake in Aceh, including the earthquakes in Nias (2005), Yogyakarta (2006), and Padang (2009), tsunami in Mentawai (2010), flash flood in Wasior (2010), and Mount Merapi eruption (2010).

From these catastrophic events, hundreds of thousands of people have been victims. Moreover, the disasters have also led to losses and damage that has cost trillions of rupiah. In fact, other natural disasters such as floods, drought, and landslide continually occur throughout country.



Flooding inundates major roadways in Jakarta , January 2013.
Source : BNPB.

School buildings at, SMP 21 Takengon, in Central Aceh severely damaged by the earthquake disaster in July 2013. Source : BNPB.

Disaster risk reduction (DRR) strategy as a preventive and preparedness measure should be mainstreamed as part of disaster mitigation in Indonesia. Human beings are the center of attention in this context because of their susceptibility to danger from these natural disater risks. All parties including the government, civil society, and the private sector should conduct variety of efforts should be conducted in parallel to ensure the risks of these disasters are mitigated as much as possible. Analysis of population data to calculate the population exposed to the hazard of natural disasters is important DRR activity. The study of exposed population is required to know the total number and characteristics of the population residing in risk areas. This information is useful for planning various appropriate DRR and preparedness programmes. These programmes can then be prioritized in area that have a large number of population and vulnerable groups at risk.

Law No. 24 of 2007 mandates that the community has rights for social protection and security, particularly for vulnerable groups. The protection is rendered by giving priority to the vulnerable groups in the form of rescue, evacuation, security, health and psychosocial services. Vulnerable group are defined to included:

a. Infants, under five children and children
b. Mothers who are pregnant or breast feeding
c. People with disabilities; and
d. The elderly.

This book is a study of disaster that discusses specifically the characteristics of exposed population based on the hazards of high and medium levels.

Landslides hit settlements in Tawangmangu , Karang Anyar , Central Java , in December 2007.
Source : BNPB

The study is the result of cooperation between BNPB and BPS with technical support from the UNFPA.

The calculation of the number of population exposed is based on the data of national disaster risk assessment from BNPB in 2011 and data from the 2010 population census by BPS. The figures show the total population and the vulnerable groups exposed to the hazards of high and medium classes. The exposed vulnerable groups consist of under five children, elderly (60 years and over), and persons with disability.

Objectives

1. To provide accurate information and data regarding the population and vulnerable groups exposed to the natural hazards of disasters, which can be used as a reference by all humanitarian actors and stakeholders (both government and non-government), in making policies and planning DRR and disaster relief programmes.
2. To enrich thematic studies relating to the population exposed in the context of disaster relief and risk management.

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PART 2

Indonesia - a Disaster Prone - Country

Demographic Conditions

Indonesia is an archipelago with over 17,000 islands, both big and small. With sea area being three times larger than the land area (± 1.9 million sq km), the administrative area of Indonesia is divided into 34 Provinces (there were only 33 Provinces in population census 2010) and 511 districts/cities. The largest province is Papua (± 300,000 sq km), while the smallest is DKI Jakarta (± 625 sq km). In addition to its large area, Indonesia also has the fourth largest population in the world after the People's Republic of China, India and the United States. According to BPS data, the total population of Indonesia is more than 237 million people (Population Census 2010) consisting of 119.5 million male and 118 female.

Approximately 58% of the population occupies the island of Java, which has an area of only 7% of the total land area of Indonesia. The three provinces

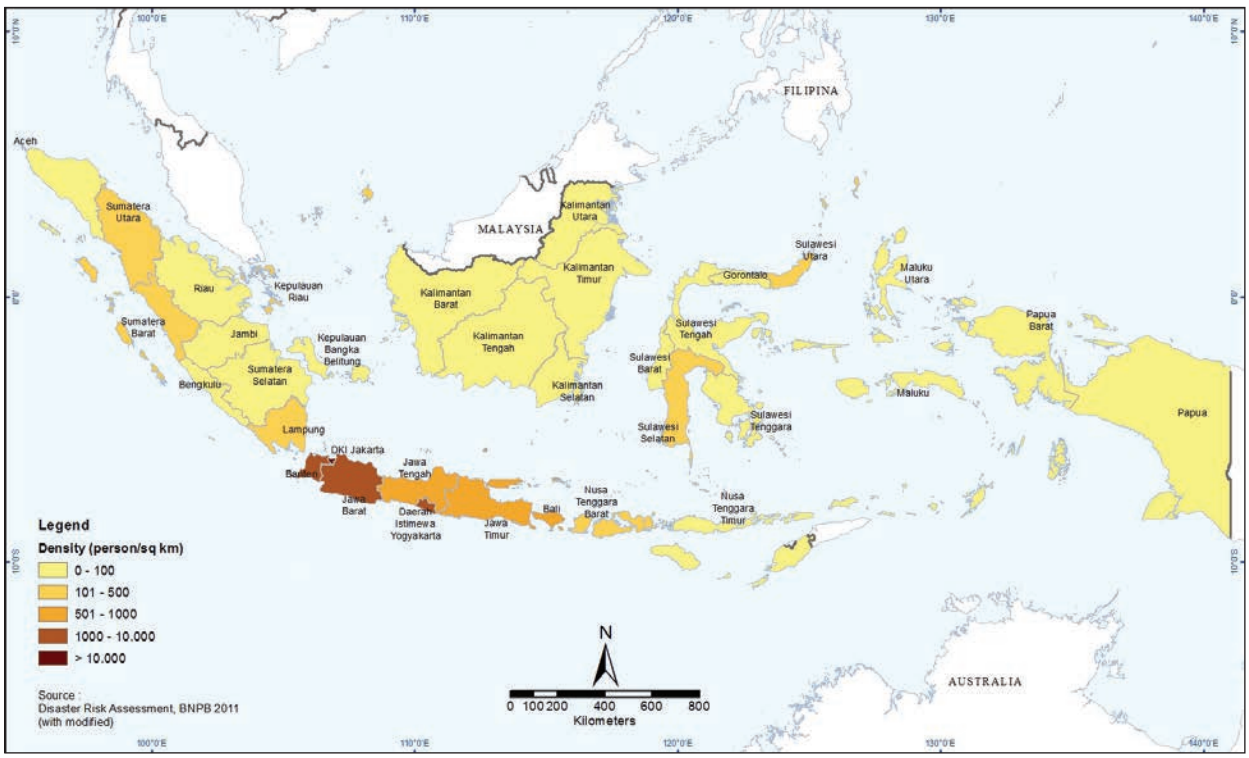


Figure 1. Map of Indonesian Population Density (Adapted from 2010 Population Census, BPS)

with the largest population are West Java (43 million), East Java (37.4 million), and Central Java (32.3 million). The population density of the island of Java is very high; the density of each province averages 1,000 inhabitants per sq km. Jakarta has the highest density level of 12,000 inhabitants per sq km, while nationally the population density is around 124 inhabitants per sq km.

In spite of being the most populous island in Indonesia, the rate of population growth on the island of Java is the lowest, with the two provinces having the lowest population growth rate being, Central Java (0.37%) and East Java (0.76%). The highest rate of population growth is in the province of Riau Islands (4.99%), Riau (3.59%) and Papua (5.46%). Compared to the data of 1970, Papua recorded a fairly high population growth, from 2.6% to 5.46%. Meanwhile population growth in Lampung province decreased from 5.77% to 1.23%. The average population growth in Indonesia from 2000 to 2010 is 1.49% or about 2.9 million per year, which is equal to the population of Singapore.

Occurrence and Impacts of Disasters

According to Law No. 24 of 2007 on Disaster Management, "disaster" means an event or a series of events threatening and disturbing the community life and livelihood, caused by natural and/or non-natural as well as human factors resulting in human fatalities, environmental damage, loss of material possessions, and psychological impact.

Figure 2 shows the number of disaster occurrences in each province during the period of 10 years from (2004 to 2013). Three provinces with the highest number of occurrences are Central Java, West Java and East Java. These provinces also have the largest population in Indonesia, which shows how that the impact of disasters are very closely related to the population condition of a region.

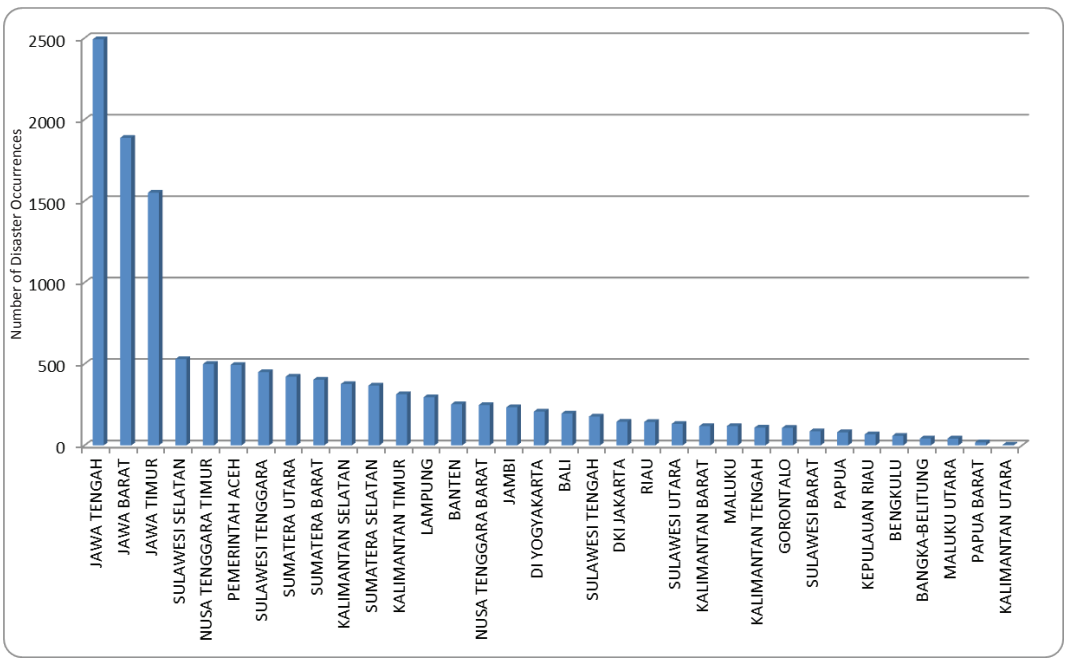


Figure 2. Disaster Occurrences by Province, 2004-2013

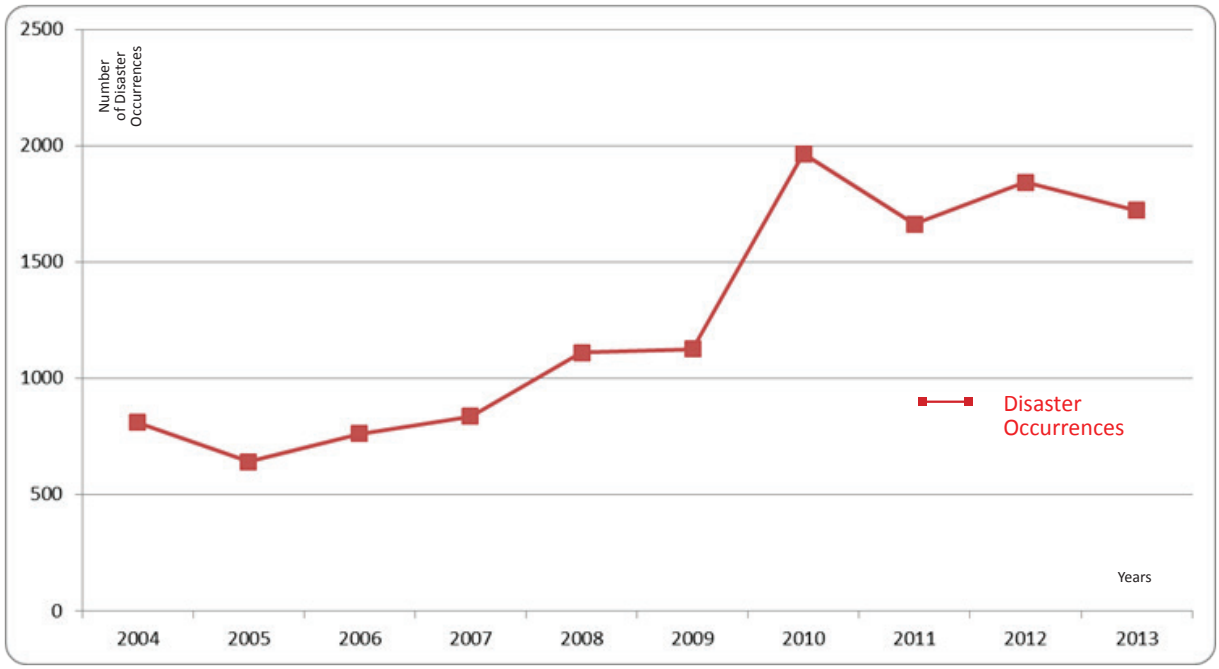


Figure 3. Disaster Occurrences, 2004-2013

The trend over the 10-year period (see Figure 3) also shows that the number of occurrences of disasters is closely related to population number. Between 2004 and 2013, the number of occurrences tendeds to increase every year. This increase is directly proportional to the average positive growth of the population of Indonesia.

Over that ten-year period, population growth reached 1.49% or around 2.9 million people per year contributing significantly to the increasing number of disasters. The high population growth rate triggers increasing demand for land for settlement. This resulted in the emergence of the buffer zones that are prone to hazards, for example, a settlement located on the Ciliwung's River bank is prone to flooding hazard. The yearly demand for space is visible from the high conversion of agricultural land into industrial or residential estates, so the absorption power of land decreases resulting in a drought in the dry season.

In the same ten year period hydro meteorological disasters were the most commonly occurring types of disasters and the frequency of occurrence increased. Hydrometeorologicaly disasters are caused by the weather. The impact of climate change is considered to be one of the causes of the increasingly frequent hydro-meteorological disasters in Indonesia.

Seasonal climactic factors in Indonesia also affect the occurrence of disasters. Normally, landslides, strong winds, abrasion and flooding occur during the rainy season. However during the dry season, some areas in Indonesia experience drought. One of the indicators of drought is limited water supply to meet the daily household, agricultural or industrial needs.

Flooding is the most common disaster; more than 4,000 incidents of flooding have occurred during the last ten years. Strong winds, landslides, and drought are the three most frequent disasters after flooding. Every year more than 90% of the disasters that occur are hydrometeorological

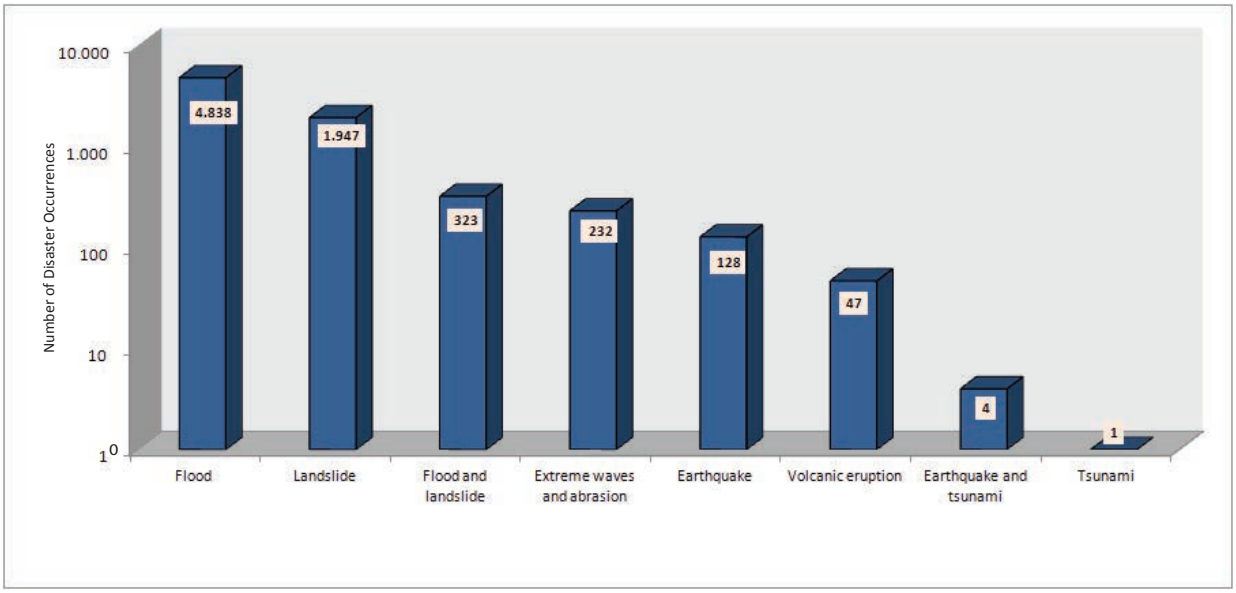


Figure 4. Type and Number of Disaster Occurrences, 2004-2013

disasters. The data indicates that although hydro-meteorological disasters are the most frequent occurrences, in terms of casualties, the geological hazard of earthquake and tsunami resulted in far greater numbers of victims. It should be noted that the main problem caused by the earthquake is due to the fact that the buildings generally cannot stand the earthquake. This means that death and injuries are due to building materials. Figure 5 shows that although earthquake and tsunami occurred only four times over the ten year period considered in the study, these disasters resulted in more than 174,000 people dead and missing. Floods which occurred more than 4,800 times have caused almost 2,000 casualties.

Experience proves that mitigation and preparedness greatly affect the number of casualties in a disaster. The capacity of the community to respond is vital in reducing the risk of damage and casualties from disasters that may occur. Efforts to provide early warning information to the people who live in the prone areas are expected to reduce the number of casualties. People with disabilities and other populations with specific needs should be included in all stages of planning, mitigation and reconstruction in order to guarantee equal access to disaster response and relief.

The concept of mitigation and preparedness during the predisaster phase is very important for disaster relief in the hope that the number of victims, particularly those caused by hydro-meteorological disasters, can be reduced. Data on the number of victims and disaster occurrences can enable minimization of fatalities in the future. People living in disaster-prone areas are vulnerable to the effects and impacts, so it is necessary to enhance their capacity, their knowledge and skills to be able to cope with and avoid the effects of disaster, either individually or in groups.

Natural disasters often damage the community facilities including housing, education, health and worship facilities. When a disaster occurs,

Figure 5. Number of Victims – Dead and Missing, 2004-2013

houses can be damaged slightly, moderately, or even heavily destroyed. Earthquake is the most common disaster resulting in damage to buildings. Constructions that are less resistant to earthquake will result in damages or even collapse due to the effect of the shocks. Now some local governments have issued regulations for earthquake-resistant housing construction with specific standards. The construction of earthquake-resistant houses can minimize the number of victims in the future.

Flood is the most common disaster that can have catastrophic impact on a large number of houses. It is often causes slightly damaged to homes but can also wash away buildings if the current is torrential. Besides causing damages, flood usually emanates mud and garbage that inundate neighborhoods. This will trigger diseases related problems if the trash is not immediately cleaned up.

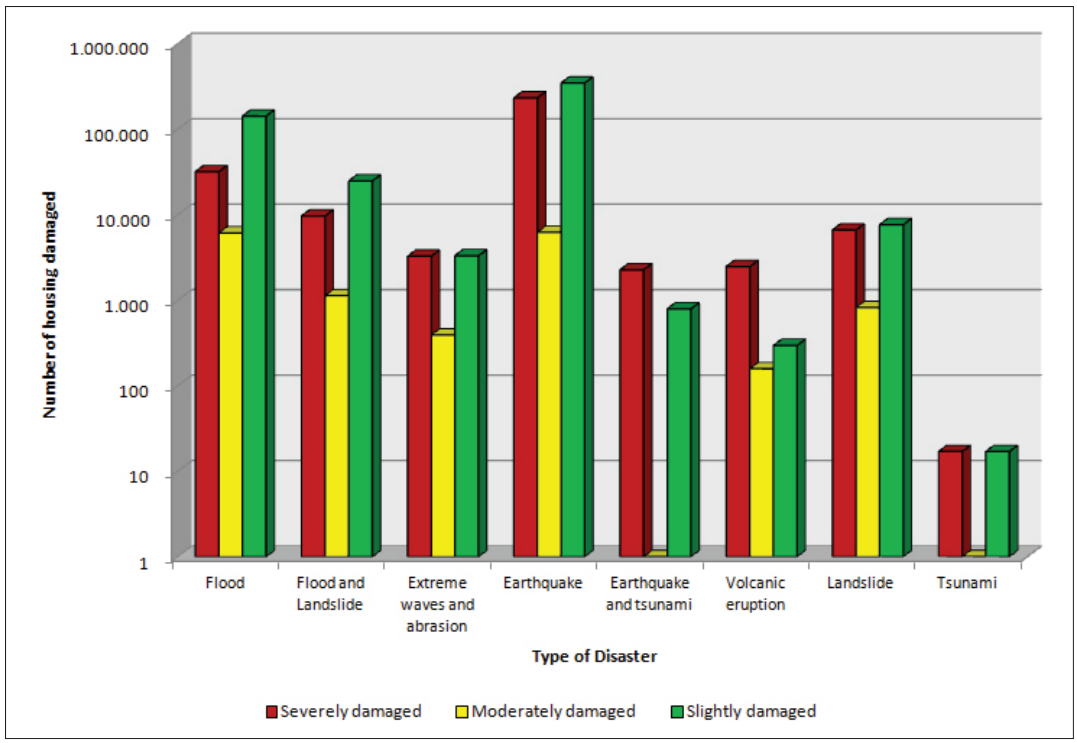


Figure 6. Number of Houses Damaged by Disasters, 2004-2013

Residents and military personnel repair homes damaged by a landslide in Selogiri, Wonogiri, January 2013. Source : Solopos.com.

Strong winds and landslides have also caused significant damage over the last ten years. The damage is usually in the form of roofs of buildings being swept off by wind gusts, while landslides usually destroy the houses as the buildings are buried by debris. Besides destroying residential buildings, earthquake, floods, landslides and strong winds also cause damage to public facilities. Another impact is disruption of community services.

Similarly, schools could be closed for a long time due to damaged education facilities, and where teachers also become victims of the disaster. The damage to these educational facilities will result in various successive impacts if not dealt with immediately, including psychologically disturbed children.

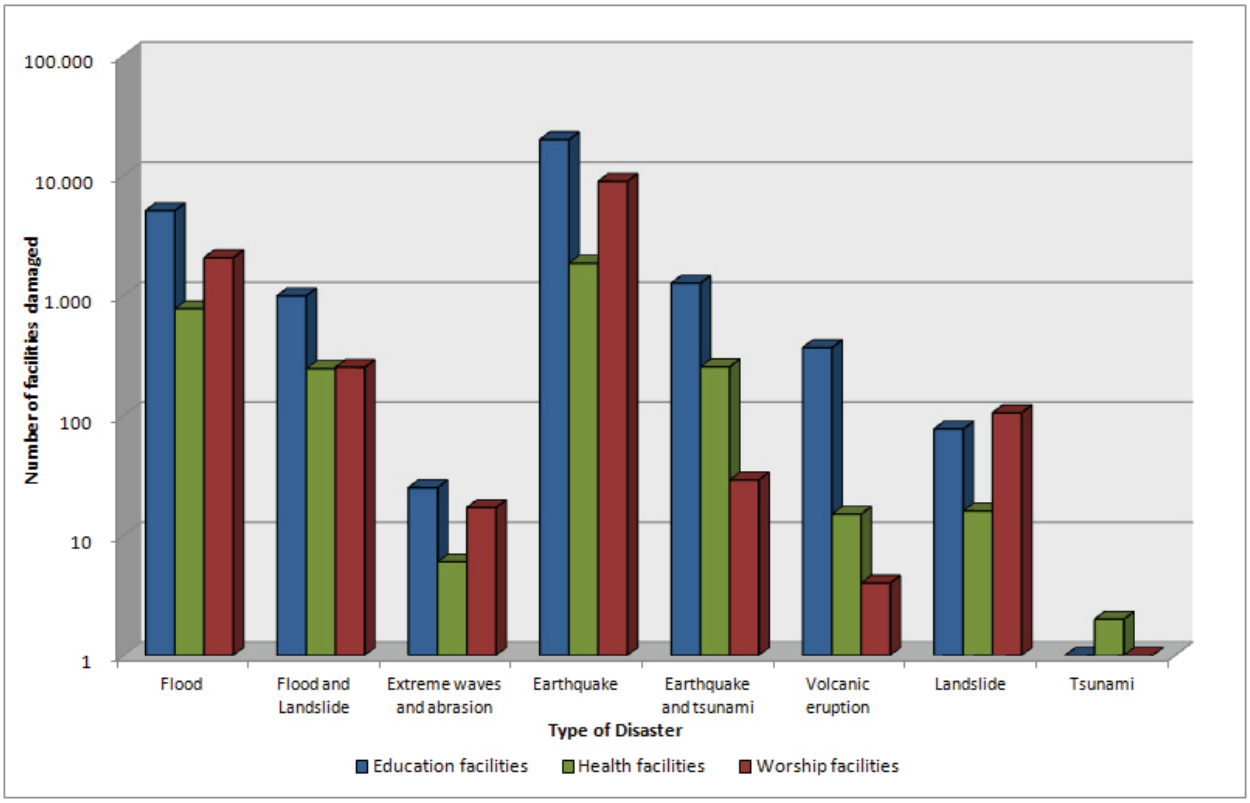


Figure 7. Number of Public Facilities Damaged by Disasters, 2004-2013

Children at IDPs camp following the Mentawai tsunami in October 2010.
Source : BNPB.

PART 3

Methodology

Scope of Problems

To date there are few studies of population exposed to the hazards in Indonesia, which means there are not many references that can be used by the Government in support of DRR policy-making and the planning of preparedness programmes.

The United Nations International Strategy for Disaster Reduction (UNISDR) defines exposure as people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses (2009). According to the Asian Disaster Reduction Center (ADRC), exposure is another component of disaster risk and refers to those exposed to natural disasters, such as people and property (2005). On theoretical side, the ADRC, considers hazards and vulnerabilities, as well as exposure in considering the impact of disaster risk.

Based on the definition of the UNISDR and the ADRC, there are at least two elements related to the exposure, this is community and property. This study will limit the consideration of exposure to the community element only.

Residents crossing a flooded street, in Kampung Melayu, Jakarta, January 2013.
Source : BNPB.

The analysis in this book is limited to the exposure to human factors. The discussion will be focused on two types of disaster characteristics, geological (earthquakes, tsunamis, volcanic eruptions and, landslide) and hydro-meteorological (floods, extreme waves and abrasion).

Both endogenic and exogenic geological process can cause dangerous natural phenomena that lead to natural disasters with severe consequences. Geological hazards can in the form of earthquakes, earthquakes and tsunamis, landslides, and volcanic eruptions. Further descriptions will be focused on these hazards and on the population exposed by the impact of the hazards.

Hydro meteorological disasters are associated with the climate. Hydro meteorological disasters are in the form of floods, landslides, strong winds, extreme waves and abrasion, as well as extreme droughts. The hazards considered in this study are flood, extreme waves and abrasion.

Use of Hazard Maps

As previously noted, the data used in this study are derived from BNPB's 2011 Disaster Risks Assesment report. In the report, hazard maps were developed in accordance with ministries and agencies respective basic tasks and functions pertaining to disaster management. For example the maps of volcanic activity hazards are taken from the volcanic disaster-prone areas maps issued by the Center of Volcanology and Geological Hazard Mitigation (PVMBG), the earthquake hazards graphs are derived from the earthquake hazard map issued by the revision team (2010) under the coordination of the Ministry of Public Works (PU).

Besides utilizing the maps that have been made by the relevant agencies, the use of these map was also intended to prevent duplication in the cartography. Table 1 shows the sources of hazard maps used in calculating the total population exposed. These maps cover the entire territory of Indonesia and the scale used is 1: 250,000.

The calculation of population exposed is based on the areas threatened by natural hazards. These natural hazards refer to the administratives regional boundaries set by the Directorate for Disaster Risk Mitigation, Deputy for Disaster Prevention and Preparedness at BNPB. The hazard regional boundaries have been recorded in the Disaster Risk Assesment (2011) in the form of disaster hazards map.

Regulation of the Head (*Perka*) of BNPB No. 2 of 2012 on general guidelines on national disaster risk assessment provides guidance on the use of the hazard maps which are sourced from basic and supporting maps for small to intermediate

Table 1. Source of Hazard Maps

No.	Hazard Map	Sources
1.	Earthquakes	Revision team on earthquake hazards map 2010 (coordinator: Ministry of Public Works)
2.	Tsunami	BMKG Tsunami Hazard Zoning Map and BNPB Tsunami Risk Assessment Methodology
3.	Volcanic Eruption	Map of Disaster-Prone Area (KRB), Center of Volcanology and Geological Hazard Mitigation (PVMBG)
4.	Landslides	Geological Agency, Ministry of Energy and Mineral Resources (ESDM)
5.	Floods	Ministry of Public Works (PU)
6.	Extreme Waves and Abrasion	Meteorology, Climatology, and Geophysics Agency (BMKG)

Source: BNPB

Educational facilities damaged by the earthquake disaster in Bengkulu, September 2007.
Source : BNPB.

scale maps. These hazard maps have the lowest level of review for the scale of 1: 250,000. The mapping units, are 100 m x 100 m (1 ha).

Use of Population Data

The enumeration of the vulnerable population refers to total population data issued by the BPS, an agency that is authorized to perform the Population Census. The population data used in this book refers to the Population Census of 2010 considering that the enumeration method applied in the census is more accurate and the data has segregated the population based on gender, age groups, as well as their constraints. Therefore, the unit of analysis in this study can illustrate not only the overall population but also the number of the vulnerable groups.

Besides groupings by gender (male or female), other categories analyzed are the vulnerable

groups. The vulnerable groups considered in the study are the age group under five children. the age group of 60 years and over (the elderly), and people with disability. These groups are classified as vulnerable because in the event of disasters they would need help from others for rescue or evacuation. The under five children and children must be helped by their parents during an evacuation. The elderly and disabled have protected response and physical constraints in the self-rescue, so they also need the help of others at the time of evacuation.

Enumeration of the Total Population Exposed

The enumeration of the vulnerable population exposed is in general based on the total number of population in the disaster-prone area (which will then be referred to as the hazard map). The process uses the approach of mapping units with a size of 100 m x 100 m (1 ha). With this kind of approach, the result will be very close to real conditions in the field. This approach is applied, because the hazard map used for measuring the exposure is not limited to the administrative boundaries only.

The unit of analysis uses the hazard maps that are based on BNPB's 2011 Disaster Risks Assesment. According to the regulations of the Head of BNPB No. 2 of 2012, the maps were developed using various indices that are obtained from the data using a special methods of calculation. The hazard maps depicts areas that have experienced natural disaster occurrences with particular intensity and frequency that are considered as harmful to living creatures, especially human beings who inhabit the areas. A map has three categories of hazard levels or classes; namely high, medium and low. The method of calculating the number of population exposed is briefly illustrated in the diagram below (Figure 8). In this diagram, when people fall into certain levels of hazard, they are categorized as exposed to disaster. In this case, the low level hazard is ignored, and therefore, the people considered to be exposed to the low-level hazards are not included in the calculation.

The process of calculating the number of population exposed uses the geographic information system and analysis grid technique. Today the users of information systems are also applying the grid analysis techniques for modeling. The grid analysis generates spatial data in several cells with a certain size. Each cell contains a number that represents a value.

The use of grid analysis techniques requires two parameters, the population number and the hazard map, that are converted first into a data format comprising several cells of data. The calculation uses the ArcGIS software 10.2, and then the data is converted into an ESRI Grid Raster format. The hazards map is already obtainable in ESRI Grid Raster format in cells measuring 100 x 100 m, while the population data from the 2010 Population Census is still in the format of vector data so that a conversion process is required.

In each village, data on the population density and the total population as well as the number of people in each vulnerable group should be calculated first. The density of total population and of the vulnerable groups is determined for a total area of 1 ha because the size of cells resulting from the conversion will be adjusted to the size of cells of the BNPB hazard maps.

After the calculation of the level of population density per hectare, the data in vector format is converted to the ESRI Grid Raster format with the cell sizes of 100 m x 100 m (1 ha). Each cell will have a value of population density per hectare that is in accordance with the results of the previous calculation.

The value of the cells in the BNPB hazard maps, although already in the ESRI Grid Raster format, should first be converted into the integer type

and sorted by levels. This will simplify the process of extracting population number based on the levels. The value is changed into an integer by multiplying it with 1,000. Therefore, the hazard categories based on levels are as follows:

- 667-1,000 : high-hazard level
- 334-666 : moderate-hazard level
- 0-333 : low-hazard level.

The low-hazard level is then removed from consideration.

After all the data has been converted into ESRI Grid Raster format, the next step is the extracting the number of population density cells that belong to the high- and medium-level hazard levels. After the extraction process using Zonal Statistics, the number of population density cells that include in the high- and medium-level hazard levels for each of the disasters can be identified. When the number of cells has been identified, in which each cell represents the level of density per hectare, the number of population exposed to the hazards can be estimated by multiplying the number of cells with the density. Figure 8 illustrates an example of this calculation.

At the beginning of this methodology explanation, it was noted that the boundary of the hazard map does not follow the administrative borders. Therefore, the use of grid analysis method is expected to produce the results that approximate the actual conditions in the field. The number of the population exposed is adapted to the extent of the area in the region concerned.

If, for example, in a district there are only few areas that belong to the hazard zones, the coverage of the population taken into account is only within these areas and not the entire population in the district.

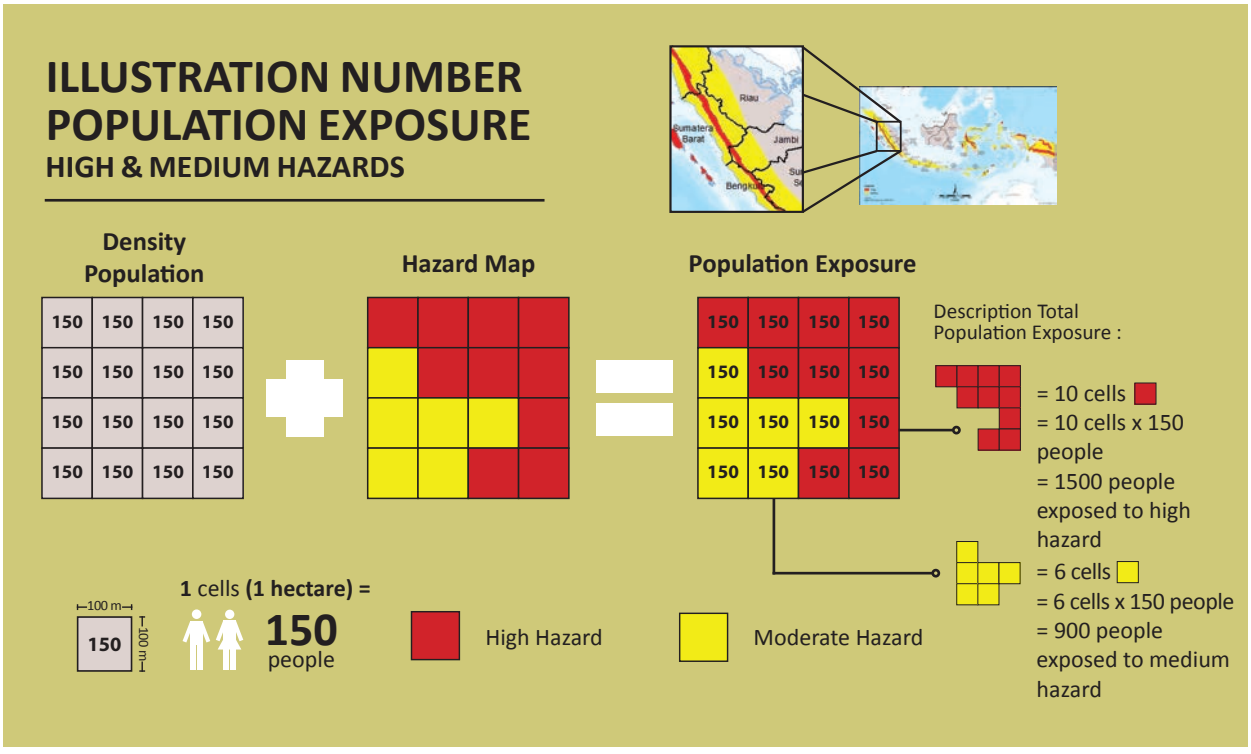
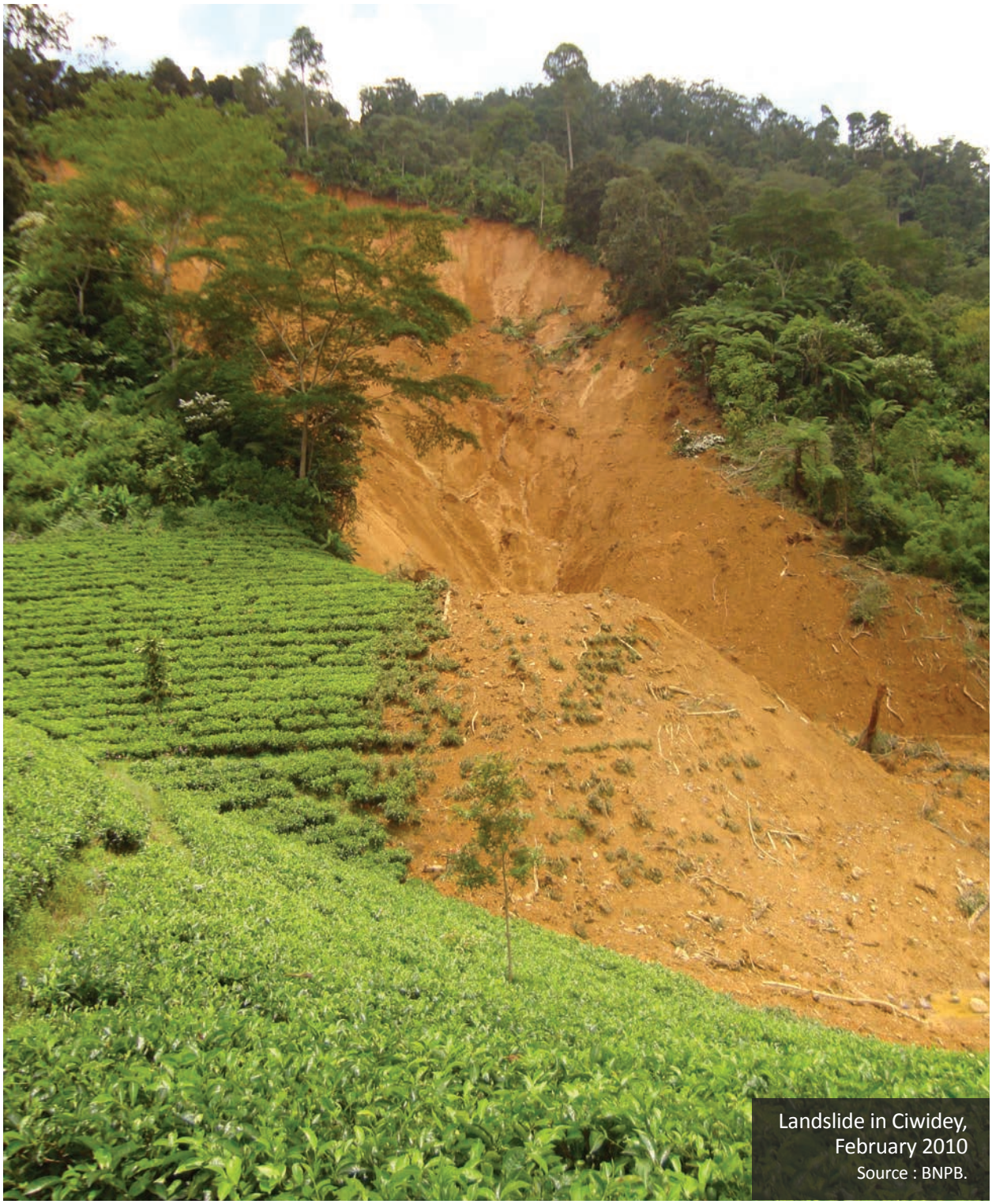


Figure 8. Illustration of the Calculation of Population Exposed to Hazards



Landslide in Ciwidey, February 2010
Source : BNPB.

PART 4

Population Exposed to Geological Hazards: Earthquake, Tsunami, Volcanoes and Landslide

Earthquake Hazards

Indonesia is situated in a very active tectonic zone because it is located in an area where three major tectonic plates of the earth and nine small plates collide and form complex lines of plate collision (Bird, 2003). The extent of interactions between these plates makes Indonesia a highly earthquake-prone region (Milson et al., 1992).

The West coast of the island of Sumatra, along which tectonic plate movements occur, is where the Asian and the Indian Ocean plates collide, while the South coast of Java and the Nusa Tenggara Islands is where Australian and the Asian plates. Sulawesi and Maluku are where the Asian and the Pacific plates collide. These sites are presented in Figure 9 that also shows the tectonic lines in Indonesia.

Indonesia is surrounded by subduction zones, which are the cause of the intense seismicity in the region with thousands of epicenters scattered along the convergence of the plates. The occurrence of submarine earthquake is a trigger for the onset of tsunamis, especially the earthquake that is followed by a deformation of the ocean floor as occurred on the West coast of Sumatra and the North coast of Papua. The volcanic eruption can also prompt a tsunami, as happened with Mount Krakatau in the Sunda Strait in 1883.

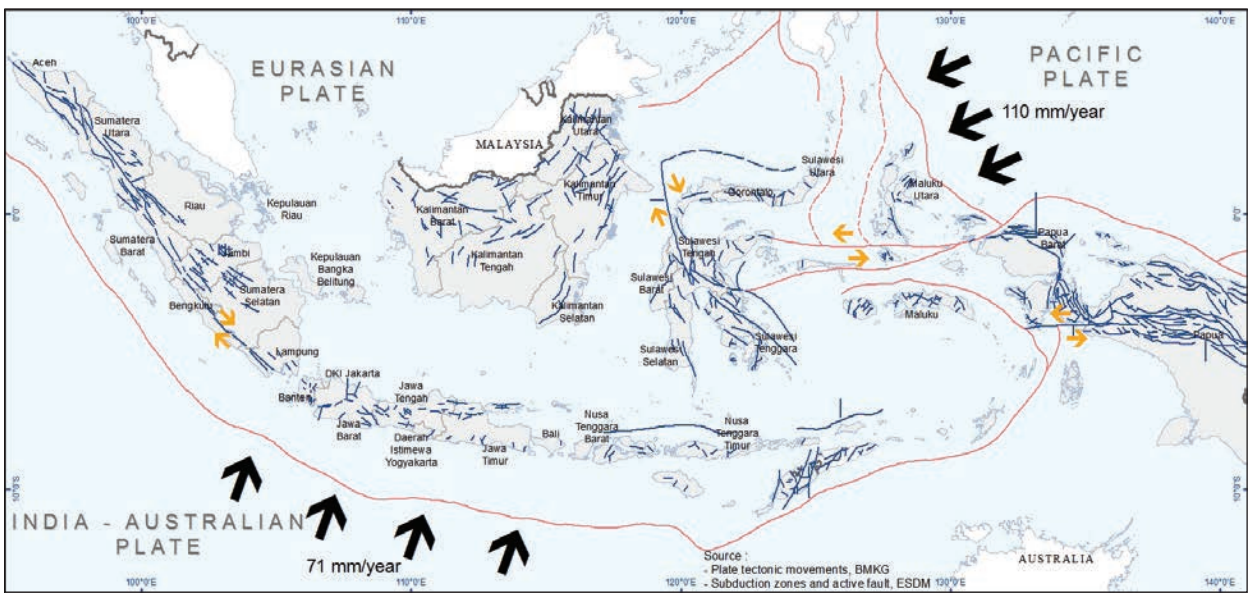


Figure 9. Map of Earthquake Hazards – Tectonic Line

148.4 Million people **62.4%** EXPOSED TO HIGH & MEDIUM LEVEL **EARTHQUAKE** HAZARDS

6.6 Million people

Exposed to High Level Earthquake Hazards

141.8 Million people

Exposed to Medium Level Earthquake Hazards

3.3 Million people **3.3 Million people**

71.3 Million people **70.5 Million people**

VULNERABLE GROUPS

740.4 Thousand people — **High Hazard** Under 5 Children (0-4 years)

13.4 Million people — **Medium Hazard** Under 5 Children (0-4 years)

49.4 Thousand people — **High Hazard** People with Disabilities

1.0 Million people — **Medium Hazard** People With Disabilities

398.2 Thousand people — **High Hazard** Elderly (60+ years)

11.6 Million people — **Medium Hazard** Elderly (60+ years)

* Source: 2010 Population Census, BPS

Figure 10. Infographics on Population Exposed to Earthquake Hazards

In 2010 the Ministry of Public Works (PU) with the support of various government agencies, universities, and professional associations agreed to revise the Indonesia National Standard (SNI) Earthquake Hazard Map SNI 03-1726-2002 by forming the Indonesia Earthquake Map Revision team. The result of the map revision (Figure 11) has been used by BNPB in the 2011 Disaster Risks Assessment.

Earthquake hazard classification is obtained from analysis of the components of the SNI Earthquake Hazards Map (Table 2) published by the Geological Agency, Ministry of Energy and Mineral Resources (ESDM), and the results of the earthquake exposure zoning that have been validated with data on disaster occurrences. In addition to these two components, there are also parameters of the active fault distance, fault density level, and the Modified Mercalli Intensity (MMI) maps in a specified time range (for example 10 years). The analysis of these components will result in the categorization of earthquake hazard levels, which is then combined with the number of population exposed by age groups and vulnerability.

In BNPB's 2011 Disaster Risk Assesment the SNI map illustrates the hazards that are classified based on the PGA values, namely > 0.7 as high level hazard; 0.2501 – 0.7 as medium level hazard; and < 0.2501 as low level hazard. However, in this study only the high- and medium levels are considered. The results of the SNI hazard map classification are shown in Figure 11.

Figure 12 shows the results of the Earthquake Hazard Map 2010 SNI hazard map classification for the high- and medium level categories. It also shows that most regions in Indonesia (40.6%) belongs to the medium level category, while 7.86% is categorized as high level . The areas in Sumatera that fall into the category of high-level earthquake hazard are located along the West coast that include parts of the provinces of North Sumatra, West Sumatra, Bengkulu and Lampung.

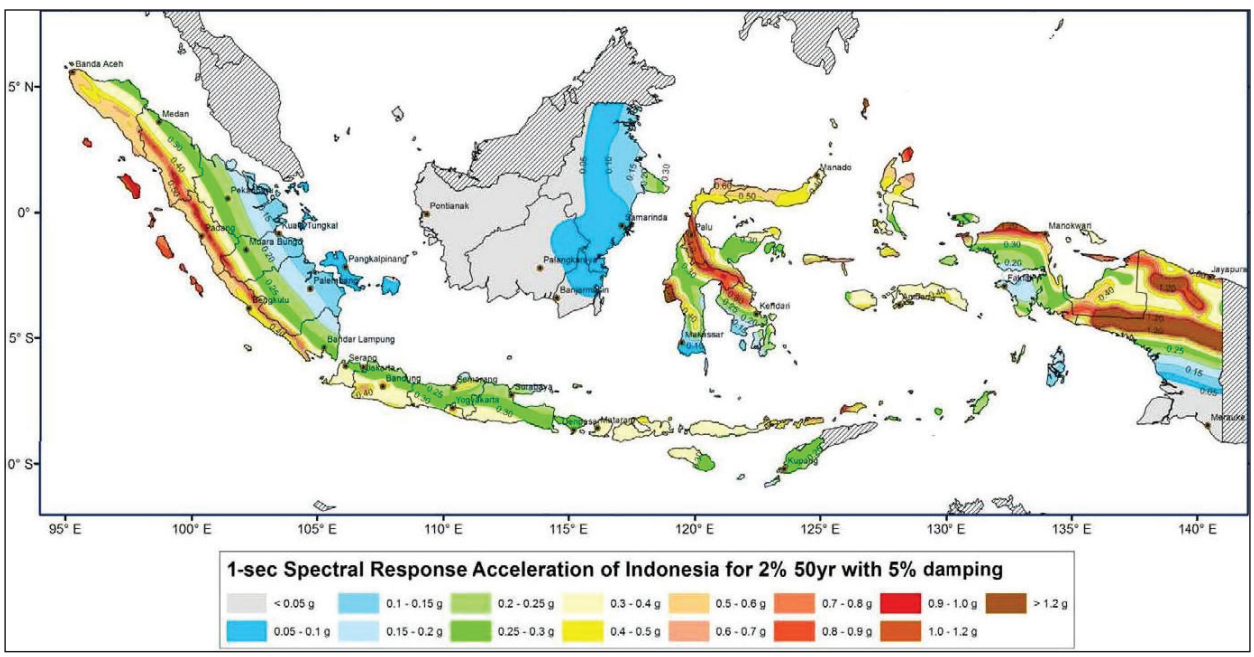


Figure 11. Indonesian Earthquake Hazard Map - Peak Ground Acceleration (PGA) for 2% 50 years with 5% damping.

In Sulawesi, parts of Central Sulawesi, Southeast Sulawesi and West Sulawesi provinces are classified as high hazard areas. On the islands of Maluku and Papua these high hazard areas are in parts of Maluku, North Maluku, Papua and West Papua. Most of the areas in Java and Nusa Tenggara fall into the category of medium level hazard. Percentage of total area by hazard levels is shown in Table 3.

Population exposed to earthquake hazard

Based on the 2010 SNI Earthquake Hazard Map, a total area of almost 50% of the land area of Indonesia is classified as medium- and high-level hazards areas. The extent of the hazard area greatly influences the total population exposed to earthquake.

Figure 13 shows the number of the population exposed to earthquake hazard in Indonesia. The total number of people exposed to the medium- and high level hazard is 148.4 million or 62.4% of the total population of Indonesia. Out of this number, 6.6 million or 2.79% are exposed to high level hazard, while 141.8 million or 59.69% are exposed to the medium level hazard. The large number of population exposed to the medium level hazard indicates that most of the densely populated areas are in this hazard class, such as those areas along the South coast of Java, part of the West coast of Sumatra, and the northern part of the island of Sulawesi. Out of the total population exposed, 74.6 million are males and 73.8 million females. In addition to the total population as a whole, another factor that also needs special attention is the number of vulnerable groups that are exposed to the hazard. The total number of people in vulnerable groups exposed to the high- and medium level earthquake hazard is 27.2 million, 51.8% of which are under five children, 44.09% elderly and 4.02% are persons with disability.

As shown in Figure 13, based on the percentage, the provinces that have sizeable population exposed to the danger of high- and medium levels are West

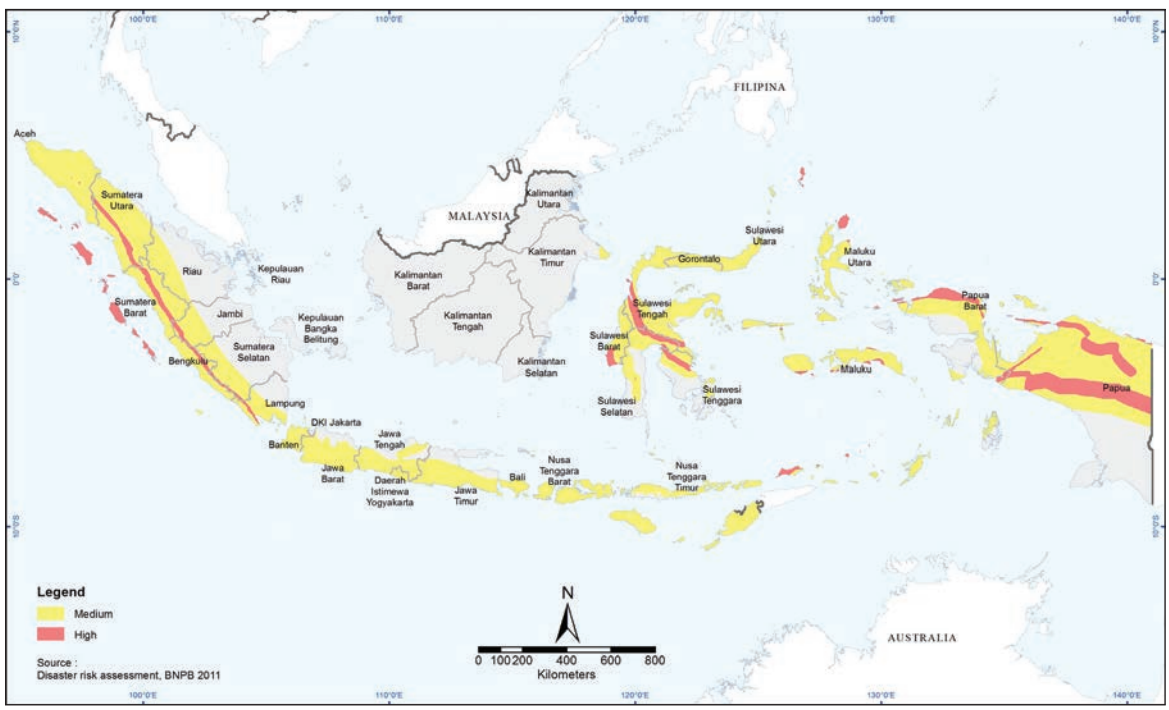


Figure 12. Map of Indonesia Earthquake Hazards Classification, SNI 2010 (High and Medium Hazard Classes)

Table 2. Components of Earthquake Hazard Map

DISASTER	COMPONENTS/ INDICATORS	INDEX CLASSES			TOTAL WEIGHT	REFERENCE
		LOW	MEDIUM	HIGH		
Earthquake	Earthquake Hazards Map	Low (PGA value < 0,2501)	Medium (PGA value 0,2501 – 0,70)	High (PGA value > 0,70)	100%	SNI referring the guidelines published by the agency for National Geology

Java (22.23%), Central Java (16.31%), East Java (15.19%), North Sumatra (8.20%), Banten (7.03%), and West Sumatra (3.24%).

Figure 16 presents a diagram of the comparison between the numbers of people exposed to the danger of high- and medium classes. It shows that the number of people exposed to the medium level hazard is higher than the number of those exposed to the high level hazard. This is due to the fact that the area exposed to the medium level hazard is larger than that of the high hazard. In addition most of the provinces have large numbers of population in medium level hazard areas, hence affecting the total population exposed. The provinces with relatively large number of population exposed include West Java, Central Java, East Java, Banten and Bali.

In terms of spatial distribution, the provincial areas exposed to the high level hazard are in North Sumatra (1.6 million people), West Sumatra (1.2 million), Papua (807,000), West Sulawesi, Central Sulawesi, Bengkulu, and Maluku. Figure 17 shows The population distribution exposed to high level earthquake hazard.

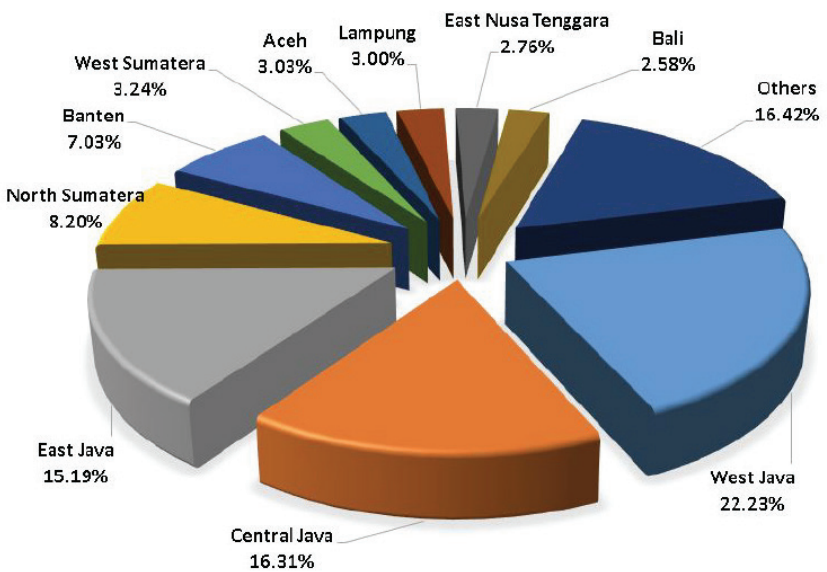


Figure 13. Percentage of Population Exposed to High- and Medium-Level Earthquake Hazards

Primary school students in NTB conduct earthquake evacuation drills, October 2013.
Source : BNPB.

Table 3. Areas Exposed to Earthquake Hazard, by Province

Province	Total Area (Ha)	High Level Hazards		Moderate Level Hazards	
		Total Area (Ha)	%	Total Area (Ha)	%
Aceh	5,710,206	222,947	3.9	5,455,199	95.53
North Sumatera	7,242,590	1,306,355	18.04	5,608,875	77.44
West Sumatera	4,223,414	1,279,813	30.3	2,923,620	69.22
Riau	8,973,900	-	-	2,570,354	28.64
Jambi	4,898,402	249,267	5.09	1,781,328	36.37
South Sumatera	8,726,219	175,568	2.01	2,363,016	27.08
Bengkulu	1,990,390	352,904	17.73	1,625,932	81.69
Lampung	3,385,034	157,226	4.64	1,559,312	46.06
Bangka Belitung Islands	1,673,759	-	-	-	-
Riau Islands	826,687	-	-	-	-
Dki Jakarta	66,121	-	-	563	0.85
West Java	3,760,300	-	-	2,892,831	76.93
Central Java	3,499,305	-	-	2,561,159	73.19
DI Yogyakarta	323,769	-	-	320,083	98.86
East Java	4,887,603	-	-	3,167,415	64.81
Banten	947,142	-	-	934,677	98.68
Bali	571,088	-	-	566,718	99.23
West Nusa Tenggara	2,011,833	-	-	-	-
East Nusa Tenggara	4,768,641	9,867	0.21	4,291,916	90
West Kalimantan	14,697,211	-	-	-	-
Central Kalimantan	15,387,727	-	-	-	-
South Kalimantan	3,749,592	-	-	-	-
East Kalimantan	19,642,234	-	-	187,348	0.95
North Sulawesi	1,451,911	83,559	5.76	1,328,231	91.48
Central Sulawesi	6,119,798	877,986	14.35	5,015,319	81.95
South Sulawesi	4,568,637	556,729	12.19	2,004,835	43.88
Southeast Sulawesi	3,682,629	401,965	10.92	1,179,290	32.02
Gorontalo	1,204,361	1,254	0.1	1,183,556	98.27
West Sulawesi	1,660,371	283,963	17.1	1,268,427	76.39
Maluku	4,671,430	462,040	9.89	3,691,564	79.02
North Maluku	3,152,702	275,559	8.74	2,776,105	88.05
West Papua	9,868,080	1,247,208	12.64	4,871,791	49.37
Papua	31,643,682	6,996,496	22.11	15,142,857	47.85
Total	189,986,768	14,940,706	7.86	77,272,321	40.67

A child standing in front of houses destroyed by the earthquake in Padang , October 2009. Source : BNPB .

Figure 18 shows the population distribution exposed to the medium level earthquake hazard. Most of these areas are in the provinces that have high population number and density including Java and Nusa Tenggara. Although in the category of medium level hazard, because there are such high population numbers and densities in these areas, Java and Nusa Tenggara warrant more attention from the Government.

From a historical point of view, earthquake disasters have generated massive casualties when they occur in Java and Nusa Tenggara. The provinces with considerable numbers of population exposed to the medium level hazard are in West Java (33.01 million people), Central Java (24.2 million), East Java (22.5 million) and Banten (10.4 million). The details of population exposed to disasters by provinces and hazard levels are presented in Appendix 1-2.

Figure 15 illustrates the vulnerable groups exposed to medium level earthquake hazards. The number of these groups is reasonably high as the provincial areas that are exposed to the hazard are densely populated, such as those in parts of the island of Java. If a disaster occurs in this region, the number of casualties would certainly be great. The vulnerable groups exposed to the medium level earthquake hazard with a high percentage are in the provinces of Yogyakarta, Banten, Aceh, Bali, Gorontalo, North Sulawesi, and East Nusa Tenggara.

The previous discussions on the population exposed to the earthquake disaster by the hazard levels are the result of an overlay of hazard map and population density in an area. A hazard map is originally a prediction by experts about the possible hazard level in an area, and to be able

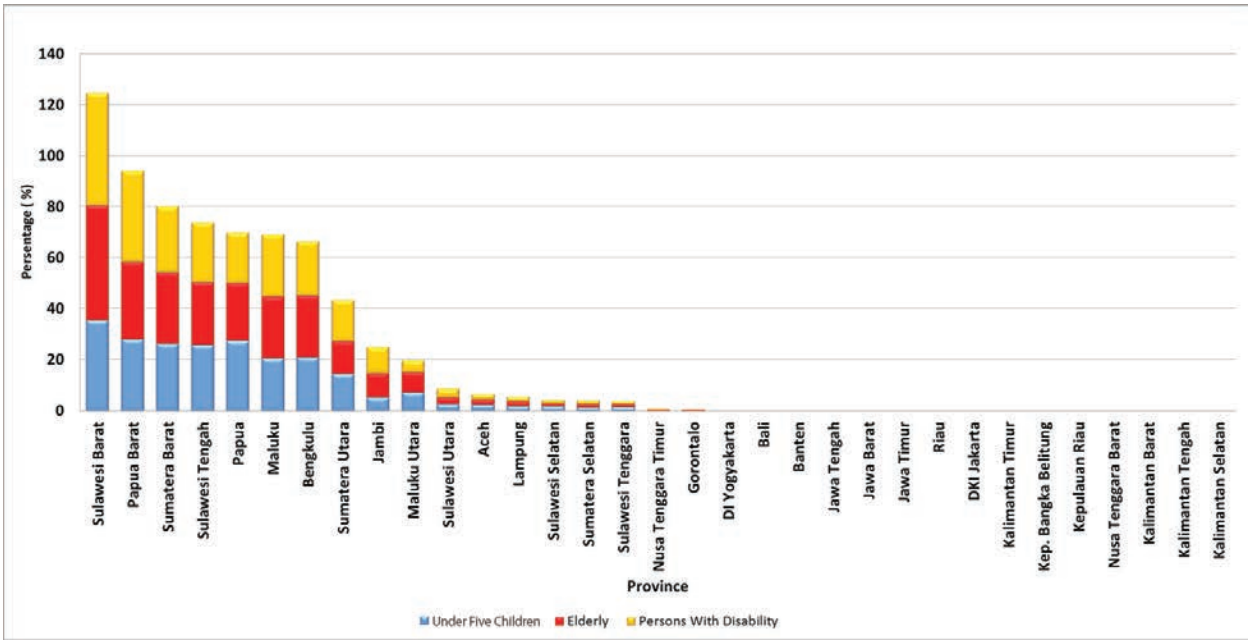


Figure 14. The Ratio of People in Vulnerable Groups Exposed to High-Level Earthquake Hazards

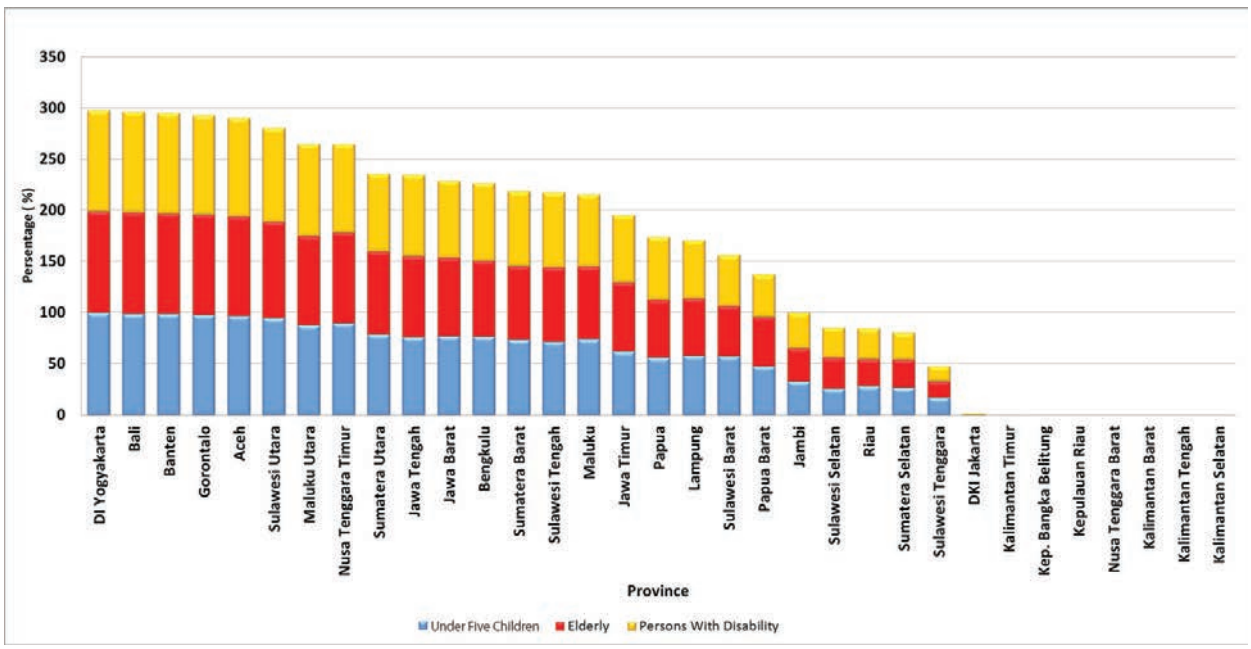


Figure 15. The Ratio of People in Vulnerable Groups Exposed to Medium-Level Earthquake Hazards

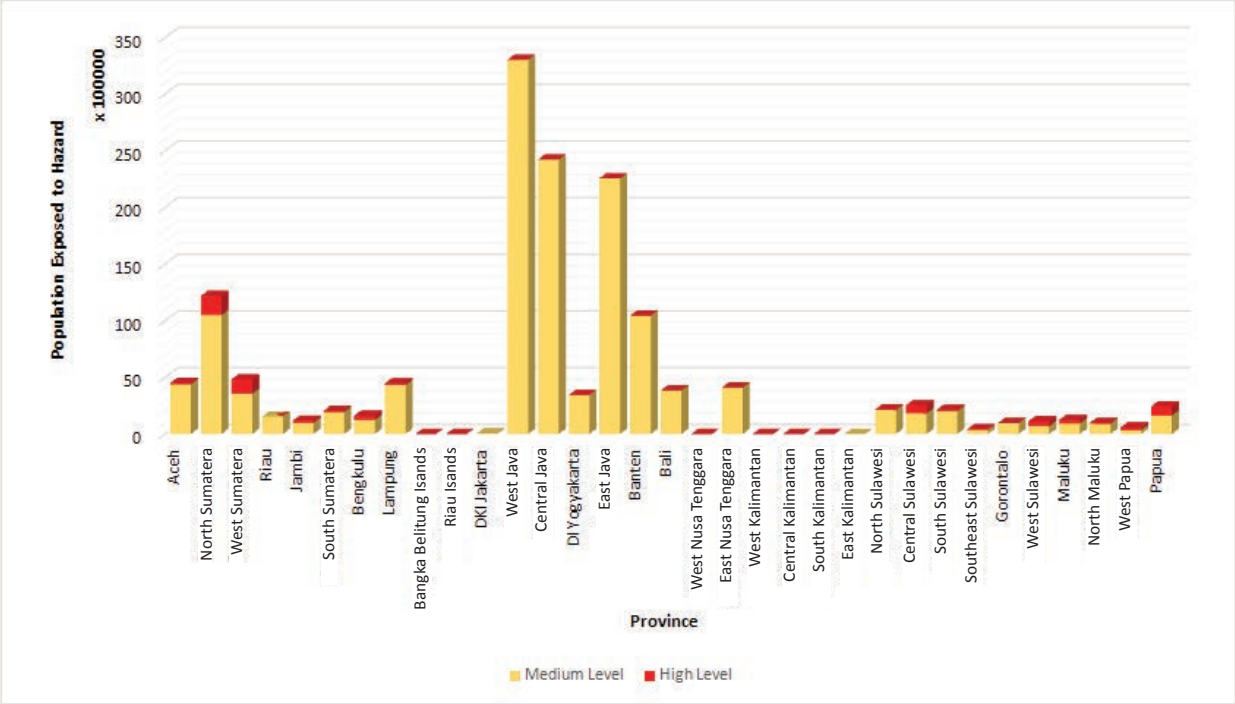


Figure 16. The Ratio of Total Population Exposed to High and Medium-Level Earthquake Hazards

to give an accurate picture, such predictions need to be linked to the real conditions of the disasters that have occurred in the area.

Based on the report from the Indonesia Disaster Data and Information (DIBI), the number of catastrophic earthquakes occurring in Indonesia during the period of 2000-2013 is 169 events that caused fatalities and damages.

Table 4 shows ten provinces with the largest number of victims, the occurrence of earthquake disasters and their impacts.

This data shows that Central Java and West Sumatra are among the 10 provinces that have a considerable number of population exposed to the earthquake hazard. Central Java with 24.2 million people exposed to high- and medium level hazards underwent six occurrences of earthquake disaster during the period of 2000-2013, with more than 1,000 casualties, West Sumatra with 4.8 million people exposed to disaster has experienced 12 occurrences of earthquake with 1,282 casualties. One of the earthquake disasters that caused a significant amount of fatalities occurred in 2009 with death toll of more than 1,100. By looking at the correlation, between historical data and the hazard Assesment, it can be possible to make evidence-based predictions about the number of people who will be affected when earthquake disasters happen in the future. In providing this information, the Government can prioritize the programmes for disaster risk reduction and preparedness for the areas with a large number of the population exposed.

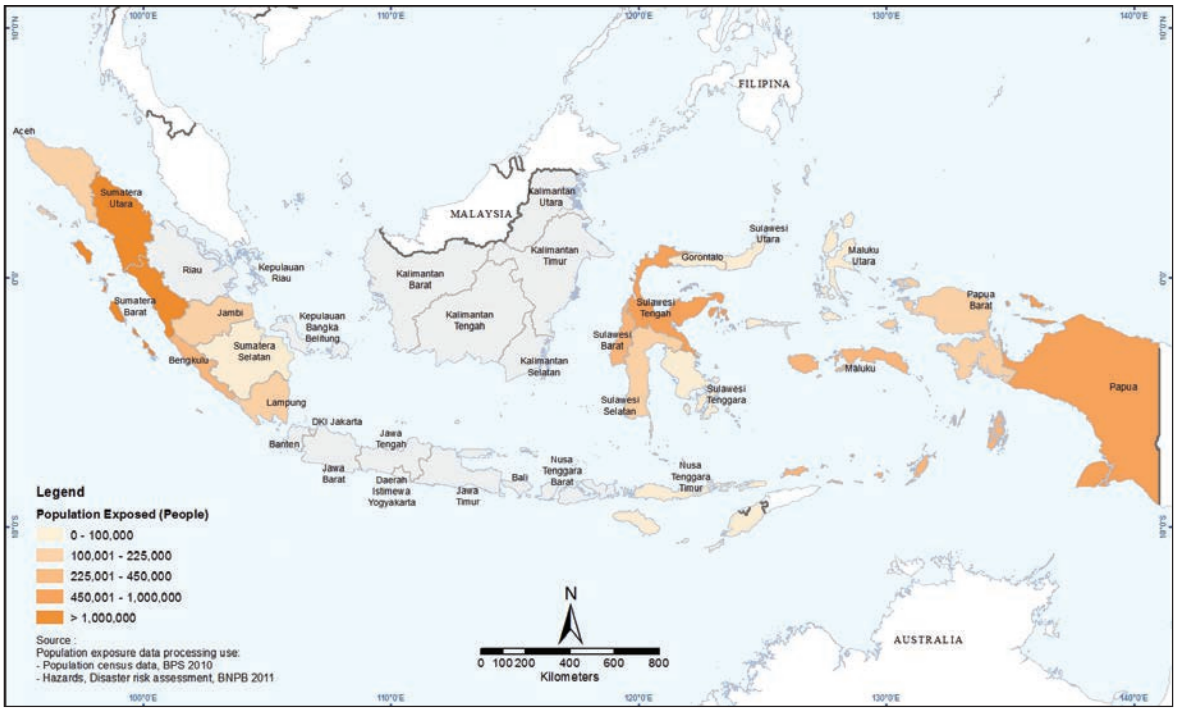


Figure 17. Map of Total Population Exposed to High-Level Earthquake Hazards

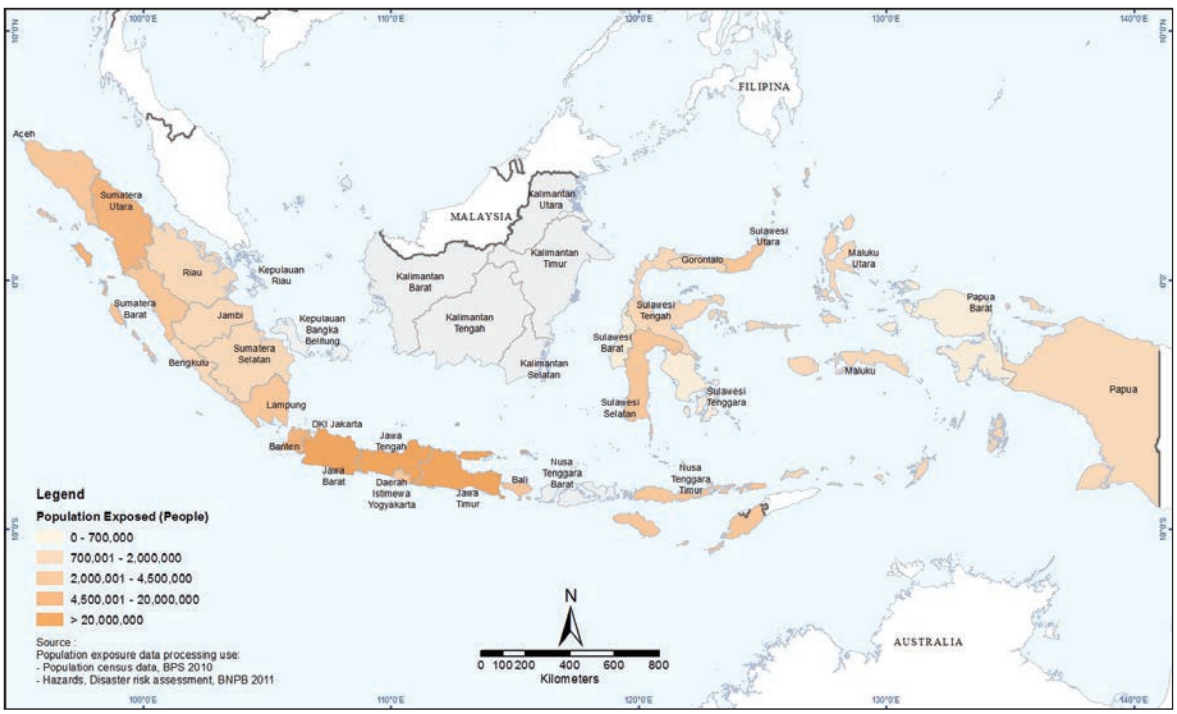


Figure 18. Map of Total Population Exposed to Medium-Level Earthquake Hazards

Table 4. Provinces with the Population Exposed to Earthquake Hazard, by Occurrence, 2000-2013

No	Province	Total Population Exposed by Level of Hazard			Number of Occurrence	Dead	Injured	Missing
		High	Medium	Total				
1.	Aceh	101,700	4,396,347	4,498,047	20	217	2,837	-
2.	North Sumatera Utara	1,693,005	10,488,302	12,181,307	9	859	8,265	1
3.	West Sumatera	1,258,547	3,549,921	4,808,468	12	1,282	2,733	2
4.	Lampung	142,941	4,318,219	4,461,160	-			
5.	West Java	-	33,015,075	33,015,075	17	83	1,294	42
6.	Central Java	-	24,214,132	24,214,132	6	1,063	18,537	-
7.	East Java	-	22,550,876	22,550,876	6	-	25	-
8.	Banten	-	10,438,898	10,438,898	2	-	1	-
9.	Bali	-	3,832,375	3,832,375	2	-	99	-
10.	East Nusa Tenggara	14,589	4,088,024	4,102,613	10	115	605	19

Integrated Health Center damaged by earthquake in Ketol Subdistrict, Central Aceh, August 2013. Source : BNPB.

4.2 Million people **1.77%** EXPOSED TO HIGH & MEDIUM LEVEL **TSUNAMI HAZARDS**

3.1 Million people

Exposed to High Level Tsunami Hazards

1.1 Million people

Exposed to Medium Level Tsunami Hazards

1.6 Million people **1.5 Million people**

538 Thousand people **527 Thousand people**

VULNERABLE GROUPS

289.9 Thousand people **High Hazard** Under 5 Children (0-4 years)

93.3 Thousand people **Medium Hazard** Under 5 Children (0-4 years)

21.9 Thousand people **High Hazard** People with Disabilities

6.5 Thousand people **Medium Hazard** People With Disabilities

224.3 Thousand people **High Hazard** Elderly (60+ years)

64.2 Thousand people **Medium Hazard** Elderly (60+ years)

* Source: 2010 Population Census, BPS

Figure 19. Infographics on Population Exposed to Tsunami Hazards

A house still standing following the earthquake and tsunami in Aceh, December 2004. Source : BNPB .

Tsunami Hazards

Tsunami is rare geological type of disaster, but it is capable of causing significant casualties and enormous damage. Earthquakes on the sea floor often trigger tsunami, although volcanic eruptions and submarine avalanches also cause tsunami. The magnitude of tsunami waves depends on the trigger. Among the ten countries affected by tsunami occurrences since 2000 years B.C until 2005 A.D. Kondoite (2006) in Rohmatulloh, et al. (2012) note Indonesia occupies the third place after Japan and the United States in terms of the number of occurrences, but ranks first when it comes to the number of people killed.

The tsunami hazard map is developed using the calculation and parameters presented in Table 5. The tsunami hazard classes are derived from

Table 5. Components of Tsunami Hazards Map

DISASTER	COMPONENT/ INDICATOR	INDEX CLASS			TOTAL WEIGHT	REFERENCES
		LOW	MODERATE	HIGH		
Tsunami	Map of Tsunami Inundation Heights Estimation/Tsunami Hazard Map	(< 1 m)	(1 - 3 m)	(> 3 m)	100%	Guidelines from the National Geological Agency - ESDM and BMKG

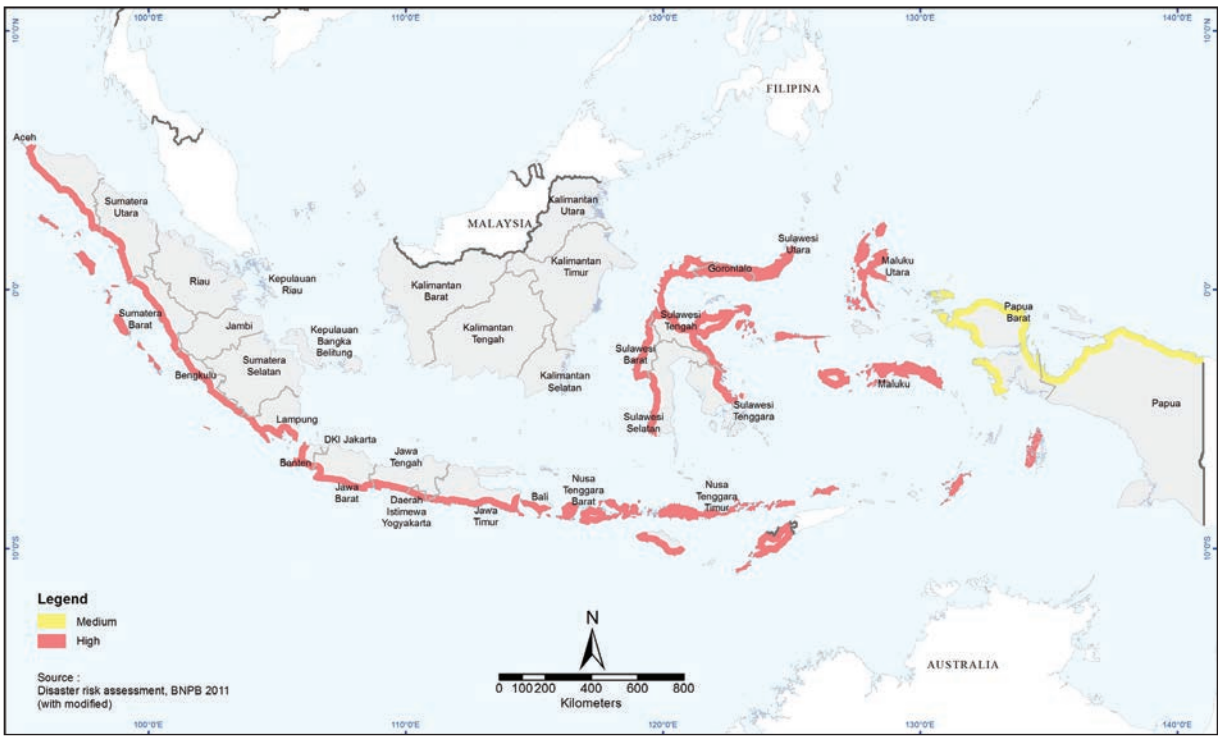


Figure 20. Indonesian Tsunami Hazards Map

tsunami inundation heights estimation available in the guidelines published by the Geological Agency, the Ministry of Energy and Mineral Resources (ESDM). The hazard is of low level if the wave height estimation is less than 1 m, medium level if the wave height estimation is between 1 and 3 m, and high level if the wave height estimation is more than 3 m.

The megathrust earthquake anticipated as inevitably striking the west coast of Sumatera is believed to generate a very devastating tsunami, as was the case in 2004 in the provinces of Aceh and North Sumatera. The tsunami in Aceh province resulted in the loss of hundreds of thousands of lives. The Pangandaran tsunami of 2006 also led to loss of lives and considerable damages. Delays in emergency response to tsunami disasters may cause various disease outbreaks, economic disruption, and psychological impact on the community. The psychological impact can be in the form of stress, fear, anxiety, frequent delirium, daydream, and even psychosis. Usually this impact will take a long time for rehabilitation.

The other side of the natural beauty and richness of Indonesia, which is surrounded by active volcanoes and the convergence of tectonic plates, is the tsunami hazard in most parts of the coastal areas. The long history of tsunami disasters indicates that in some of the affected areas, tsunamis will occur again in the future. As well as submarine earthquake, tsunami in Indonesia have also triggered by the volcanic eruption, such as the Mount Tambora eruption in 1815 and the Krakatau eruption in 1883.

The tsunami-prone areas in Indonesia are shown in Figure 20. The areas of high level hazard are shown in red colour, while those of medium level are in yellow. The Western coastline of Sumatera Island is one of the areas classified as vulnerable to tsunami hazard. Research, enhanced preparedness

and community capacity-building are necessary in anticipation of megathrust earthquakes and subsequent tsunami. Other areas that are also vulnerable to tsunami include the Southern coastline of Java Island, Bali, East Nusa Tenggara, West Nusa Tenggara, Sulawesi, Maluku and some coastal areas of Papua. The development of the tsunami hazard map is one of the mitigation efforts in disaster risk reduction, with the objective that the people who live in the hazard area become awareof the risks and response strategies, so that the number of casualties and damage when tsunami occurs can be minimized.

Table 6 shows that 0.62% of the overall area of Indonesia is classified as being in high level tsunami hazard areas, while 0.32% is in medium level hazard areas. The largest area percentages of the high- and medium level hazard are in Maluku province, amounting to 10.84% and 3.37% of the total area, respectively. Other regions which also have sizable tsunami hazard areas are Banten, Central Java, Yogyakarta, West Sumatra, South Sulawesi and Aceh.

Even though the total extent of the tsunami hazard indeed looks very small, being less than 1%, of the total territory of Indonesia, what should be critically considered is the number of people who conduct daily activities in these risky areas. Some major residential areas and business districts that are situated on the coastline, such as in Padang and Manado, are at risk. The devastating waves of tsunamis that strike in a matter of minutes can destroy buildings and infrastructures, as it did in almost all the coastline areas of Aceh in 2004.

According to UNISDR, Indonesia ranks the first among 265 countries in the world at risk of tsunami because the population exposed to the tsunami hazard reaches 5.4 million, followed by Japan (4.4 million), Bangladesh (1.5 million) and India (1.1 million).

The Population Exposed to the Tsunami Hazard

As shown in Figure 19, the population exposed to the high level tsunami hazard is 3.1 million, or 1.30% of the total population, consisting of 1.6 million men and 1.5 million women. The largest number of population exposed to the high level tsunami hazard is in Central Java province, namely 865,000 inhabitants or 1.33% of the total population of the province. Other provinces that have a considerable number exposed to the hazard are South Sulawesi, Aceh, Banten, Bali, and Maluku.

Volcanic eruptions, submarine landslides, and coastal rock falls can generate a tsunami, as can a large asteroid impacting the ocean. The wavelength is closely linked to the sea depth. As the sea depth decreases, the wavelength decreases. At the same time, the height of the wave increases. Near the shore line the wave has decreased the speed but can reach up to tens of meters high, with a massive destructive power. About 4.2 million people are exposed to the hazard of tsunami, consisting of 3.1 million are exposed to the high-level hazard and 1.1 million exposed to the medium level hazard, which amounts to 1.77% of total population. The deadly tsunami that struck Indonesia were, among others, from the Krakatau volcanic eruption in 1883, the tsunami in the Indian Ocean that caused the deaths of more than 160,000 in Aceh in 2004, and in Pangandaran Beach, West Java in 2006. The earthquake that occurred in Japan in 2011 also caused tsunami waves that reached Papua region causing damage to some houses and other buildings.

Most parts of Indonesia, particularly the coastal areas, are susceptible to tsunami hazards. People who live in these areas are very vulnerable to the disasters, if they are not provided with adequate capacity to prepare and respond. Manado and Padang are among the major cities situated on the coastline that

Table 6. Total Areas Exposed to Tsunami Hazards, by Province

Province	Total Area of Province (Ha)	High Hazard Level		Medium Hazard Level	
		Area (Ha)	%	Area (Ha)	%
Aceh	5,710,206	63,344	1	35,011	0.61
North Sumatera	7,242,590	50,208	1	23,235	0.32
West Sumatera	4,223,414	80,111	2	48,497	1
Riau	8,973,900	-	-	-	-
Jambi	4,898,402	-	-	-	-
South Sumatera	8,726,219	-	-	-	-
Bengkulu	1,990,390	23,309	1	18,799	0.94
Lampung	3,385,034	10,092	0	9,781	0.29
Bangka Belitung Islands	1,673,759	-	-	-	-
Riau Islands	826,687	-	-	-	-
DKI Jakarta	66,121	-	-	-	-
West Java	3,760,300	14,123	0.38	4,327	0.12
Central Java	3,499,305	72,691	2.08	12,12	0.35
DI Yogyakarta	323,769	6,237	1.93	1,163	0.36
East Java	4,887,603	16,866	0.35	8,136	0.17
Banten	947,142	28,714	3.03	9,998	1.06
Bali	571,088	6,302	1.1	2,645	0.46
West Nusa Tenggara	2,011,833	22,855	1.14	5,027	0.25
East Nusa Tenggara	4,768,641	8,876	0.19	12,803	0.27
West Kalimantan	14,697,211	-	-	-	-
Central Kalimantan	15,387,727	-	-	29	0
South Kalimantan	3,749,592	-	-	6,986	0.19
East Kalimantan	19,642,234	-	-	61,767	0.31
North Sulawesi	1,451,911	8,427	0.58	1,469	0.1
Central Sulawesi	6,119,798	35,825	0.59	5,785	0.09
South Sulawesi	4,568,637	119,482	2.62	8,94	0.2
Southeast Sulawesi	3,682,629	16,929	0.46	3,114	0.08
Gorontalo	1,204,361	698	0.06	-	-
West Sulawesi	1,660,371	18,859	1.14	9,963	0.6
Maluku	4,671,430	506,543	10.84	157,603	3.37
North Maluku	3,152,702	53,759	1.71	66,721	2.12
West Papua	9,868,080	9,758	0.1	28,501	0.29
Papua	31,643,682	128,55	0.41	89,752	0.28
Total	189,986,768	1,174,137	0.68	611,133	0.32

are prone to tsunami disaster. In terms of the percentage of population exposed, Maluku is the province with the largest percentage, being 13.51% of the total population. Other provinces that have population exposed to more than 6% are Aceh (6.36%), West Sumatera (6.61%), South Sulawesi (7.53%) and North Maluku (6.22%).

About 0.45% of the Indonesian population is exposed to the medium level tsunami hazard, consisting of 538,000 males and 527,000 females. This calculation will give an overview of the need for preparedness efforts of the population exposed. The creation of evacuation path, training drills, introduction to the early warning system, as well as recognition of the local habits in responding to tsunami, need to be considered in an effort to increase the capacity of the community to cope with disasters.

As has been mentioned earlier, Maluku is a province with the percentage of total population most affected by tsunami. In terms of the hazard classification, the population of this province is exposed to the high level hazard. Central Java, West Sumatra and Aceh also have high numbers of people exposed to the high level tsunami hazard. Figure 22 shows that the majority of population exposed to tsunami are in the high level hazard area. Indonesia's total population that is exposed to the hazard of this disaster is 4.2 million consisting of 3.1 million exposed to the high class and 1.1 million to the medium class hazard. Central Java largest exposure, with 865,084 people exposed to the high level hazard and 158,749 people exposed to the medium level hazard. Other provinces with more than 200,000 people exposed are Aceh (285,857), West Sumatera (320,410), East Java (242,025), Banten (321,996), Bali (227,209), South Sulawesi (604,924) and Maluku (207,184).

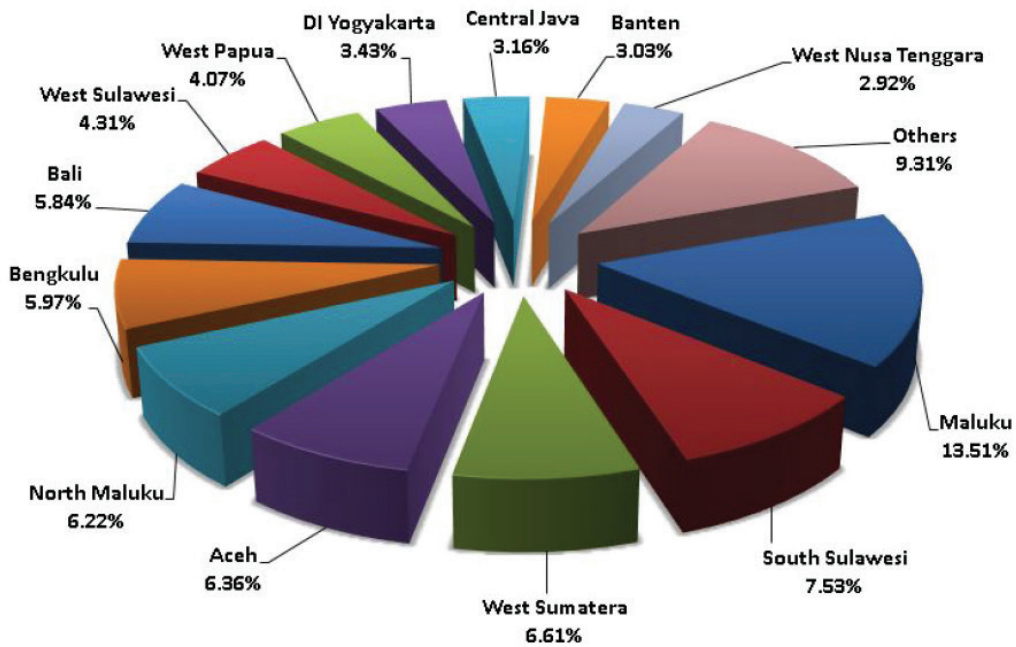


Figure 21. The Percentage of Population Exposed to High- and Medium-Level Tsunami Hazards

The provinces that have largest number of population exposed to the high level tsunami hazard are Central Java, South Sulawesi, Banten, West Sumatera, and Aceh (Figure 22). Provinces that have relatively large number of population exposed to the medium level hazard are Central Java, West Sumatera, Aceh, and Banten. Kalimantan does not have a large population exposed to tsunami hazard because it is not in the subduction zone.

BPS data can be used to identify vulnerable groups in each province based on the distribution of high- and medium level tsunami hazards.

Figure 25 shows that the provinces of North Maluku, West Sulawesi, and Maluku each has a high number of vulnerable groups of less than 16%, less than 16% and less than 12%, respectively. The analysis of the population exposed to the high level tsunami hazard shows that the provinces of South Sulawesi, Aceh, West Sumatera and Central Java each has large number of population exposed, but vulnerable groups in these four provinces are not the largest. Vulnerable groups in the province of South Sulawesi are less than 1%, about 1% in Aceh, less than 1% in West Sumatera, and less than 2% in Central Java.

The map of vulnerable groups' exposure to medium level tsunami hazard shows that North Maluku and West Sulawesi each has vulnerable groups' exposure of less than 16%, while Maluku has less than 12%. The map of population's exposure to medium level tsunami hazard shows that the province of Aceh, West Sumatera and Central Java each has quite large number of population exposed. However, exposure to the vulnerable groups in Central Java and Aceh each is less than 2%, and in West Sumatra is less than 1%. Many vulnerable groups are scattered in West Sulawesi, Maluku and North Maluku because in this area the number of vulnerable

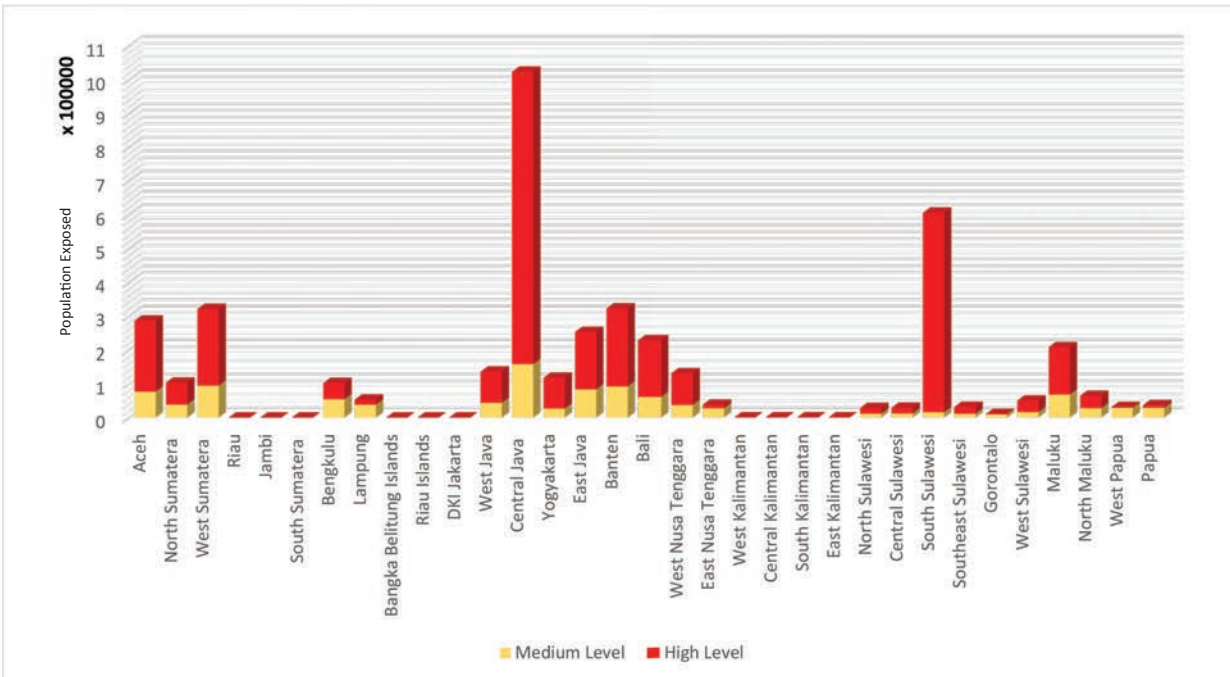


Figure 22. Population Exposed to Medium- and High-Level Tsunami Hazards, by Province

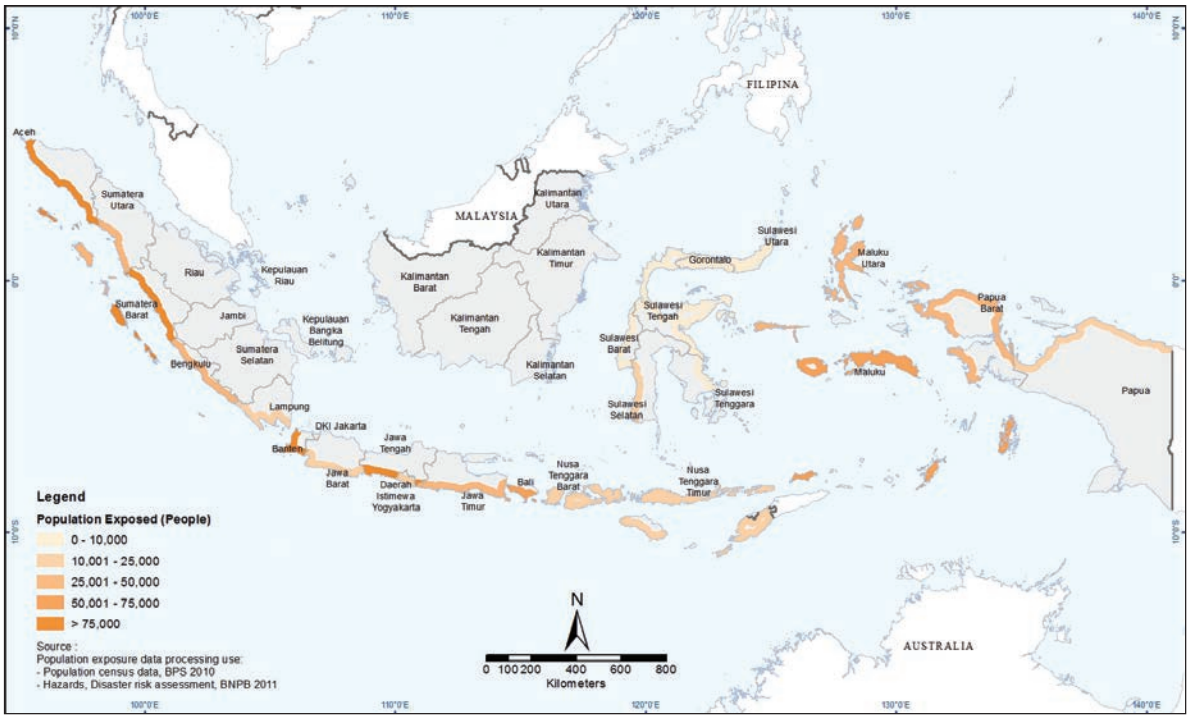


Figure 23. Map of Total Population Exposed to Medium-Level Tsunami Hazards

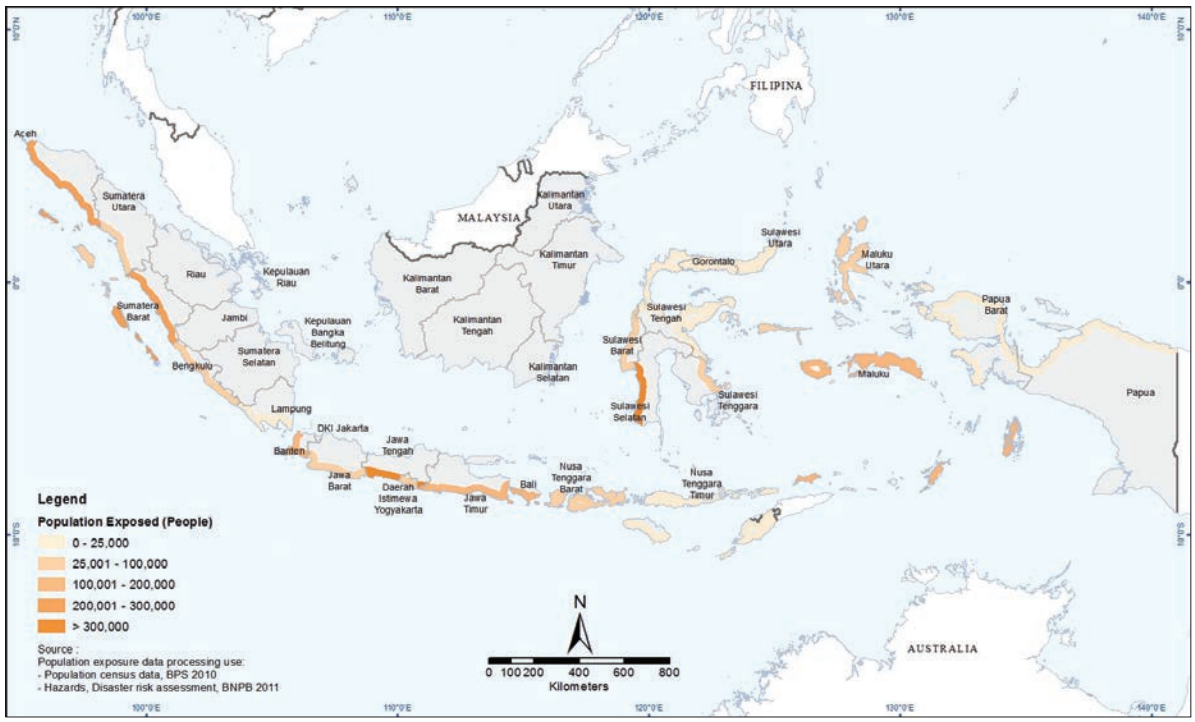


Figure 24. Map of Total Population Exposed to High-Level Tsunami Hazards

groups exposed to medium level tsunami hazard is quite a lot.

Indonesia, which ranks the first in terms of population exposed to tsunami, should be cautious in anticipating these threats so as to become resilient in facing the catastrophe. A good coordination between the Government, the community, and the business world is crucial in disaster management as well as in preparing contingency plan in the event of a tsunami.

Housing destroyed by the tsunami in Mentawai, October 2010.Source : BNPB.

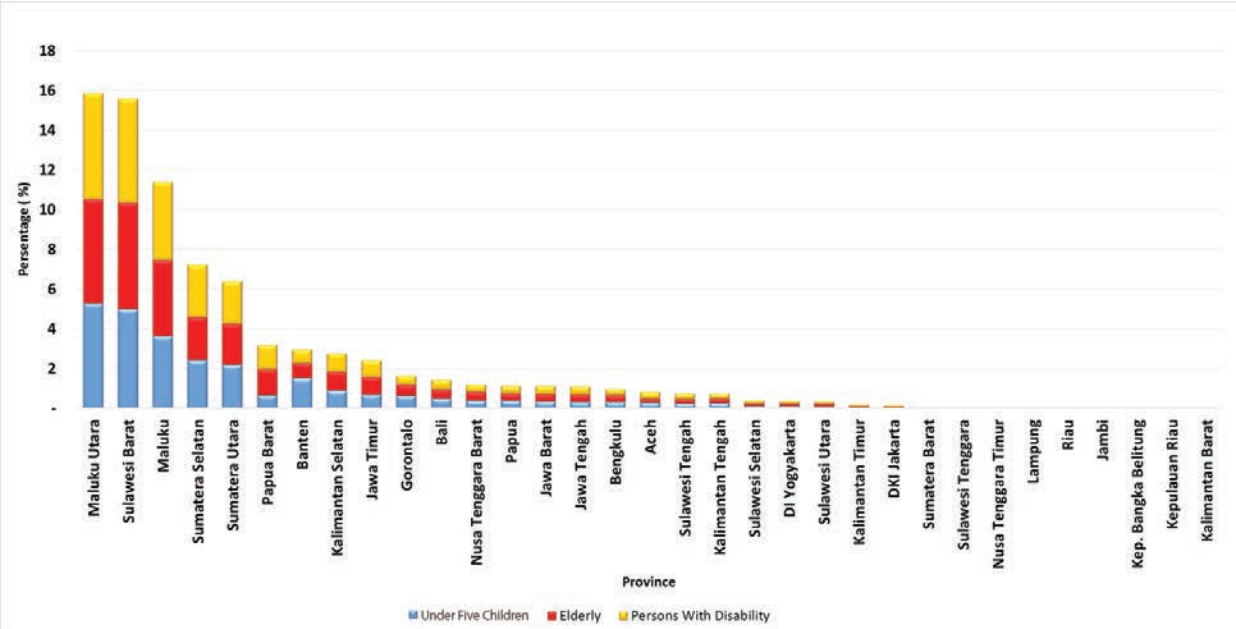


Figure 25. The Ratio of People in Vulnerable Groups Exposed to Tsunami Hazards

A mosque surrounded destroyed houses by after the tsunami in, Aceh, December 2004. Source : Intisari-online.com.

3.98 Million people **1.68%** EXPOSED TO HIGH & MEDIUM LEVEL **VOLCANO** HAZARDS

1.05 Million people

Exposed to High Level Volcano Hazards

2.93 Million people

Exposed to Medium Level Volcano Hazards

527 Thousand people

528 Thousand people

1.47 Million people

1.46 Million people

VULNERABLE GROUPS

99.5 Thousand people — **High Hazard** Under 5 Children

277.7 Thousand people — **Medium Hazard** Under 5 Children

239.6 Thousand people — **High Hazard** People with Disabilities

673.8 Thousand people — **Medium Hazard** People With Disabilities

105.4 Thousand people — **High Hazard** Elderly (60+ years)

279.9 Thousand people — **Medium Hazard** Elderly (60+ years)

* Source: 2010 Population Census, BPS

Figure 26. Infographics on Population Exposed to Volcanic Hazards

Residents flee the Mount Kelud volcanic eruption, February 2014. Source : BNPB.

Volcanic Hazards

The level of population exposure to the volcanic hazards is based on calculations made in the map of disaster-prone area (KRB) that has been validated with data of events by Geological Agency, Ministry of Energy and Mineral Resources (ESDM). The map depicts the categories of high-, medium-, and low class hazards. The level of exposure to the high class hazard is quite different if compared with the level of exposure to the medium class. The total number of population exposed to the high class hazard is 1.05 million, whereas the total population exposed to the medium class hazard is 2.93 million.

The number of vulnerable groups exposed to the high class hazards is estimated at 444 thousand people consisting of 99 thousand under five children, 105 thousand elderly, and 239 thousand person with disabilities. The total number of vulnerable groups exposed to the medium class hazards is 1.2 million. In the two areas of high- and medium class hazard the total number of vulnerable groups is 1.6 million people or 0.71% of the total number of persons exposed.

The collision of continental and ocean plates results in the process of volcanic formation. The tougher continental plate subducts into the softer ocean plate. This subduction causes the rock on the ocean plate melt. A volcano begins as melted rock (magma) which rises from deep inside the earth toward the surface. As the gas-filled magma rises, it melts gaps in the surrounding rock and forms a large chamber. Pressure from the solid rock around it forces the magma up to the surface through the channel in a weakened part of the rock. The gas and melted rock blast out an opening called the central vent. The erupted materials gradually pile up around the vent,

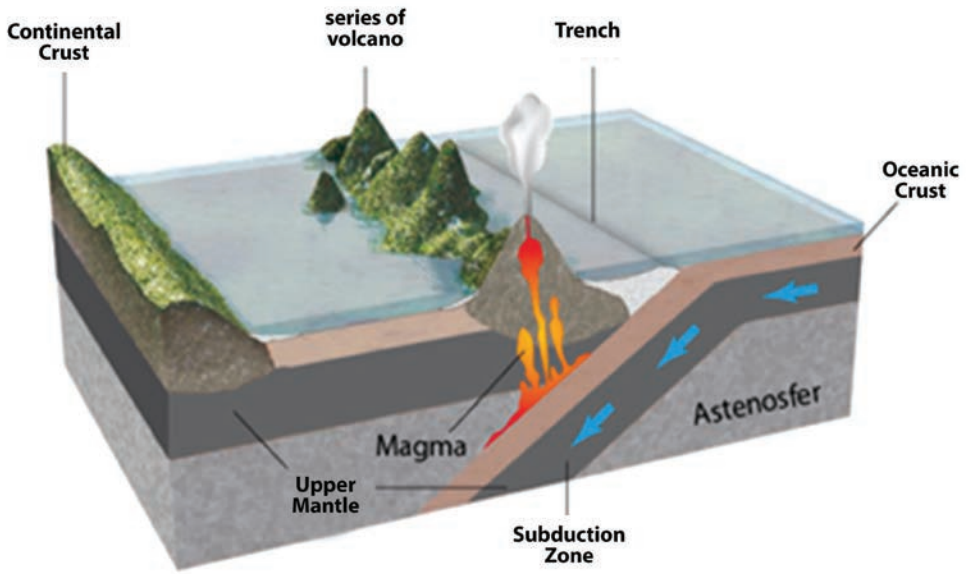


Figure 27. The Volcanic Formation Process

forming a volcano or mountain that has a depth of layers up to 35 km. Hence, a mountain serves as a peg that ties the continental plate at the base of oceanic crust.

The range of volcanoes in Indonesia stretches from the West coast of Sumatera, through the islands of Java, Bali, Nusa Tenggara, to the eastern part of Maluku and turn to Sulawesi (see Figure 28. So the entire volcano range encircles the islands in Indonesia forming a ring that is then part of the bigger volcanic ring around the Pacific Ocean (hence the term “ring of fire”).

Indonesia has 129 volcanoes, which is equivalent to 13% of the total number of volcanoes in the world, but not all the volcanoes in Indonesia have erupted. There are three volcanic types in Indonesia: type A, type B and type C (see Figure 28).

Type A volcanoes are those that have erupted in historic time or the activities of which have been escalating since 1600 to the present. The year 1600 is probably taken as a benchmark due to the availability of historical records. There are a total of 78 Type A volcanoes. Type B volcanoes have not had historical eruptions since the year 1600

Table 7. Components of Volcano Hazard Map

DISASTER	COMPONENT/ INDICATOR	INDEX CLASSES			TOTAL WEIGHT	REFERENCES
		LOW	MEDIUM	HIGH		
Volcanic Eruptions	Disaster Prone Areas (DPA) Map (validated by occurrance data)	DPA I	DPA II	DPA III	100%	Guidelines from the National Geological Agency - ESDM

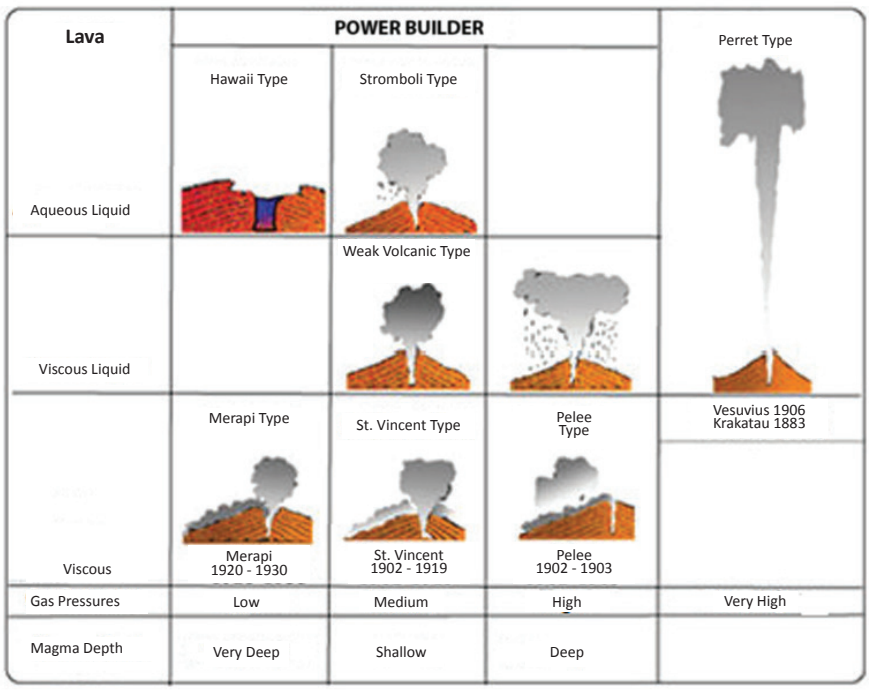


Figure 28. Types of Volcanoes

or earlier, but there are vents of former eruption or inactive craters on top. There are 30 volcanoes of this type. Type C volcanoes are those that only have geothermal manifestations (solfatara or fumaroles) at the surface, but have not had any historical eruptions since the year 1600 or earlier or eruption fissures on its peak or slope. There are 21 volcanoes of this type.

The threats posed from volcanic hazards include hot clouds, bursts of dust, lava flow, and cold lava.

The level of population exposure to the volcanic hazards in Indonesia is based on calculations made in with the map of disaster-prone area (KRB) that has been validated with data of events by Geological Agency, Ministry of Energy and Mineral Resources (ESDM), in particular the Center of Volcanology and Geological Hazard Mitigation (PVMBG). KRB I refers to low-level volcanic class hazard; KRB II to the medium-level hazard and KRB III to the high-level hazard. The classification of KRB is adapted to the type of volcanic eruption (see Figure 28). Further details are described in Table 7.

The areas prone volcanic eruption are predominately located in the island of Java. The total area affected by the volcanic hazard is relatively small, only 82,000 hectares or 0.04% of the territory of Indonesia for the high level hazard, and 0.14% for the medium level hazard. The percentage of area by classes is presented in Table 8.

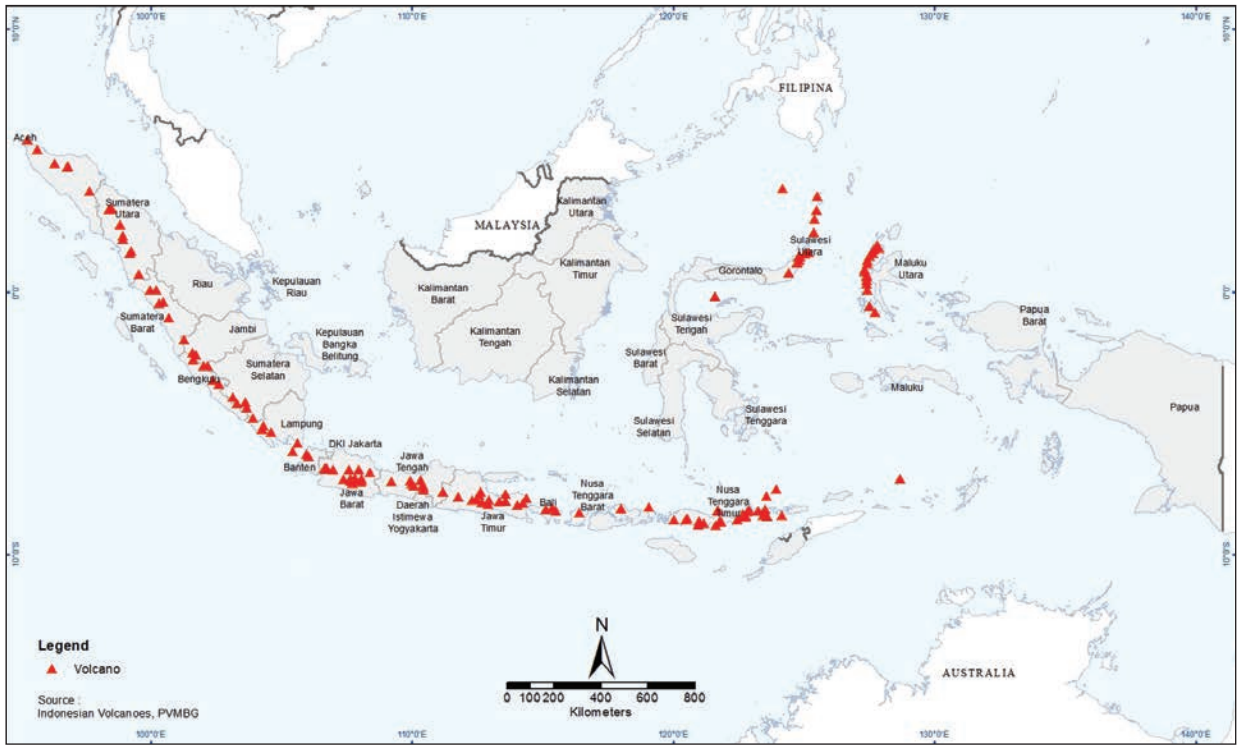


Figure 29. Locations of Volcanoes in Indonesia

Women cook together in a common kitchen after evacuating from the Mount Sinabung volcanic eruption, November 2013. Source : BNPB.

Table 8. Total Areas Exposed to Volcanic Hazards by Province

Province	Total Area (Ha)	High Class Hazards		Medium Class Hazards	
		Area (Ha)	%	Area (Ha)	%
Aceh	5,710,206	6,510	0.01	19,457	0.34
North Sumatera	7,242,590	1,270	0.00	10,036	0.14
West Sumatera	4,223,414	6,199	0.15	25,272	1
Riau	8,973,900	-		-	
Jambi	4,898,402	486	0.01	2,551	0.05
South Sumatera	8,726,219	353	0.00	7,079	0
Bengkulu	1,990,390	1,738	0.09	6,916	0.35
Lampung	3,385,034	248	0.01	936	0.03
Bangka Belitung Islands	1,673,759	-		-	
Riau Islands	826,687	-		-	
DKI Jakarta	66,121	-		-	
West Java	3,760,300	971	0.03	18,334	0.49
Central Java	3,499,305	9,889	0.28	30,459	0.87
DI Yogyakarta	323,769	3,413	1.05	3,042	0.94
East Java	4,887,603	6,602	0.14	40,007	0.82
Banten	947,142	-		-	
Bali	571,088	26,244	4.60	9,271	1.62
West Nusa Tenggara	2,011,833	2,099	0.10	3,245	0.16
East Nusa Tenggara	4,768,641	4,369	0.09	51,599	1.08
West Kalimantan	14,697,211	-		-	
Central Kalimantan	15,387,727	-		-	
South Kalimantan	3,749,592	-		-	
East Kalimantan	19,642,234	-		-	
North Sulawesi	1,451,911	3,933	0.27	22,232	1.53
Central Sulawesi	6,119,798	-		-	
South Sulawesi	4,568,637	-		-	
Southeast Sulawesi	3,682,629	-		-	
Gorontalo	1,204,361	-		-	
West Sulawesi	1,660,371	-		-	
Maluku	4,671,430	5,533	0.12	8,815	0.19
North Maluku	3,152,702	2,999	0.10	14,422	0.46
West Ppapua	9,868,080	-		-	
Papua	31,643,682	-		-	
Total	189,986,768	82,856	0.04	273,673	0.14

Population Exposed to the Volcanic Hazard

Figure 31 shows the total population in each province exposed to volcanic hazards. In total, about 3.98 million or 1.68% of the total population of Indonesia is exposed to the high- and medium-level hazards; 1.05 million people are exposed to the high-level hazards, while 2.93 million people are exposed to the medium-level hazards.

Parts of Indonesia that are prone to volcanic disasters, include those in the coastal areas of Sumatra, Java, Nusa Tenggara, and North Sulawesi. The provinces that have the highest percentage of population exposed to high and medium level volcanic eruption hazards are North Sulawesi, North Maluku, East Nusa Tenggara, West Sumatera, DI Yogyakarta, Bali, West Java, West Nusa Tenggara, and Bengkulu. North Sulawesi has the highest percentage with 10.38% of the population exposed to volcanic hazards, followed by North Maluku (7.94%), East Nusa Tenggara (5%), West Sumatera (4.99%) and Yogyakarta (4.93%). A total of 17 provinces are not exposed to high and medium level volcanic hazards.

For the purposes of DRR planning, it is necessary to consider the high percentage of the levels of exposure to volcanic hazards in these densely populated areas in order to minimize future losses, damage, and other risks arising from volcanic hazards.

East Java has the largest number of vulnerable population group exposed to the high- and medium level volcanic hazards with 452,787 people at risk. The data shows that exposure is medium level hazards; however it is still necessary to be vigilant, especially in the areas adjacent to active volcanoes, mainly in Central Java, East Java, West Java, West Sumatra and North Sulawesi.

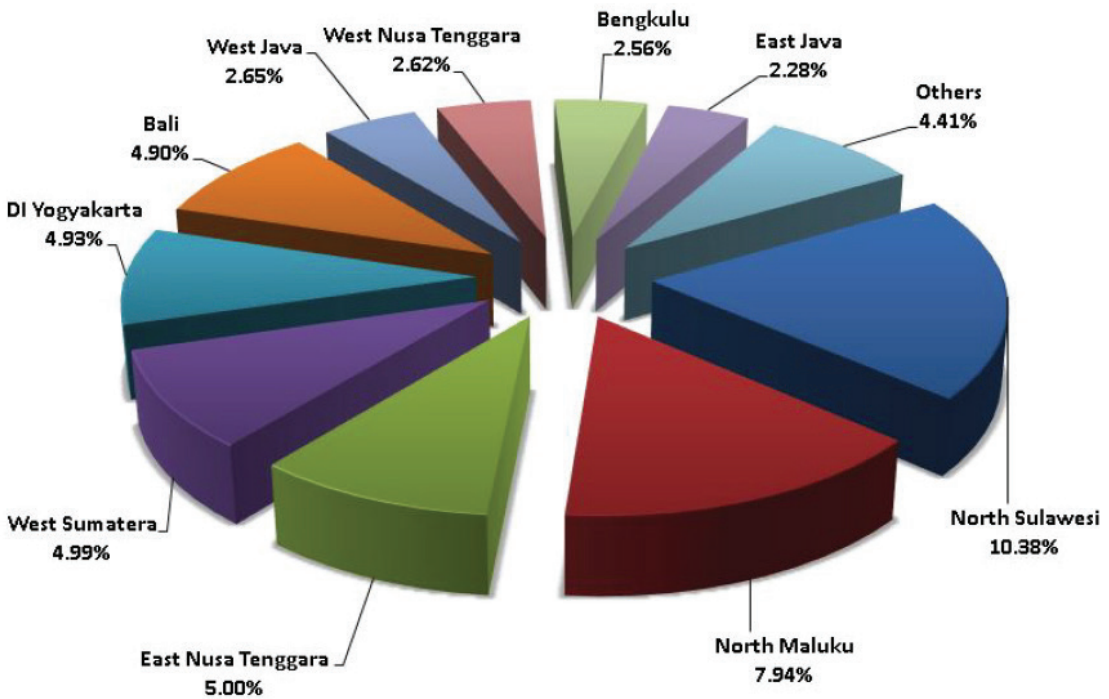


Figure 30. The Percentage of Population Exposed to High- and Medium-Level Volcanic Hazards

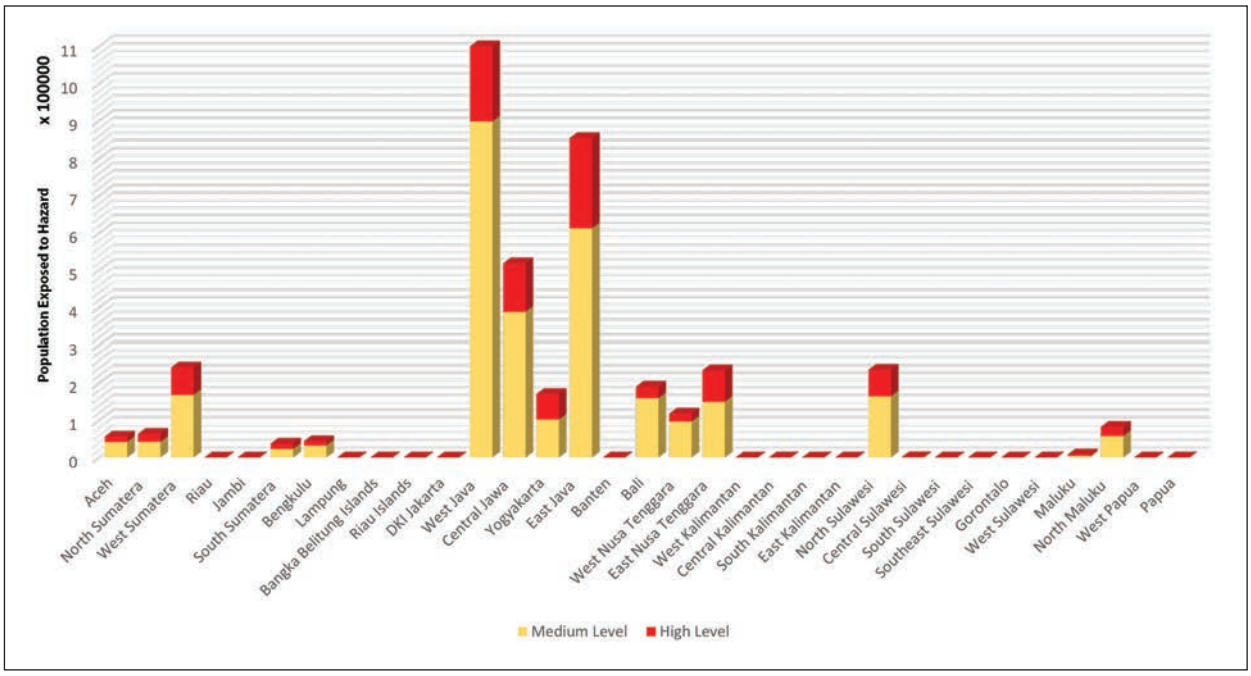


Figure 31. Population Exposed to Medium- and High-Level Volcanic Hazards, by Province

The total population who live in the high level hazard areas is 1.1 million (0.44%). A total 2.93 million people (1.68%) live in the medium level hazard areas. The location of the volcanic disaster-prone areas corresponds to the tectonic line; that is in the provinces bordering the Indian Ocean, Banda Sea and Sulawesi Sea.

Distribution of total population exposed to the high level hazard is shown in Figure 32. There are only six provinces with more than 10,000 people exposed where, the level of exposure is greater that 1%; namely West Sumatra, West Java, Central Java, Yogyakarta, East Java, and Bali. In West Java 1,138,827 people or 2.65% of its total population are exposed. Other provinces that are also considered as having high exposure are East Java (853,629 people) and Central Java (518,664 people). There are three provinces with more than 500,000 people exposed, namely West Java, East Java, and Central Java.

The percentage and number of population exposed to the high- and medium level hazards are shown in Figure 31.

West Java is the province with the largest population (898,061 people) exposed to the medium level hazard, followed by East Java (612,221 people) and Central Java (338,082 people), however the percentage of exposure is still low, namely below 3%. The highest level of exposure is in North Sulawesi where 7.23% of its population is exposed to the medium level volcanic hazard.

Although most of the areas exposed are in the category of medium level hazards and there is a low overall percentage of exposure, in view of the numbers exposed and population density of the disaster-prone areas in Java, Bali, and North Sulawesi, it is still necessary pay more attention to these areas for DRR planning.

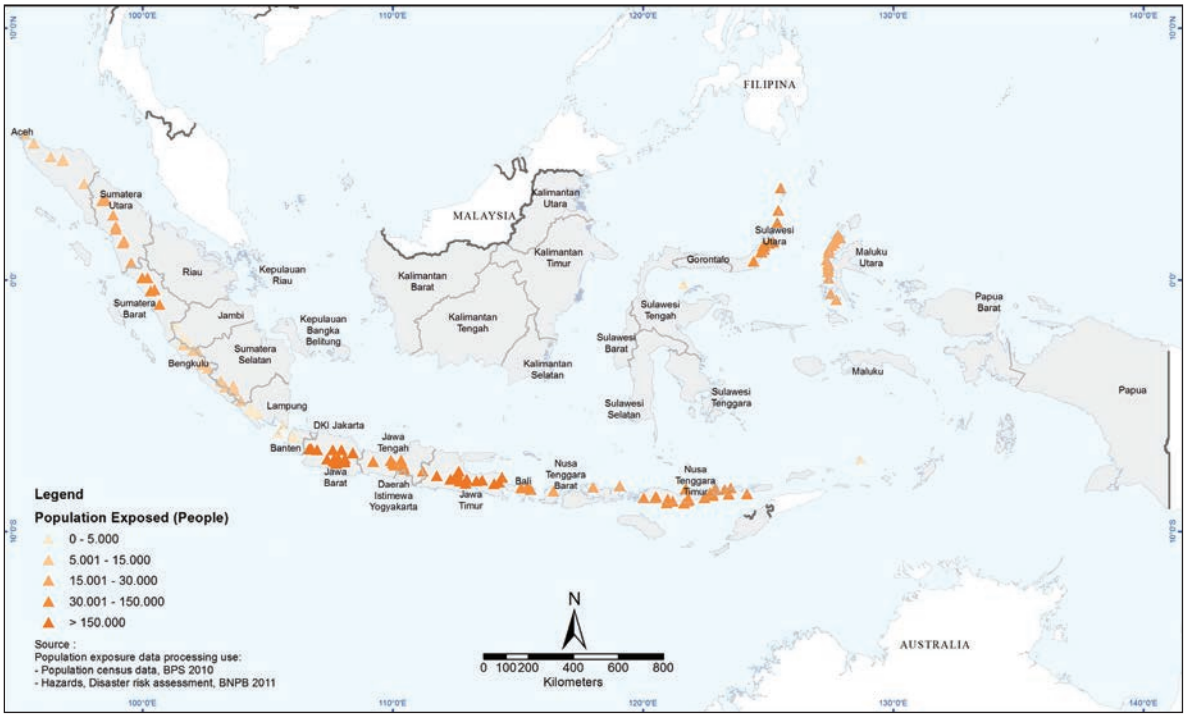


Figure 32. Map of Total Population Exposed to High-Level Volcanic Hazards

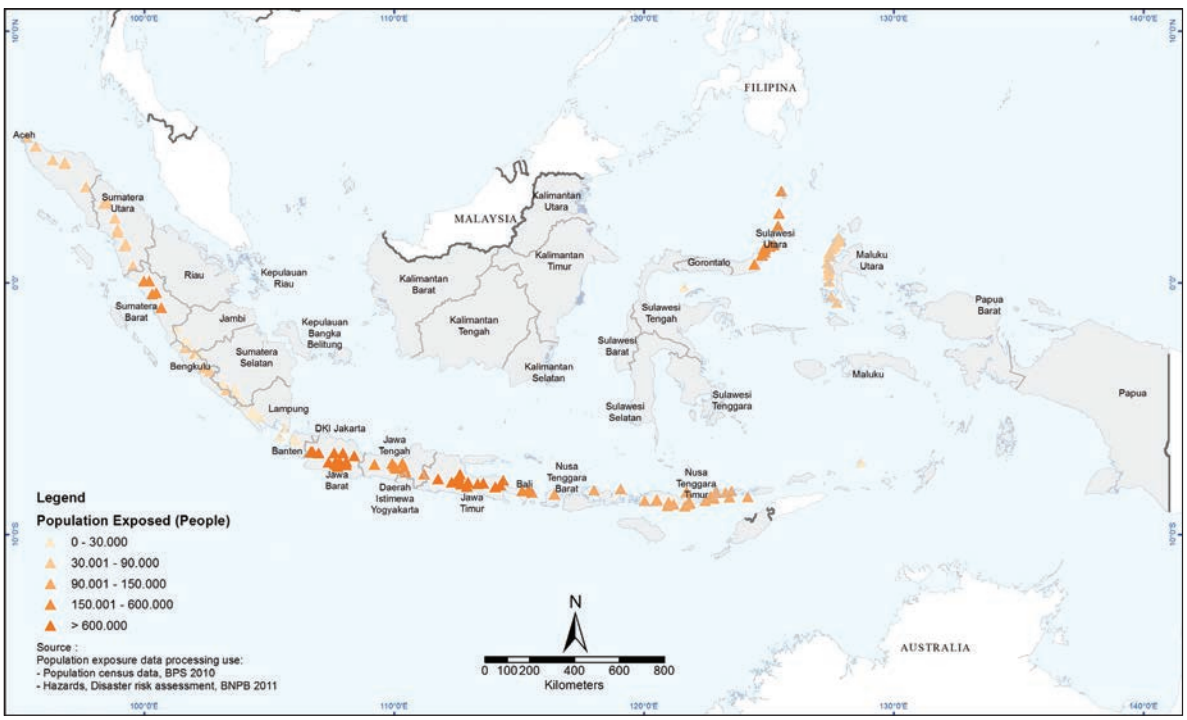


Figure 33. Map of Total Population Exposed to Medium-Level Volcanic Hazards

Distribution of the population exposed to the medium level volcanic hazards is shown in Figure 33. Besides the population (male and female) size, another factor of susceptibility to hazards that also needs attention are the vulnerable groups. The number of people in vulnerable groups exposed to the high-level hazards is estimated at 444,000 in total, consisting of 99 thousand under five children, 105 thousand elderly, and 239 thousand person with disabilities. The total number of people in vulnerable groups exposed to the medium-level hazards is 1.2 million. In areas of high- and medium-level hazards, the total number in vulnerable groups is 1.6 million people or 0.71% of the total number of persons exposed. Figure 34 and 35 show the proportion of the vulnerable groups that are exposed to the high- and medium level volcanic hazards, respectively, by province.

Figure 34 shows that Bali has the largest number of people in vulnerable groups exposed to the volcanic eruption hazards with the elderly and persons with disability being the groups most exposed to the hazards. Other provinces that also have large numbers exposed to the hazards are Central Java, Yogyakarta, East Java and West Sumatera.

Figure 35 shows the proportion of vulnerable groups that are exposed to the medium level volcanic hazards. The total number of people in these groups in this class is larger than that in the high level. Most of areas that are considered to be at risk to medium level volcanic hazards are densely populated; for example most parts of the island of Java. In the event of a disaster in this region, the resulting casualties would undoubtedly be also very large. The areas with large percentages of vulnerable groups exposed to the medium level volcanic hazards are particularly located in Central Java, West Java and East Java, the exposure rate is less than 3% as a percentage, the numbers of people at risk are significant.

IDPs in an emergency relief camp after the eruption of Mount Merapi, January 2011. Source: BNPB

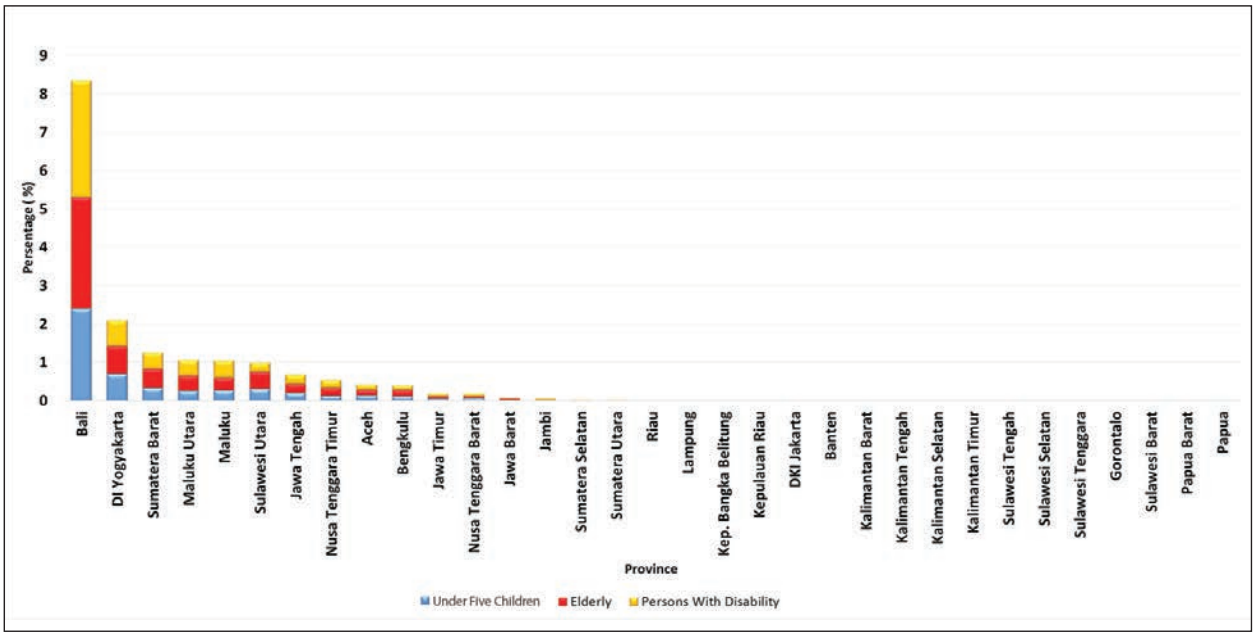


Figure 34. The Ratio of People in Vulnerable Groups Exposed to High-Level Volcanic Hazards

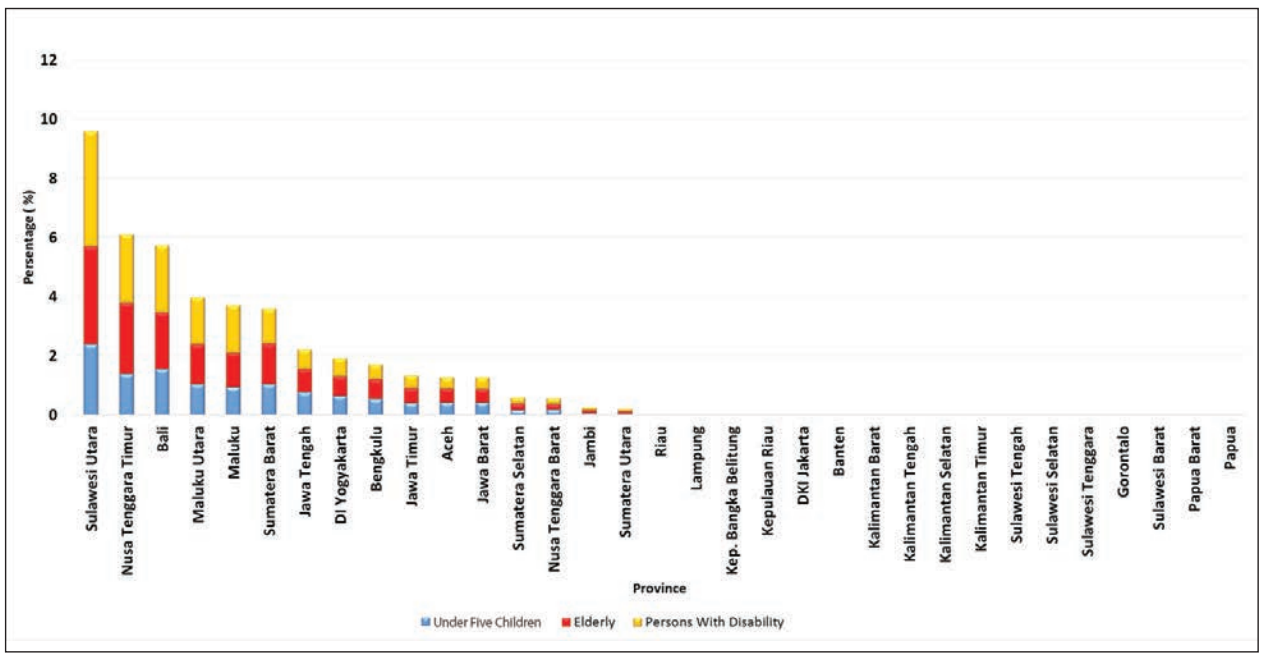


Figure 35. The Ratio of People in Vulnerable Groups Exposed to Medium Class Volcanic Hazards

Figure 36. Infographic on Population Exposed to Landslide Hazards

Residents observing an area affected by a landslide, Padang, October 2009. Sumber: BNPB.

Landslide Hazards

A landslide is the movement of rock, earth, or debris down a sloped section of land due to the instability and disruption of soil or rocks which make up the hill slope. Based on characteristics of the movement, there are six types of landslides, translational slides, rotational slides, avalanches, topples, lateral spreads, and debris flows. The translation slides and rotational slides are the most common occurrences in Indonesia, while debris flows result in the largest number casualties (ESDM 2008).

The landslide hazard map was prepared with supporting data from the Geological Agency of the Ministry of Energy and Mineral Resources (ESDM). That was includeed in BNPB's 2011 Disaster Risks Assesment.

Landslide hazard classes are generated from the classifications used in the landslide hazard map. Other parameters included to produce the map are: the slant of slopes, vegetative structures, annual rainfall, and distance from faults. The data was validated against data of historical occurrences. Identification of landslide hazard classes is based on the zoning of ground motion threats. The high threat ground motion zones are included in the high-class hazard class; the moderate threat ground motion

Table 9. Components of Landslide Hazard Map

DISASTER	COMPONENT/ INDICATOR	INDEX CLASS			TOTAL WEIGHT	REFERENCES
		LOW	MODERATE	HIGH		
Landslides	Land Motion Hazard Map (validated by occurrence data)	Very low - low ground motion susceptibility zone	Medium ground motion susceptibility zone	High ground motion susceptibility zone	100%	Guidelines from the National Geological Agency, ESDM

Residents in front of houses destroyed by landslides in , Sinjai, South Sulawesi, June 2006. Source: Bakornas.

zones are included in the medium-level hazard class; and the low to the very low threat ground motion zones are included in the low-level hazard class. Components of the landslide hazards map are depicted in Table 9.

Landslide disasters commonly occur in the areas with hilly and mountainous topography. Other triggers may include: type of soil, vegetation, precipitation, and changes in land use. These factors may be involved individually or together to contribute to a landslide event. According to the analysis in this study, West Java province has the largest population and vulnerable groups exposed to high- and medium level hazards.

One example of the largest landslide disaster occurred in the village of Tenjolaya, Ciwidey, Bandung Regency. The disaster that occurred early in 2010 resulted in 33 deaths, hundreds of people displaced, and the losses the amounts of billions of rupiah. The landslide occurred in a tea plantation with unstable soil, a very steep slope, and saturated ground water, which was close to a residential area. These land and topographic conditions jeopardized the inhabited area below.

The Landslide Hazard Map (Figure 37) shows that the western part of Sumatera, middle part of Java, middle and northern parts of Kalimantan, Nusa Tenggara, middle part of Sulawesi, and middle and northern parts of Papua are areas that have the level of medium to high level landslides hazards.

Population Exposed to the Landslide Hazards

The level of population exposure to landslide hazards is based on the calculation from the overlay of the Landslide Hazard Grading Map, and the population density map derived from the Population Census 2010. There is a vast difference in the exposure levels between the high class and the medium level hazards. The total population exposed to the high level hazards is 4.8 million (2.4 million males and 2.4 million females), while

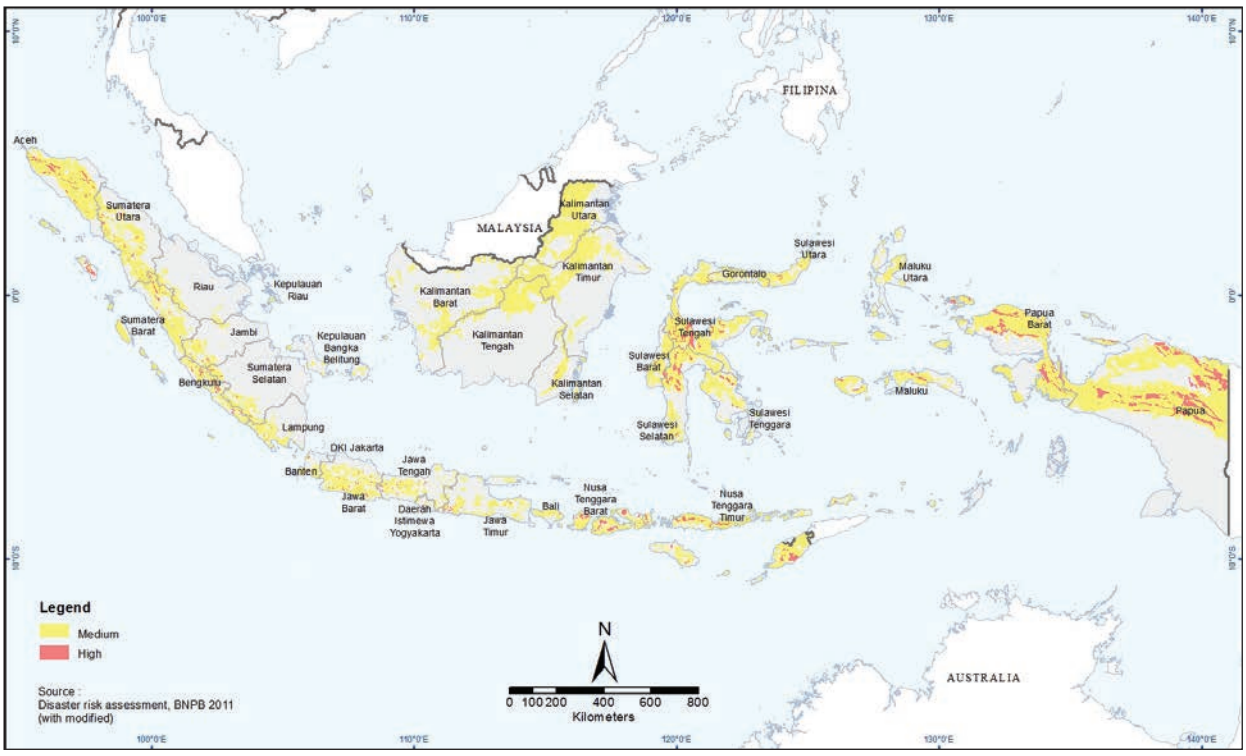


Figure 37. Landslide Hazards Map (High and Medium-Level Hazards)

the total population exposed to the medium level hazards is 36 million (18.1 million males and 17.9 million females).

The vulnerable groups consisting of the elderly, under five children, and persons with disability need special attention in disaster management. It is estimated that nationally the total number of people in vulnerable groups exposed to the high level landslide hazards is 914,000 comprising 488 thousand under five children, 386,000 elderly, and 39,000 persons with disabilities. The total number of people in vulnerable groups exposed to the medium level landslide hazards is 6.8 million consisting of 3.6 million under five children, 2.9 million elderly, and 284,000 persons with disabilities. The total number of people in vulnerable groups exposed to both the high and medium level hazard areas is 7.7 million or 18.2% of the total population exposed to the landslide hazards.

When compared with the other provinces in Indonesia, West Java which is densely populated and situated in the high-level landslide disaster prone zone, has the largest population exposed to the landslide hazards.

Landslides generally occur around the slopes of hilly and mountainous areas. Areas with this topography should not be used as settlements but rather be developed as conservation area or afforested. However, current trends of development has led to people constructing buildings and houses in areas that have hilly and mountainous topography. Lack of public awareness of the dangers has in landslide-prone areas. Landslides can cause loss of life and property, unless people have a strong awareness and capacity to respond when living in the areas prone to landslides.

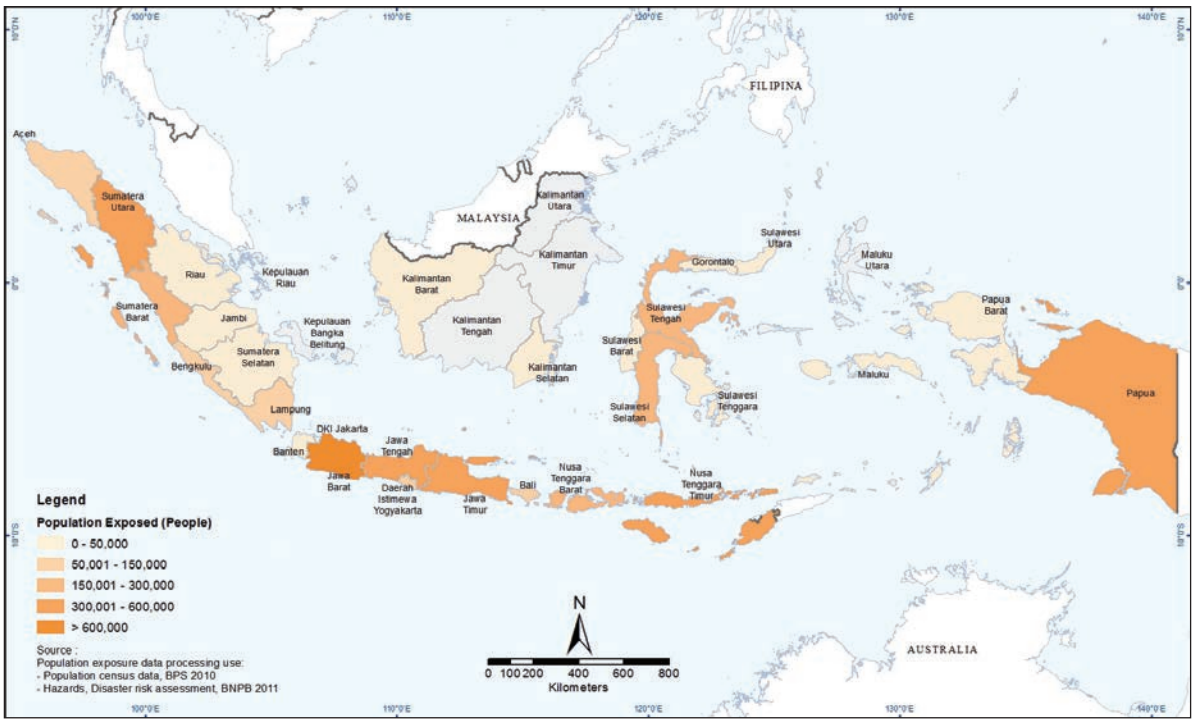


Figure 38. Map of Total Population Exposed to High-Level Landslide Hazards

Figures 37 and 38 show that West Java has the largest population exposed to the landslide hazards, being 21.52%. This is consistent with the frequency of occurrence and the population density of the province. Other provinces with more that population exposed to the landslide hazards 5% are North Sumatra (5.07%), East Nusa Tenggara (6.40%), West Nusa Tenggara (8.70%), East Java (9.19%), and Central Java (11.05%).

West Java has the largest amounts of population affected by landslides; with 8,800,431 people exposed; the total population exposed to the high level hazards 983,857, while the number of those exposed to the medium level hazards is 7,816,574. The total population exposed to the landslides hazards in Indonesia is approximately 40 million consisting of nearly 5 million exposed to the high level hazards and more than 36 million exposed to the medium level hazards. The provinces in which the total population exposed to the landslide hazards is more than 2 million are the provinces of West Java, Central Java, East Java, West Nusa Tenggara, East Nusa Tenggara, and North Sumatera.

In terms of the population exposed to the medium level landslide hazards, West Java is the highest in Indonesia, 7,816,574 people or 18.16% of the province's total population exposed, Central Kalimantan is the province with lowest number of population exposed, with 53,035 or 2.4% of its total population.

The total number of the vulnerable groups exposed to the high level landslide hazards is 914,070 or 2.17% consisting of 488,658 under five children (2.17%), 386,255 elderly (2.16%), and 39,157 persons with disabilities (2.35%). Based on the results of the calculation of vulnerable groups exposed to the high level landslide hazards, West Java province is the region with the largest number at risk, namely,

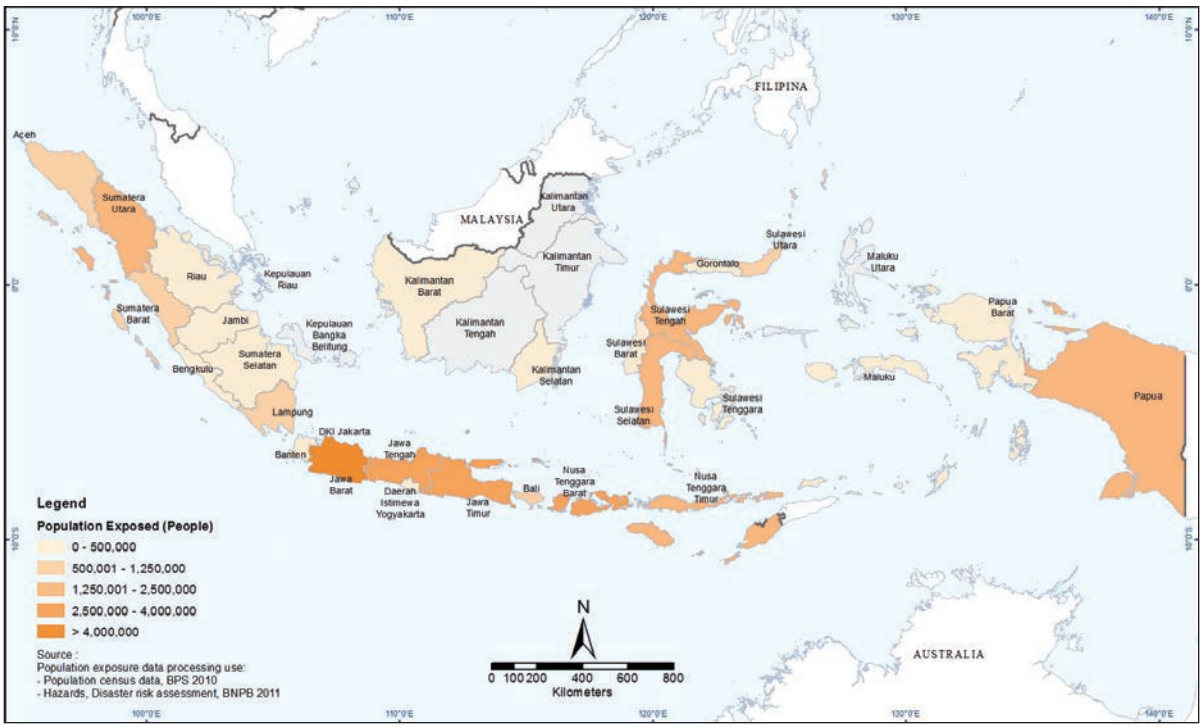


Figure 39. Map of Total Population Exposed to Medium-Level Landslide Hazards

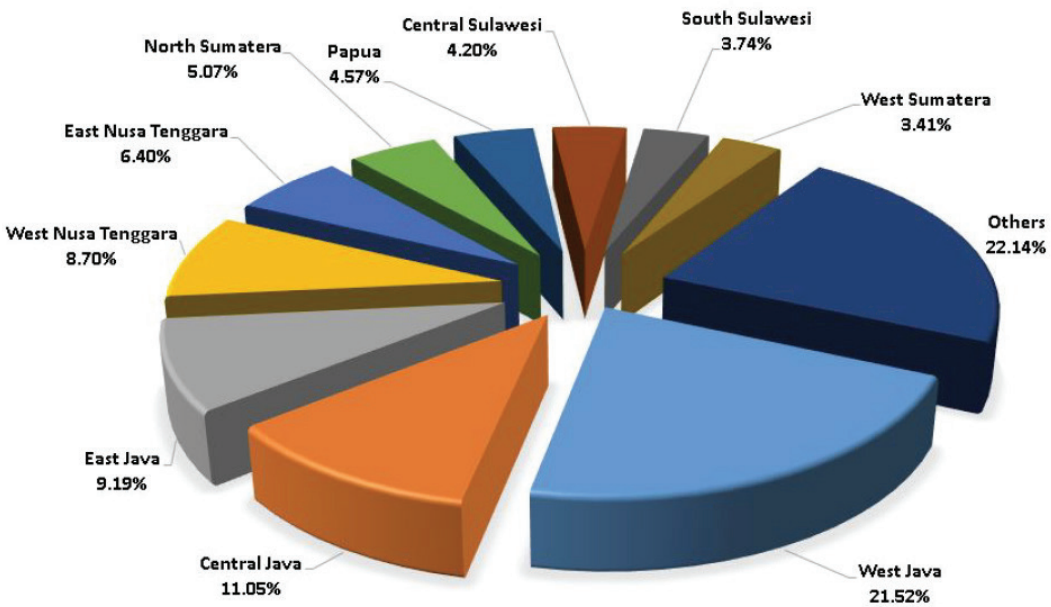


Figure 40. Percentage of Population Exposed to the High- and Medium-Level Landslide Hazards

185,798 or 2.48%, consisting of 95,286 under five children (2.29%), 83,136 elderly (2.73%), and 7,376 persons with disabilities (2.64%).

The total number of vulnerable groups exposed to the landslide hazards is 6,794,566 (16,12%). This include 3,617,905 under five children (16,04%), 2.892.088 elderly persons (16,14%), and 284,573 persons with disabilities (17.05%). Based on the results of the calculation of vulnerable groups exposed to the medium level landslide hazards, again, West Java province is the region with the largest number, namely, 1,453,954 people (19,42%) comprising 760.500 under five children (18.30%); 638,201 elderly (20.92%); and 55,254 persons with disabilities (19,79%).

Meanwhile, the smallest number of vulnerable groups exposed to the medium level landslide hazards is in Central Kalimantan, the total of which is 9,092 (2.47%) with 6.294 under five children (2.59%), 2.470 elderly (2.24%), and 327 persons with disabilities (2.24%).

It is suggested that populations in medium- to high-level hazard zones need to take into account the landslide occurrences record of the locality. Preventative measures include: avoiding cutting into the rock cliff, maintaining vegetation on slopes, and minimizing the construction of buildings around steep slopes and on where active ground motion occurs frequently. If living in a landslide area is unavoidable, it is necessary to recognize the early signs of landslide occurrence, for instance the roaring sound during heavy rainfall indicates a warning to evacuate the people to a safer location. Moreover, people should also prepare equipment such as an early warning system with the kentongan, communication tools (HT), evacuation equipment, and medical supplies.

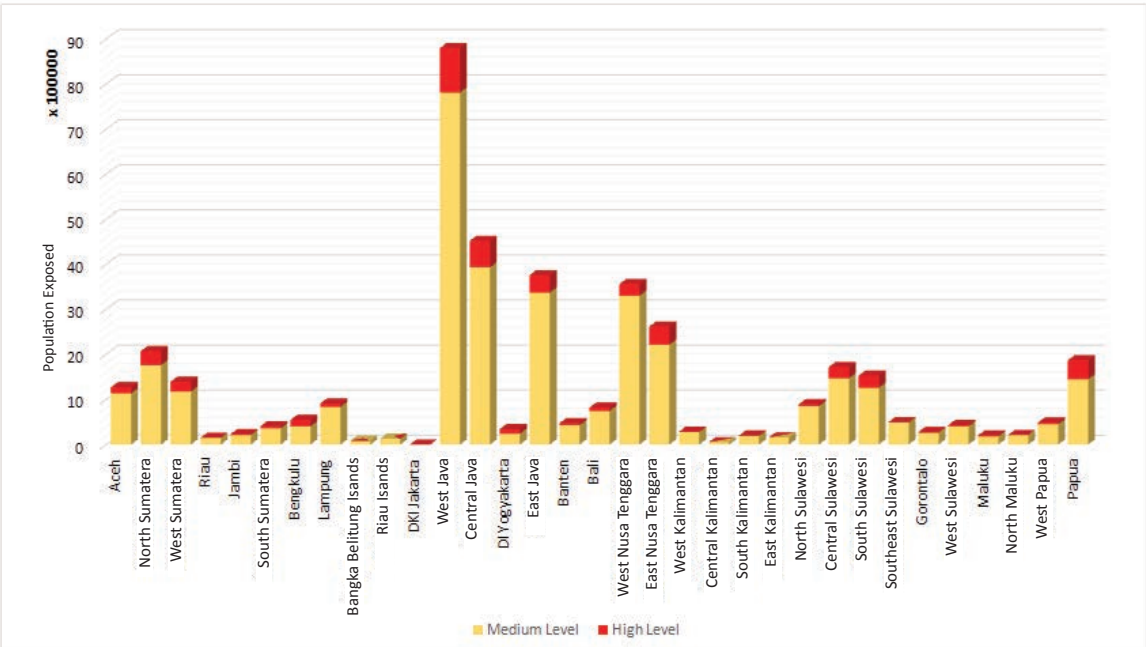


Figure 41. Total population Exposed to High- and Medium-Level Landslide Hazards

A Rescue team searching for landslide victims in Bandung District, West Java, February 2010.
Source: BNPB.

Homes damaged by landslides in Cianjur, November 2008. Source: BNPB.

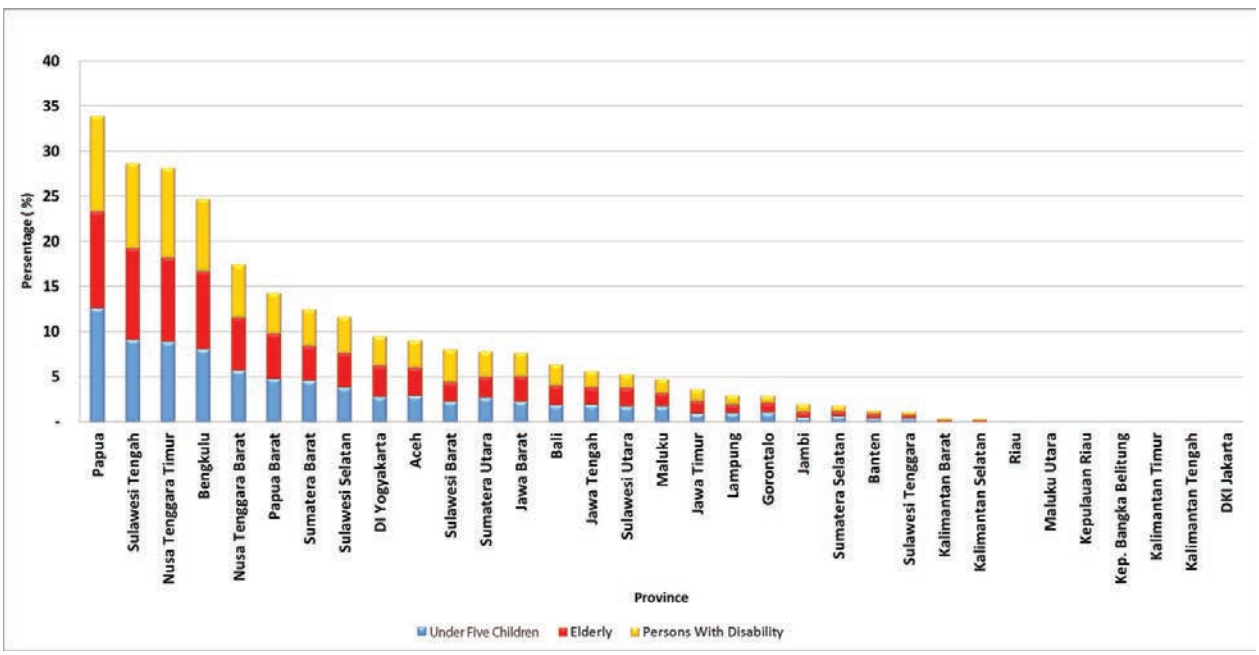


Figure 42. The Ratio of People in Vulnerable Groups Exposed to High-Level Landslide Hazards

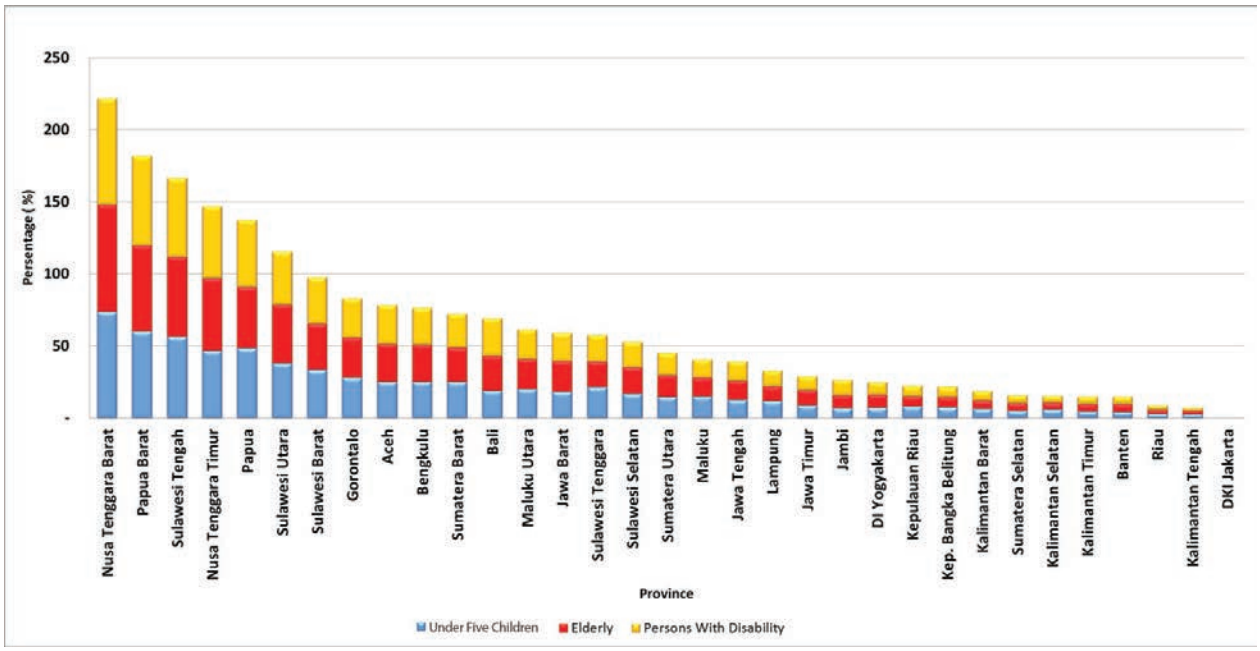


Figure 43. The Ratio of People in Vulnerable Groups Exposed to Medium-Level Landslide Hazards

Damaged residential areas hit by landslides, Central Java, December 2007.
Source: BAKORNAS.

5

PART 5

Population Exposed to Hydro-Meteorological Hazards: Floods & Extreme Waves & Abrasion

Flooding Hazards

Flooding occurs where an area of land becomes inundated due to increased water volume in the vicinity. Many factors can cause the occurrence of floods, but in general the causes of floods can be classified into two categories: floods caused by natural factors and floods due to human activities. Natural causes of flooding include, among others, heavy rainfall, the position of river channels, tidal influences, and erosion and sedimentation. Flooding caused by human actions includes, among others, the reduction of function of watersheds as catchment areas, over-development of crowded urban settlements (slums) along riverbanks, debris, damage to flood control constructions, and inappropriate flood control system planning. Many parts of Indonesia are regularly inundated during the annual rainy season. The capital city of Jakarta tends to experience annual flooding; flood emergencies in Jakarta affect businesses and residential areas, and may impact the growth of the national economy.

The classification of flooding hazards is based on mapping of flood-prone areas that is validated with data of disaster occurrences. Other parameters for analysis of flooding hazards includes locations of watershed, geomorphology, vegetation cover, soil type, and annual rainfall. The effect of flooding on communities in areas located near rivers is one example of flooding hazards. In addition to the availability of river water, the soil from the alluvial process on the riverbanks means these areas are also very fertile, making these areas attractive for development. However, over time, deforestation in upstream areas, increasing sedimentation, and

Rescue teams working to evacuate residents caught in flooding, in Kampung Melayu, Jakarta, January 2013. Source: BNPB

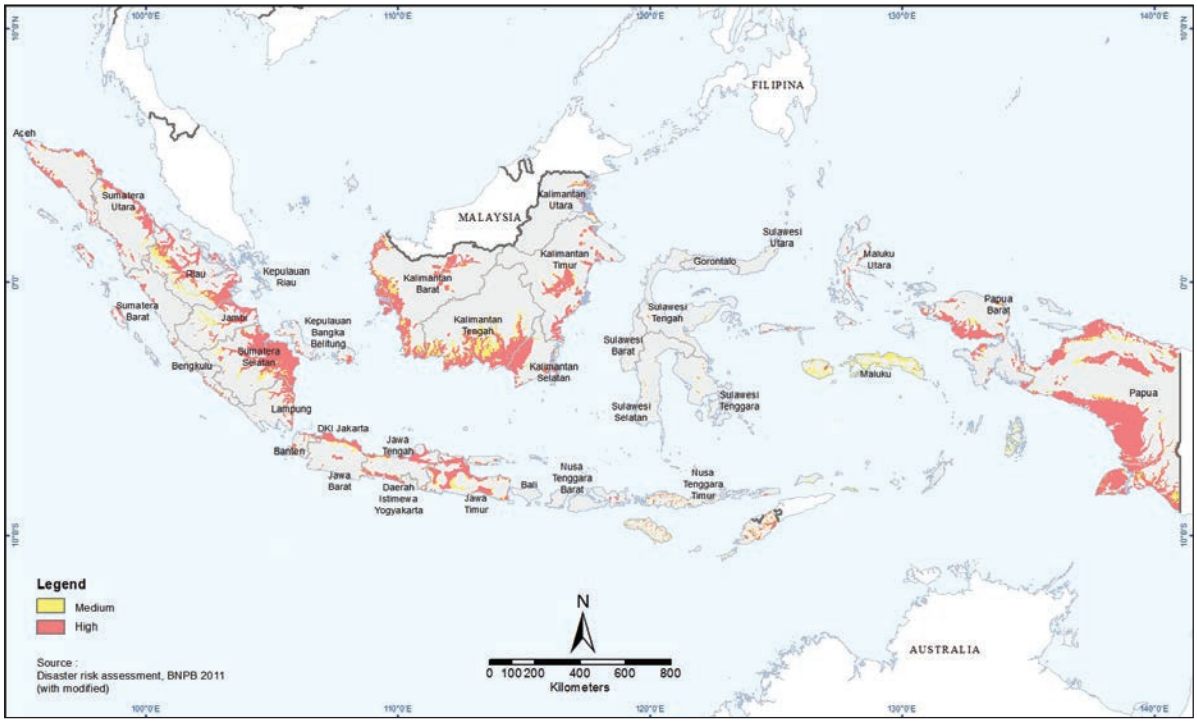


Figure 44. Flood Hazards Map, SNI 2010 (High- and Medium-Level Hazards)

conversion of land use affects the volume of rivers, resulting in flooding in areas that historically were not subject to inundation.

Figure 44 shows that the location of flood-prone areas correlates with coastal areas that are associated with peat areas. For example, the extensive flood-prone areas in Central Kalimantan and Papua are peat areas.

The Regulations of the Head of BNPB No. 2 of 2012 provides that the flood-prone area zoning map is divided into three classes based on the flooding height; that is: low (< 0.76 m), moderate (0.76 to 1.5 m), and high (> 1.5 m). This corresponds to low-, medium- and high-level hazard classifications; as with the other types of hazards, low-level hazards are excluded and the medium- and high-level hazards are included in this study (see Table 10).

Table 10. Components of Flood Hazard Map

DISASTER	COMPONENT/ INDICATOR	INDEX CLASSES			TOTAL WEIGHT	REFERENCES
		LOW	MEDIUM	HIGH		
Floods	Flooding Prone Areas Zoning Map (validated by occurrence data)	Low (< 0,76 m)	Moderate (0,76 – 1,5 m)	High (> 1,5 m)	100%	Guidelines from the Ministry of Public Works, BMKG, and BIG

Table 11. Total Areas Exposed to High- and Medium-Level Flooding Hazards, by Province

Province	Total Area (Ha.)	High Class Hazards		Medium Class Hazards	
		Total Area (Ha.)	%	Total Area (Ha.)	%
Aceh	5,710,206	687,947	12.05	157,032	2.75
North Sumatera	7,242,590	885,584	12.23	200,456	2.77
West Sumatera	4,223,414	143,912	3.41	60,388	1.43
Riau	8,973,900	1,452,542	16.19	912,282	10.17
Jambi	4,898,402	551,588	11.26	189,442	3.87
South Sumatera	8,726,219	2,502,638	28.68	637,031	7.30
Bengkulu	1,990,390	54,413	2.73	34,467	1.73
Lampung	3,385,034	330,524	9.76	97,286	2.87
Bangka Belitung Islands	1,673,759	92,286	5.51	63,835	3.81
Riau Islands	826,687	0	0.00	0	0.00
Dki Jakarta	66,121	28,000	42.35	3,670	5.55
West Java	3,760,300	463,911	12.34	186,737	4.97
Central Java	3,499,305	664,808	19.00	117,116	3.35
DI Yogyakarta	323,769	16,710	5.16	6,796	2.10
East Java	4,887,603	1,150,220	23.53	328,634	6.72
Banten	947,142	90,302	9.53	30,919	3.26
Bali	571,088	0	0.00	0	0.00
West Nusa Tenggara	2,011,833	31,559	1.57	10,723	0.53
East Nusa Tenggara	4,768,641	120,521	2.53	127,152	2.67
West Kalimantan	14,697,211	1,930,011	13.13	1,030,193	7.01
Central Kalimantan	15,387,727	1,824,984	11.86	1,653,656	10.75
South Kalimantan	3,749,592	928,467	24.76	80,755	2.15
East Kalimantan	19,642,234	1,388,511	7.07	598,283	3.05
North Sulawesi	1,451,911	2,432	0.17	4,310	0.30
Central Sulawesi	6,119,798	3,530	0.06	21,426	0.35
South Sulawesi	4,568,637	1,517	0.03	14,448	0.32
Southeast Sulawesi	3,682,629	2,537	0.07	20,308	0.55
Gorontalo	1,204,361	298	0.02	1,686	0.14
West Sulawesi	1,660,371	525	0.03	3,027	0.18
Maluku	4,671,430	34,438	0.74	1,322,963	28.32
North Maluku	3,152,702	132,315	4.20	61,028	1.94
West Papua	9,868,080	1,322,529	13.40	292,462	2.96
Papua	31,643,682	8,213,783	25.96	1,576,941	4.98
Total	189,986,768	25,053,342	9.68	9,845,452	3.90

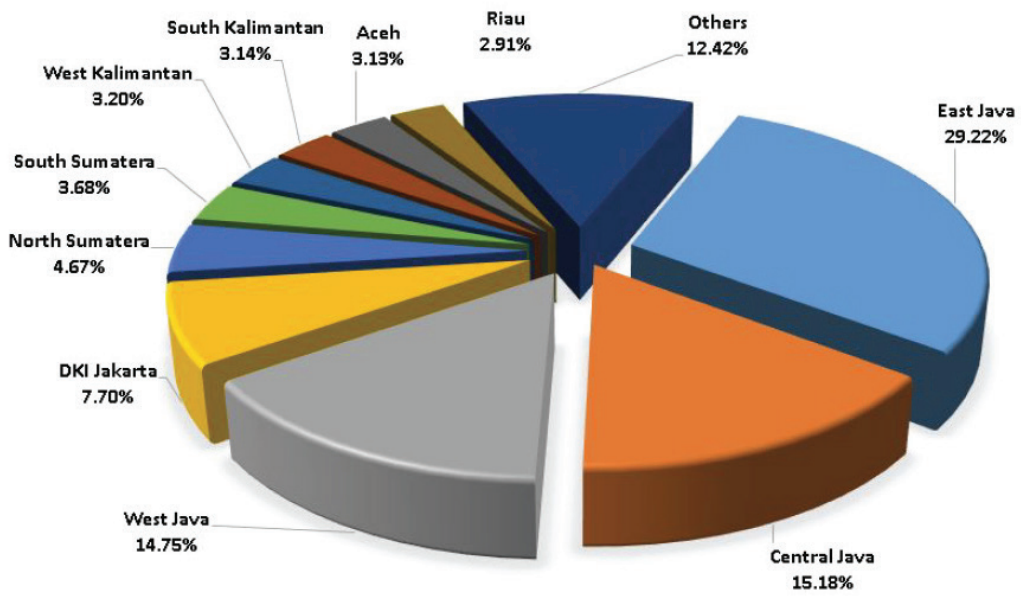


Figure 45. Percentage of Population Exposed to the High- and Medium Class Flood Hazards

Residents in an emergency shelter following flooding in GOR Otista, Jakarta, January 2013.
Source: BNPB

63.7 Million people **26.8%** EXPOSED TO HIGH & MEDIUM LEVEL **FLOOD** HAZARDS

50.8 Million people

Exposed to High Level Flood Hazards

12.9 Million people

Exposed to Medium Level of Flood Hazards

25.5 Million people

25.3 Million people

6.5 Million people

6.4 Million people

VULNERABLE GROUPS

4.6 Million people
High Hazard Under 5 Children (0-4 years)

1.2 Million people
Medium Hazard Under 5 Children (0-4 years)

343.7 Thousand people
High Hazard People with Disabilities

93.3 Thousand people
Medium Hazard People With Disabilities

3.8 Million people
High Hazard Elderly (60+ years)

1.0 Million people
Medium Hazard Elderly (60+ years)

* Source: 2010 Population Census, BPS

Figure 46. Infographic on Population Exposed to Flood Hazards

A total of 25.05 million ha (9.68%) are exposed to high-level flood hazards, and 9.84 million ha (3.9%) are exposed to medium-level hazards (see Table 11).

Indonesia's rainy season can bring significant rainfalls. According to BNPB, floods occur in most parts of Indonesia and floods have a high frequency of occurrence. In addition to affecting the environment, floods also have a significant impact on people and can result in the loss of lives. The four provinces with the largest percentages of population exposed to the flood disaster are on Java, namely East Java (29.22%), Central Java (15.18%), West Java (14.75%) and DKI Jakarta (7.70%). On the other islands, the areas affected by floods are generally quite extensive, but the demographic conditions outside Java are significantly different. The high population density in Java will leave more people exposed in the event of flooding, while in the outer islands there are still large tracts of undeveloped areas, especially along riverbanks that have not been developed into high-density residential settlements. In Java, the level of demand for residential land is high, and many people develop settlements on land along riversides and in flood-prone areas.

Population Exposed to Flooding Hazards

It is necessary to prepare for flood disasters to minimize the risk of damage and casualties. More than a quarter of the Indonesian population live in the areas that are categorized as being subject to medium- to high-level flooding hazards. About 63.7 million people or 26.8% of the total population must deal with annual risks of flooding hazards. Based on the results of the overlay of the flood hazards map and data from the 2010 Population Census data, the total population who live in high-level flooding hazard areas is 50.8 million people (21.3%). Some

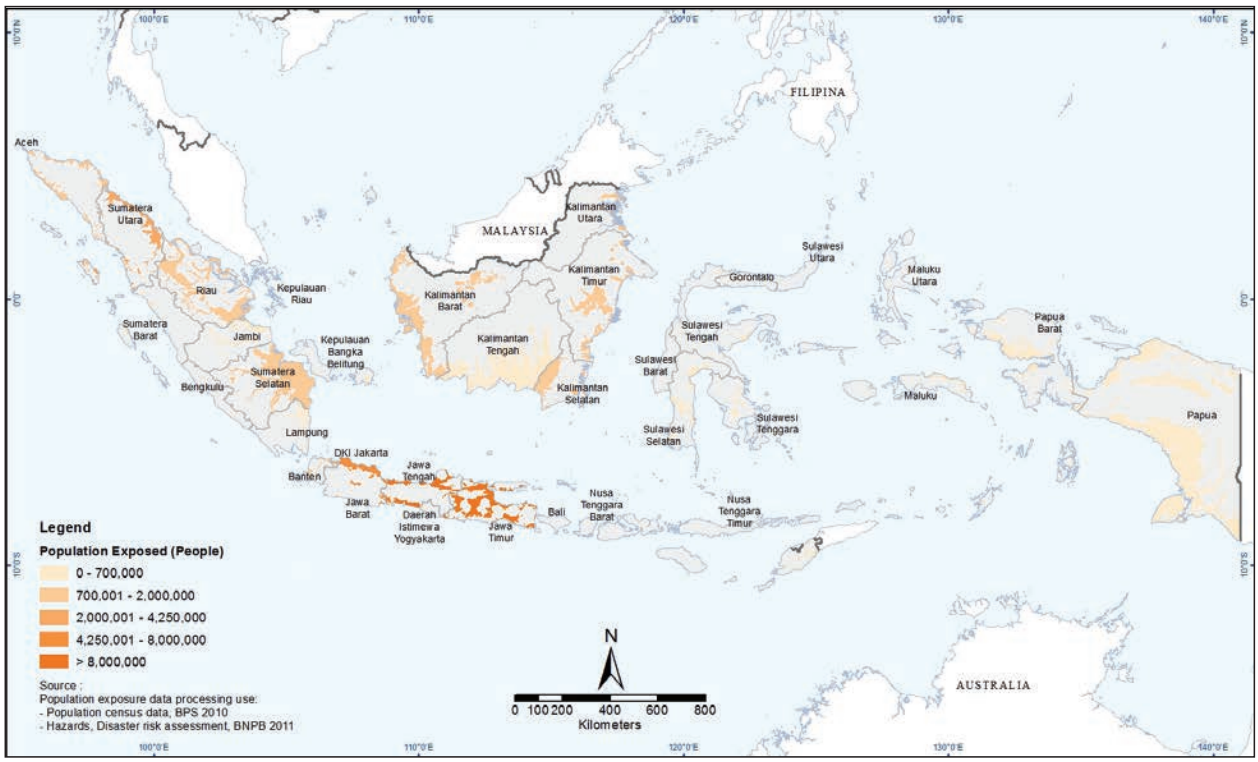


Figure 47. Map of Total Population Exposed to High-Level Flood Hazards

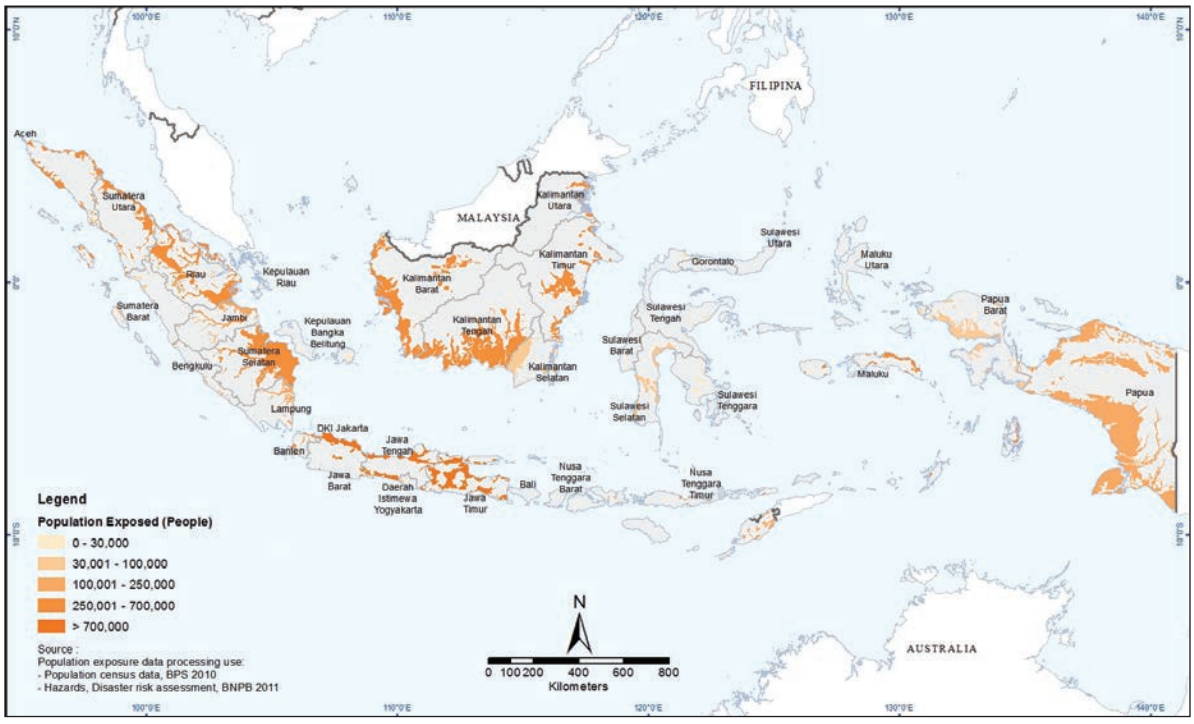


Figure 48. Map of Total Population Exposed to Medium-Level Flood Hazards

12.9 million people (5.44%) live in medium-level hazard areas. The distribution of the number of people exposed to the high-medium level flooding hazard is shown in Figure 47 - 48.

East Java has the highest total number of population exposed to high-level flooding hazards, with a total of 15 million people or 41% of the province's total population exposed. South Kalimantan has the second highest, with 1.9 million people or 53% of its population exposed, while other provinces that are also considered as having high exposure are Central Java (8 million people), West Java (6 million), and DKI Jakarta (4 million).

East Java also has the greatest total number of population exposed to the medium-level flooding hazards, with 2.9 million people at risk, followed by West Java (2.8 million), and Central Java (1.6 million). The exposure level is less than 10% of their respective total population but the numbers are significantly high. The percentage of population exposed to the medium-level flooding hazards is smaller than that of population exposed to the high-level, nevertheless, it is important that attention is given to these areas, particularly for densely populated areas in Java, Sumatera, and Maluku.

Figure 49 shows a graph of the level of exposure of people in vulnerable groups to high-level flooding hazards. The graph indicates that South Kalimantan has the highest level of vulnerable group exposure; people in the vulnerable groups make up 51% of the total number of population exposed in that province. Riau Islands and Bali are in the lowest position with no vulnerable groups exposed to high-level flooding hazards.

Figure 50 shows the graph of the level of exposure of people in vulnerable groups to the medium-level of flooding hazards. The graph shows that Maluku province has the highest level of vulnerable groups exposure; people in the vulnerable groups make

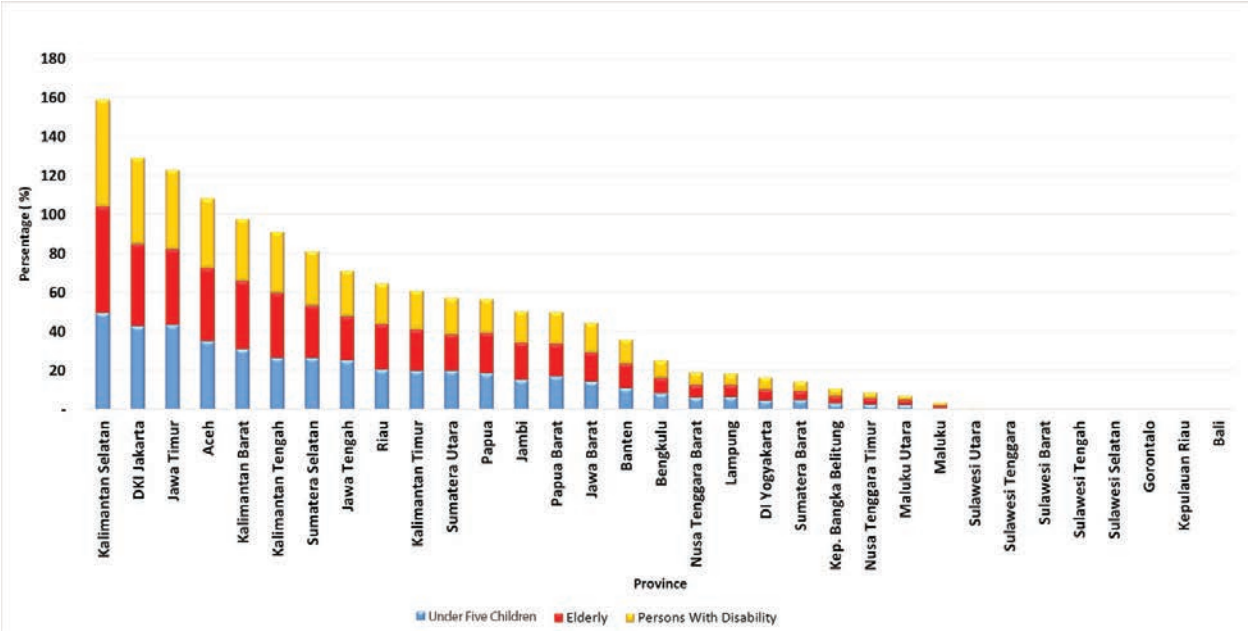


Figure 49. The Ratio of People in Vulnerable Groups Exposed to High-Level Flood Hazards

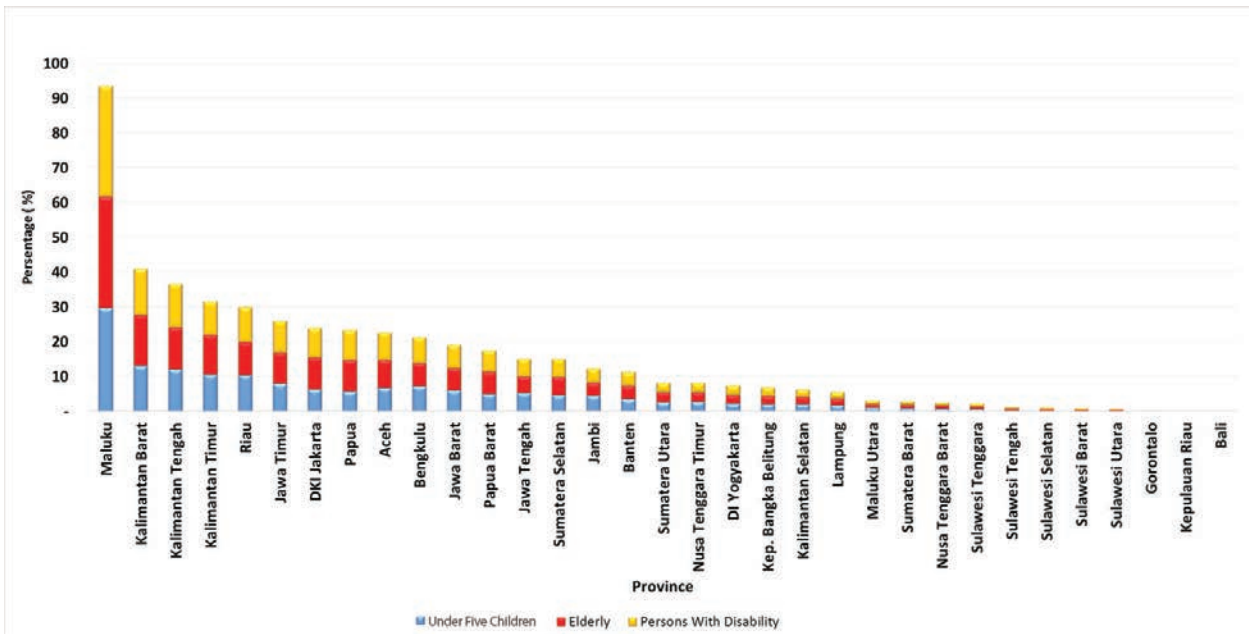


Figure 50. The Ratio of People in Vulnerable Groups Exposed to Medium-Level Flood Hazards

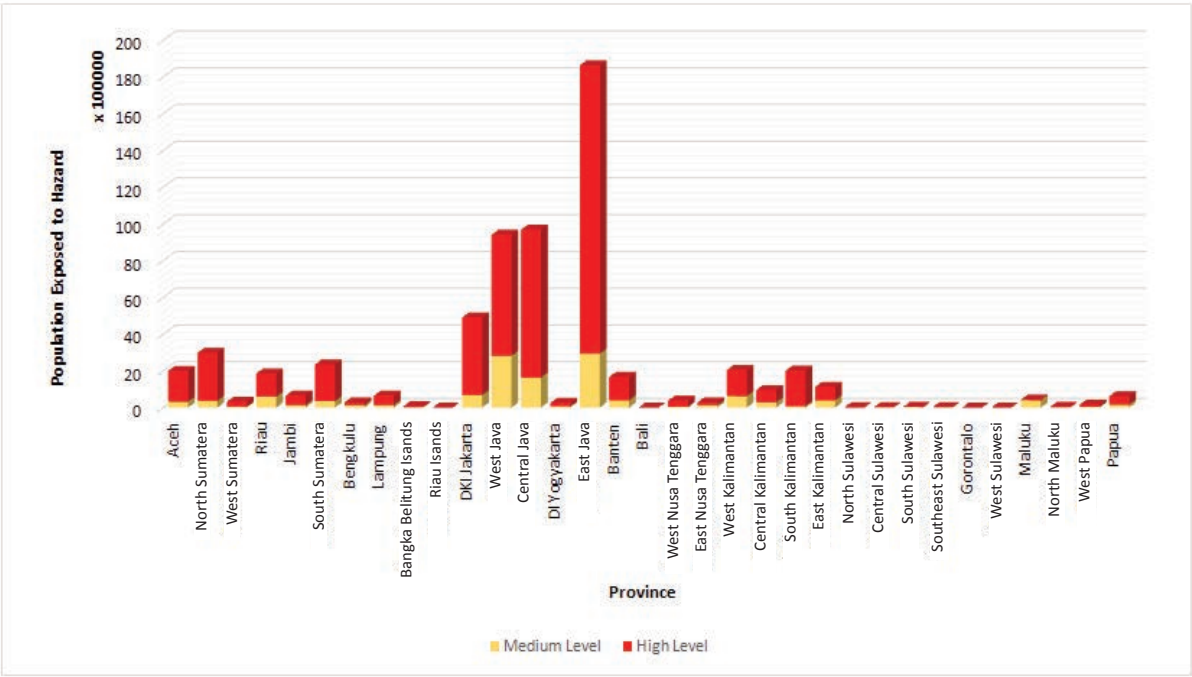


Figure 51. The Ratio of Total Population Exposed to High- and Medium-Level Flood Hazards

up 30% of the total number of people exposed in that province. Again, Riau Islands and Bali have no vulnerable groups exposed to the medium-level of flooding hazards.

Figure 51 shows that a large proportion of the population in East Java is exposed in areas of high-level flood hazards. The significant number of people living in urban settlements located on the dangerous flood-plain areas along the Solo River causes heavy burdens on the capacities of local communities and authorities to responds to emergencies. Almost every year, problems occur from flooding of the Solo River in towns like Ngawi, Cepu, Bojonegoro and Lamongan, all of which are located in high-level flood hazard areas. In terms of population distribution in those high-level flood hazard areas, around 9 million more people are exposed in East Java than in the three subsequent provinces (Central Java, West Java, and DKI Jakarta).

A teenager riding the a door to escape from a flooding in Jakarta, January, 2012. Source: BNPB

11.1 Million people **4.7%**

EXPOSED TO HIGH & MEDIUM LEVEL
EXTREME WAVES & ABRASION
HAZARDS

3.2 Million people

Exposed to High Level Extreme Waves and Abrasion Hazards

7.9 Million people

Exposed to Medium Level Extreme Waves and Abrasion Hazards

1.6 Million people

1.6 Million people

4.0 Million people

3.9 Million people

VULNERABLE GROUPS

309.6 Thousand people — **High Hazard** Under 5 Children

755.7 Thousand people — **Medium Hazard** Under 5 Children

21.9 Thousand people — **High Hazard** People With Disabilities

53.7 Thousand people — **Medium Hazard** People With Disabilities

214.1 Thousand people — **High Hazard** Elderly (60+ years)

572.5 Thousand people — **Medium Hazard** Elderly (60+ years)

* Source: 2010 Population Census, BPS

Figure 52. Infographics on Population Exposed to Extreme Waves and Abrasion Hazards

Debris from foundations of homes destroyed by coastal erosion, Polewali Mandar District, January 2014.
Source: BPBD Polewali Mandar.

Extreme waves and Abrasion Hazards

Extreme waves and abrasion are related hazards. Similar indicators have become benchmarks of the two hazards, such as wave height, currents, land cover or coastal vegetation, and the shape of the coastline. These indicators are used in the development of extreme waves and abrasion indices in the Regulations of the Head of BNPB No. 2 of 2012. As both disasters have these indicators in common, extreme waves and abrasion are incorporated into one hazard category in this study.

The extreme waves hazard results from ocean waves that naturally occur in coastal areas. The ocean waves can be due to two factors, namely internal and external. The internal factors refer to the difference in density of seawater, horizontal pressure gradient, and friction of water layers. The external factors include differences in air and wind pressures. However, many other external factors, such as the climate change, affect ocean waves and trigger them to become extreme.

Today, adaptation to climate change is a discussion being held at the global level. The climatic conditions of a country could be triggered by the climatic conditions in other parts of the world. Indonesia has not escaped from the impact of climate change, as seen in changes to rainfall patterns, average temperatures, and sea level changes.

Regulation of Head of BNPB No. 2 of 2012 states that the wave heights of 2.5 meters and above are categorized as high-level hazards, while the wave heights between 1 and 2.5 meters are moderate. The following table sets out indicators of low-, high- and medium-level extreme waves and abrasion hazards.
Table 12. Components of Extreme Waves and Abrasion Hazards Map

The calculation of the extreme waves and abrasion hazards classes are derived from the analysis of the wave height, ocean currents, coastal vegetation cover, and the shape of the coastline. The wave height and ocean currents components are available from the

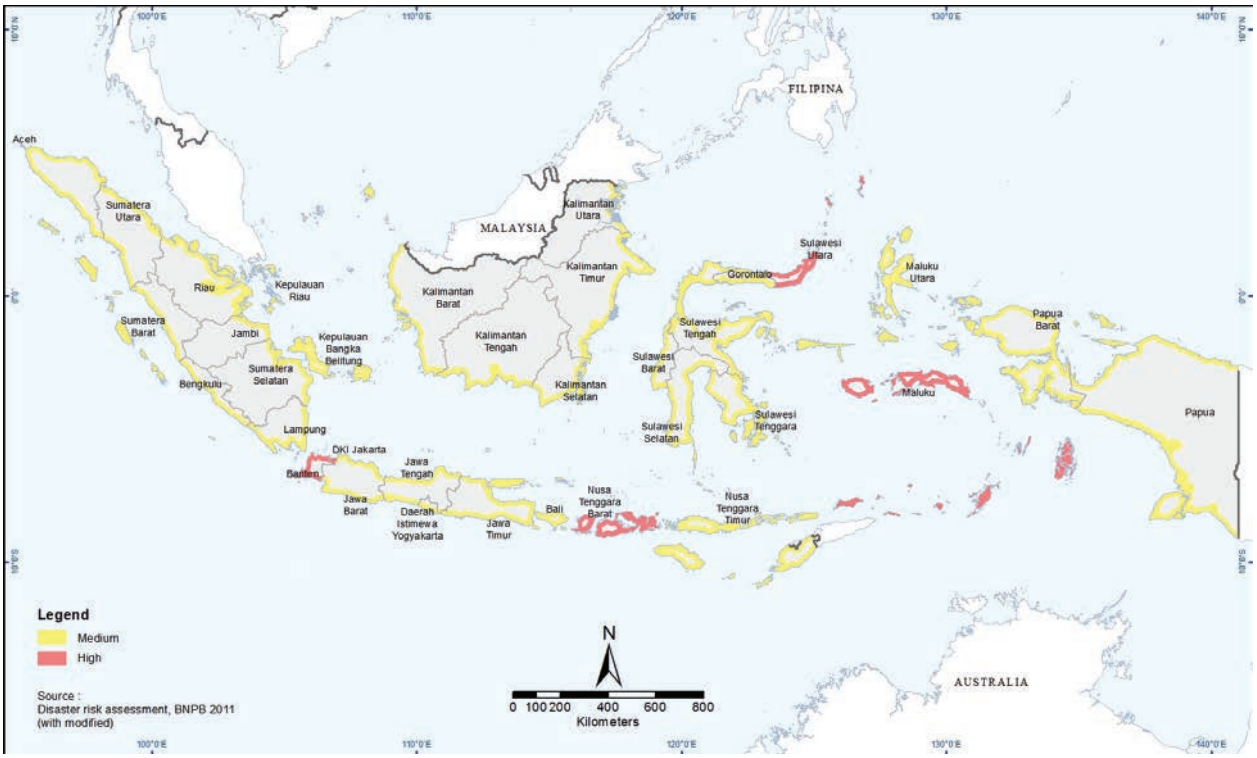


Figure 53. Map of High and Medium-Level Extreme Waves and Abrasion Hazards

BMKG and the Office of Hydrology and Oceanography (Dishidros), while vegetation cover is obtained from the Ministry of Forestry, and the shape of the coastline is taken from the Geospatial Information Agency (BIG).

Meanwhile, extreme weather and climate phenomena such as El Nino and La Lina can also trigger changes in ocean wave conditions. El Nino and La Lina are symptoms of irregularities on the

Table 12. Components of Extreme Waves and Abrasion Hazard Map

DISASTER	COMPONENT/ INDICATOR	INDEX CLASSES			TOTAL WEIGHT	REFERENCES
		LOW	MEDIUM	HIGH		
Extreme Waves and Abrasion	1. Waves Hight	< 1 m	1 m – 2,5 m	> 2,5 m	30%	Guidelines from BMKG, and Dishidros
	2. Ocean Currents	< 0,2 m	0,2 m – 0,4 m	> 0,4 m	30%	Guidelines from BMKG
	3. Land cover/ coastal vegetation	> 80%	40% - 80%	< 40%	15%	Guidelines from Ministry of Forestry
	4. Coastline shape	Bay	Straight with indentation	Straight	15%	Guidelines from BIG

surface temperature of the Pacific Ocean on the West coast of Ecuador and Peru that is higher or lower than the normal average. The phenomena may cause the levels of precipitation and sea surface temperature to impact the sea level. El Nino typically takes place at the end of the rainy season and in the middle of the dry season, that is, in May, June, and July. On the other hand, extreme waves in Indonesia occur during the period of July to September, which is the East monsoon peak.

Peopulation Exposed to the Extreme Waves and Abrasion Hazards

The Indonesia, coastal areas have high levels of settlement. We can take the examples of coastal communities on all major islands of Sumatra, Java, Kalimantan, Sulawesi and Papua. There are many reasons why people live near the coast, including job opportunities, natural resources, culture, and economy. Because of the economic benefits that accrue from access to ocean navigation, human settlements are often more concentrated in the coastal zone. As population density and economic activity in the coastal zone increases, pressures on coastal ecosystems increase. Coastal communities are often negatively affected by extreme waves and abrasion. It is important to recognize that a high population concentration in the low-elevation coastal zone increases coastal residents' vulnerability to coastal hazards.

As an archipelago, Indonesia has a population exposed to extreme waves and abrasion of various classes. Over 3 million people (1.35% of the population) are exposed to high-level extreme waves and abrasion hazards, and about 8 million people (3.34%) are exposed to medium-level hazards.

It is again emphasized that the vulnerable groups consisting of the elderly (over 60 years of age),

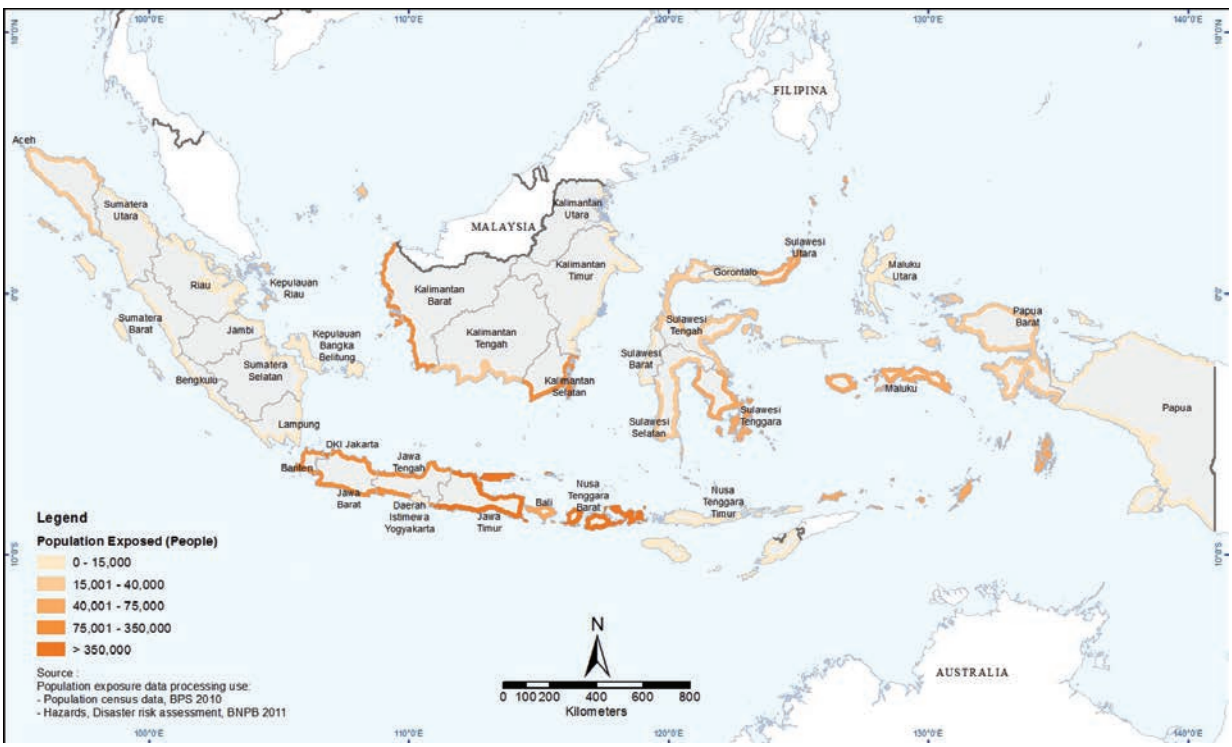


Figure 54. Map of Total Population Exposed to High-Level Extreme Waves and Abrasion Hazards

under five children and persons with disabilities should be included in all stages of disaster management to guarantee equal access to disaster response and relief. On a national scale the number of people in vulnerable groups exposed to high-level extreme waves and abrasion hazards amount to 523,000 people consisting of 309,000 under five children, 214,000 elderly people, and 21,000 persons with disabilities. The total number exposed to medium-level hazards is 1.3 million, being 755,000 under five children, 572,000 elderly people, and 53,000 people with disabilities. The total number of people in vulnerable groups exposed to extreme waves and abrasion amount to 1.9 million or 4.5% of the total population exposed to these disasters. In terms of population density, the provinces in Java except Yogyakarta have a large numbers of population exposed to the high-level extreme waves and abrasion hazards, while West Kalimantan and West Nusa Tenggara are the two provinces in the outer islands that are have high numbers of people exposed to hazards in this class (Figure 54). For the exposure to the medium-level hazards, East Java, Central Java, West Java, East Kalimantan, Bali, Riau Islands and Aceh are included in this category. The figure also shows that large numbers of people live near coastal areas.

As illustrated in Figure 58, West Nusa Tenggara province has the highest number of people in vulnerable groups (young children, the elderly, and persons with disability) exposed to the high-level extreme waves and abrasion, at around 40%. Other provinces with relatively high percentage of people in vulnerable groups exposed to the hazards are West Kalimantan (25%) and DKI Jakarta (22%). The percentage of people in vulnerable groups exposed to the medium-level extreme waves and abrasion in Riau Islands come to about 78%, East Kalimantan 52%, and Bali 42%.

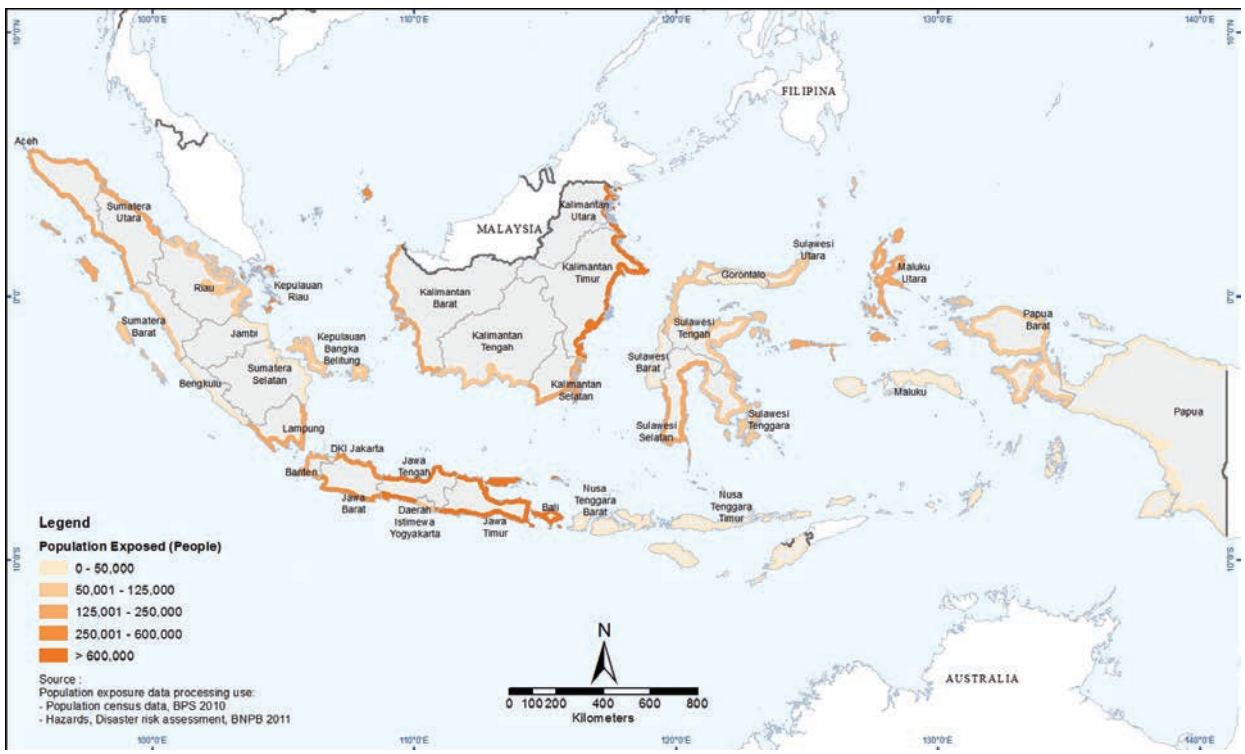


Figure 55. Map of Total Population Exposed to Medium-Level Extreme Waves and Abrasion Hazards

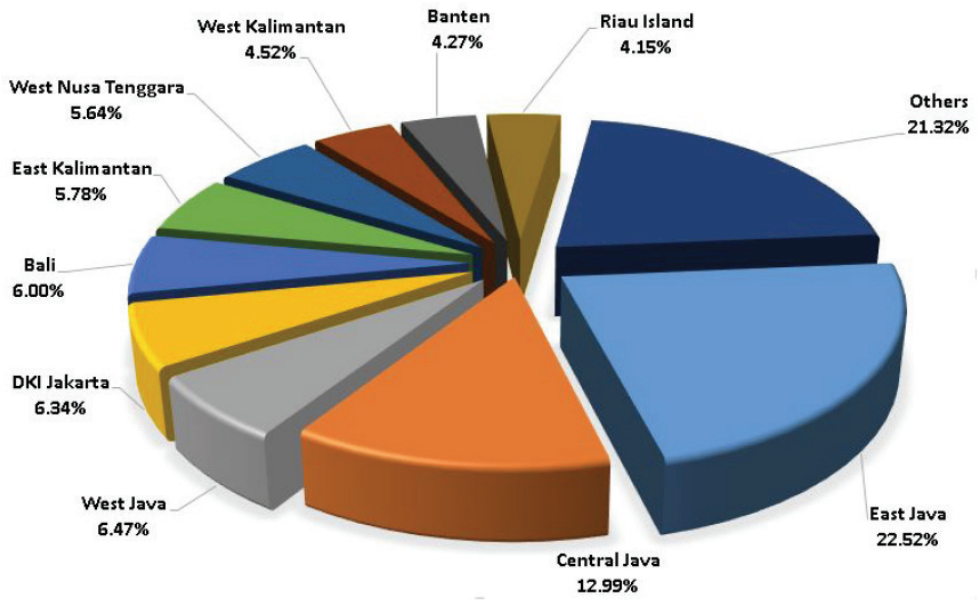


Figure 56. Percentage of Population Exposed to High- and Medium-Level Extreme Waves and Abrasion Hazards

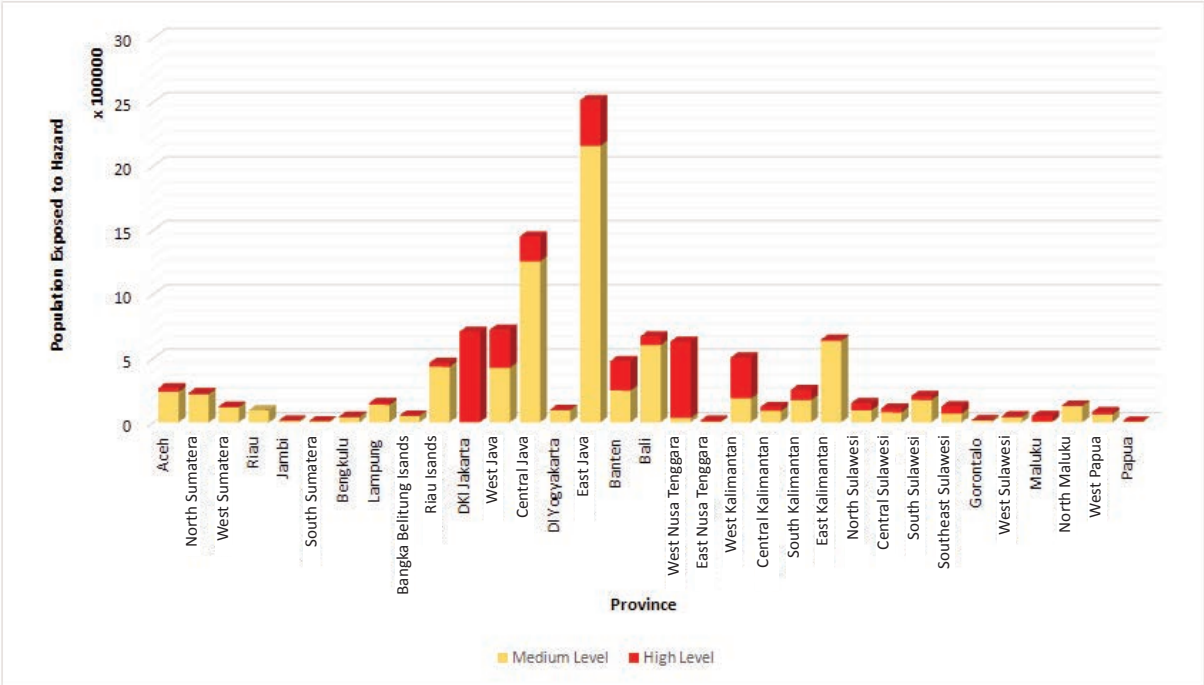


Figure 57. Ratio of Total Population Exposed to High- and Medium-Level Extreme Waves and Abrasion Hazards

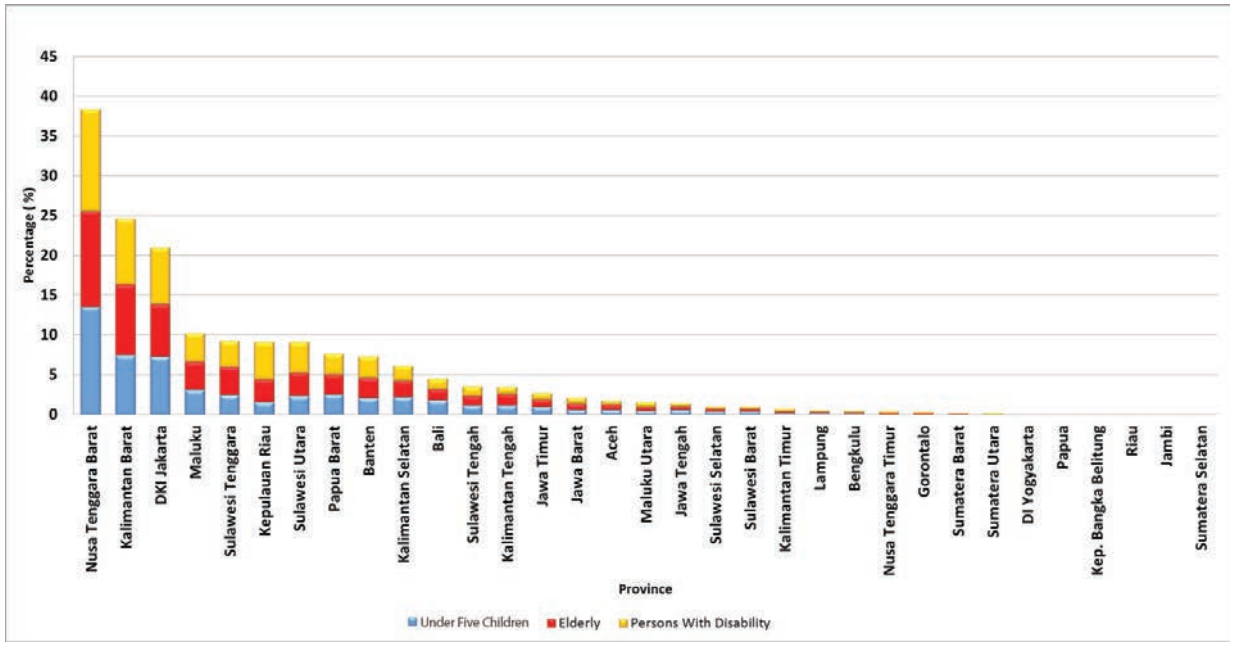


Figure 58. Ratio of People in Vulnerable Groups Exposed to High Class Extreme Waves And Abrasion Hazards

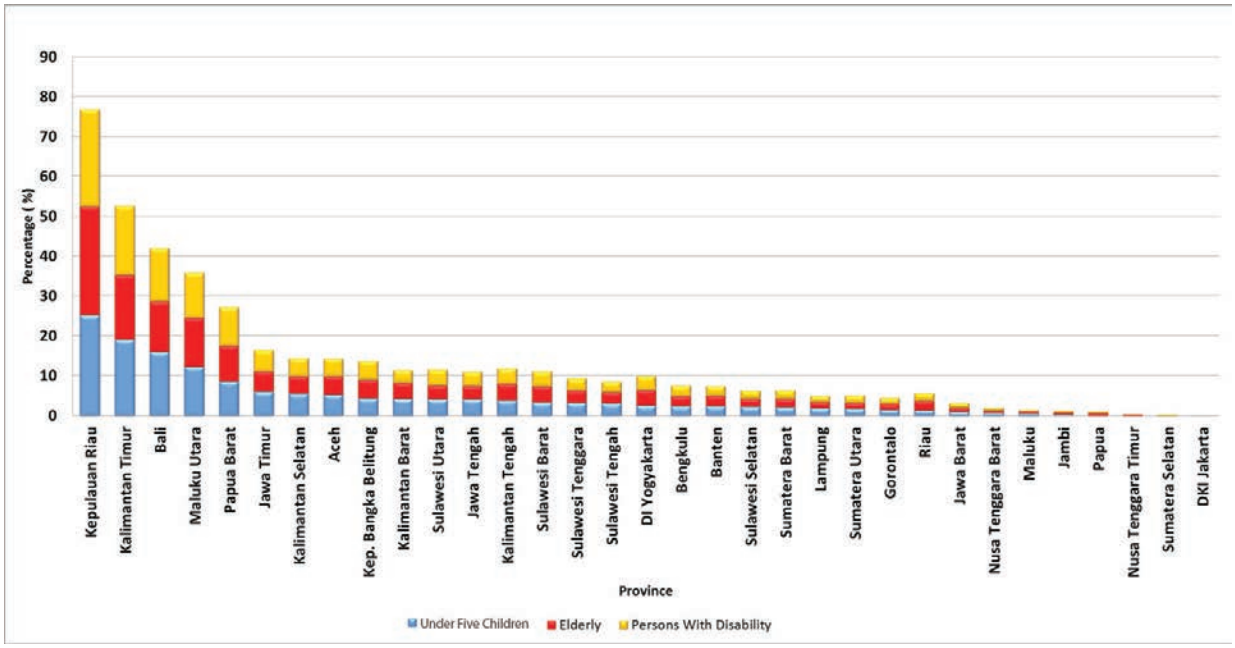


Figure 59. Ratio of People in Vulnerable Groups Exposed to Medium-Level Extreme Waves And Abrasion Hazards

Based on Indonesian Disaster Data and Information (DIBI) data, the extreme waves and abrasion hazards tended to escalate during the last ten years. From 2003 to 2013, the largest number of extreme wave and abrasion disasters was in 2009 when there were 46 events, but the most severe impact on the population exposed occurred in 2007. In 2013 the largest number of population exposed to the disasters was in DKI Jakarta. The exposure parameters refer to, among others, the number of deaths, injuries, and people evacuated. Table 12 and 13 show the number of occurrences and impacts from the extreme wave and abrasion disasters during 2003-2013 by province.

Housing severely damaged toby extreme waves and coastal erosion in Polewali Mandar District, January 2014. Source: BPBD Polewali Mandar.

The DIBI data show that during the this 10-year period, East Nusa Tenggara underwent the highest number of extreme wave and abrasion disasters with 33 occurrences, followed by Aceh (25) and East Nusa Tenggara (20). However, in terms of the number of people suffered from the disasters, Jakarta ranked the highest; more than 17,000 people went through affected and over 4,000 and evacuated. Based on the exposure assessment, Jakarta is considered as one of the provinces with a high-level population exposure to disasters.

Table 13. Extreme Waves and Abrasion Disasters Occurences, 2003-2013

Year	Occurence	Death	Injured	Missing	Victims	Suffering	Displaced	Evacuated
2003	6	0	0	0	0	0	0	217
2004	8	0	0	0	0	43	0	1,045
2005	6	0	0	0	0	675	0	573
2006	14	0	19	0	0	0	0	9,114
2007	30	4	174	0	0	17,835	0	10,275
2008	34	9	6	2	0	2,841	0	3,039
2009	46	2	2	0	0	4,144	0	809
2010	12	0	3	12	0	324	0	267
2011	17	4	2	32	0	0	0	1,165
2012	29	1	11	0	0	8,418	0	773
2013	36	5	3	2	0	204	0	1,267
TOTAL	238	25	220	48	0	34,484	0	28,544

Table 14. Extreme Waves and Abrasion Disasters Occurences by Province, 2003-2013

Province	Occurence	Death	Injured	Missing	Victim	Suffering	Displaced	Evacuated
Aceh	25	2	2	0	0	108	0	567
North Sumatera	4	0	0	1	0	0	0	60
West Sumatera	17	1	3	0	0	675	0	4,504
Bengkulu	2	1	0	0	0	0	0	0
Lampung	5	1	0	0	0	0	0	0
Riau Islands	1	1	3	0	0	0	0	0
Dkl Jakarta	8	0	167	0	0	17,923	0	4,300
West Jawa	9	4	4	0	0	1,785	0	646
Central Jawa	15	5	0	33	0	0	0	150
DI Yogyakarta	6	0	0	0	0	0	0	0
East Jawa	9	3	0	1	0	34	0	0
Banten	2	0	0	0	0	0	0	1,400
Bali	13	0	0	0	0	2,205	0	13
West Nusa Tenggara	16	0	1	0	0	0	0	4,341
East Nusa Tenggara	33	5	0	2	0	3,144	0	601
West Kalimantan	1	0	18	0	0	0	0	0
South Kalimantan	6	1	11	0	0	8,110	0	563
East Kalimantan	5	0	0	0	0	0	0	302
North Sulawesi	10	0	1	0	0	250	0	1,206
Central Sulawesi	6	0	0	0	0	0	0	225
South Sulawesi	3	0	0	0	0	0	0	0
Southeast Sulawesi	20	0	2	11	0	250	0	0
Gorontalo	1	0	0	0	0	0	0	0
West Sulawesi	4	0	6	0	0	0	0	447
Maluku	10	0	1	0	0	0	0	4,391
North Maluku	1	1	1	0	0	0	0	60
West Papua	1	0	0	0	0	0	0	14
Papua	5	0	0	0	0	0	0	4,754
TOTAL	238	25	220	48	0	34,484	0	28,544

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PART 6

Conclusion

This book presents an analysis of the population exposed to risks of geological and hydro-meteorological disasters in Indonesia. Many factors cause geological and hydro-meteorological hazards and preparing for these disasters needs to be given serious attention and priority, given the ever-increasing frequency of occurrences. The Indonesia Disaster Risk Index (IRBI) developed in 2013 identified areas prone to disasters in the high, medium, and low-level categories.

This study examined the areas and the number of people in those areas exposed to natural disaster hazards. People who choose to stay in a particular area that is at risk of being affected by these hazards should be aware of those risks and be capable of adapting to any potential hazards that might occur. They need to make judgements about local conditions the region and how it adapts to any potential threat of danger. Risk factors not only include exposure but also vulnerability and capacity to respond to hazards. People who are exposed directly must understand those risks but should also consider their ability to adapt and response to face the threat of danger should these natural disasters occur.

When the risks are identified, it is necessary to pass this information on. This is an ongoing responsibility. This study may help to always transmit information regarding exposure and risk. In addition, the efforts of mainstreaming DRR are very important in every part of development policy both at the national and local levels. This publication provides analysis which can be used for evidence-based development policy making at all levels. In the "Reducing Vulnerability and Exposure to Disasters: Asia-Pacific Disaster Report 2012" the UNISDR states that the population exposure is a consequence of public policy and investments in development planning. Poor planning and weak enforcement of zoning and building regulations will exacerbate risk conditions.

Studies in this publication are helpful for making and reviewing risk-sensitive policy on issues such as land use, urban planning and spatial order to ensure that the principle of DRR-oriented development can be realized. The Government and relevant agencies at all levels can use the study and analysis in this book to support the planning of various DRR programmes and planning policy. These programmes eventually can be prioritized in the areas that have a large numbers of people and vulnerable groups exposed to disasters for more effective responses.

Flood victims in Teluk Jambe, East Karawang, January 2014.
Source: BNPB.

PART 7

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PART 8

Apendix

Apendix 1. Total population Exposed to Medium and High Classes Earthquake Hazards

No	Province	Population Exposure Hazard Class						Total	% Exposed
		High			Moderate				
		Male	Female	Total High	Male	Female	Total Moderate		
1	Aceh	51,824	49,876	101,700	2,198,672	2,197,675	4,396,347	4,498,047	100.00%
2	North Sumatera	833,502	859,503	1,693,005	5,245,796	5,242,505	10,488,302	12,181,307	93.83%
3	West Sumatera	619,134	639,414	1,258,547	1,766,406	1,783,515	3,549,921	4,808,469	99.21%
4	Riau	-	-	-	789,917	741,581	1,531,499	1,531,499	27.65%
5	Jambi	95,508	96,165	191,673	503,822	482,642	986,464	1,178,137	38.10%
6	South Sumatera	51,801	47,212	99,013	991,770	944,034	1,935,804	2,034,817	27.31%
7	Bengkulu	186,511	180,295	366,807	640,973	609,177	1,250,151	1,616,957	94.25%
8	Lampung	75,589	67,352	142,941	2,219,520	2,098,698	4,318,219	4,461,159	58.63%
9	Bangka Belitung Islands	-	-	-	-	-	-	-	0.00%
10	Riau Islands	-	-	-	-	-	-	-	0.00%
11	DKI Jakarta	-	-	-	25,997	25,009	51,006	51,006	0.53%
12	West Java	-	-	-	16,766,467	16,248,608	33,015,075	33,015,075	76.68%
13	Central Java	-	-	-	12,014,673	12,199,459	24,214,132	24,214,132	74.78%
14	DI Yogyakarta	-	-	-	1,697,074	1,736,138	3,433,212	3,433,212	99.30%
15	East Java	-	-	-	11,175,083	11,375,793	22,550,876	22,550,876	60.17%
16	Banten	-	-	-	5,340,086	5,098,812	10,438,898	10,438,898	98.18%
17	Bali	-	-	-	1,931,491	1,900,884	3,832,375	3,832,375	98.50%
18	West Nusa Tenggara	-	-	-	-	-	-	-	0.00%
19	East Nusa Tenggara	7,231	7,358	14,589	2,034,511	2,053,513	4,088,024	4,102,614	87.59%
20	West Kalimantan	-	-	-	-	-	-	-	0.00%
21	Central Kalimantan	-	-	-	-	-	-	-	0.00%
22	South Kalimantan	-	-	-	-	-	-	-	0.00%
23	East Kalimantan	-	-	-	4,361	3,914	8,275	8,275	0.23%
24	North Sulawesi Utara	29,929	28,653	58,583	1,076,054	1,030,366	2,106,420	2,165,003	95.35%
25	Central Sulawesi	362,185	348,426	710,611	932,318	882,710	1,815,028	2,525,640	95.85%
26	South Sulawesi	56,836	54,026	110,862	981,492	1,030,406	2,011,898	2,122,760	26.42%
27	Southeast Sulawesi	16,620	15,058	31,678	193,849	185,253	379,101	410,779	18.40%
28	Gorontalo	1,149	1,122	2,271	479,873	476,277	956,150	958,421	92.14%
29	West Sulawesi	217,058	229,015	446,073	349,047	334,649	683,696	1,129,769	97.51%
30	Maluku	154,016	154,130	308,146	471,556	459,732	931,288	1,239,434	80.82%
31	Maluku Utara	38,431	36,204	74,635	464,578	443,046	907,624	982,259	94.62%
32	West Papua	112,636	102,494	215,130	185,901	164,556	350,458	565,587	74.38%
33	Papua	431,280	376,294	807,574	860,864	761,572	1,622,436	2,430,010	85.76%
	Total	3,341,240	3,292,597	6,633,838	71,342,151	70,510,524	141,852,679	148,486,517	62.40%

Apendix 2. Total vulnerable groups Exposed to Medium and High Classes Earthquake Hazards

No	Province	Population Vulnerable Groups Hazard Class									% Exposed
		High				Moderate				Total	
		Under Five Children	Elderly	Disability	Total High	Under Five Children	Elderly	Disability	Total Moderate		
1	Aceh	12,370	5,362	807	18,539	481,752	258,383	38,543	778,679	797,218	17.74%
2	North Sumatera	212,556	98,521	14,201	325,278	1,142,720	623,384	66,988	1,833,092	2,158,370	16.63%
3	West Sumatera	131,911	108,988	12,751	253,650	367,939	279,457	35,643	683,039	936,689	19.33%
4	Riau	-	-	-	-	189,646	61,456	9,176	260,279	260,279	4.70%
5	Jambi	17,376	16,065	2,019	35,460	105,089	54,730	6,921	166,740	202,200	6.54%
6	South Sumatera	10,627	6,595	609	17,830	198,507	123,850	13,191	335,548	353,378	4.74%
7	Bengkulu	35,695	23,789	2,646	62,129	130,103	72,240	9,535	211,879	274,008	15.97%
8	Lampung	14,523	9,296	978	24,797	420,531	302,008	28,783	751,322	776,119	10.20%
9	Bangka Belitung Islands	-	-	-	-	-	-	-	-	-	0.00%
10	Riau Islands	-	-	-	-	-	-	-	-	-	0.00%
11	DKI Jakarta	-	-	-	-	4,844	2,079	203	7,126	7,126	0.07%
12	West Java	-	-	-	-	3,185,585	2,335,577	209,288	5,730,449	5,730,449	13.31%
13	Central Java	-	-	-	-	2,020,237	2,588,021	190,500	4,798,758	4,798,758	14.82%
14	DI Yogyakarta	-	-	-	-	255,140	444,207	35,431	734,778	734,778	21.25%
15	East Java	-	-	-	-	1,756,876	2,575,238	193,044	4,525,158	4,525,158	12.07%
16	Banten	-	-	-	-	1,031,836	479,674	47,802	1,559,312	1,559,312	14.67%
17	Bali	-	-	-	-	329,288	377,058	27,136	733,482	733,482	18.85%
18	West Nusa Tenggara	-	-	-	-	-	-	-	-	-	0.00%
19	East Nusa Tenggara	1,775	1,008	154	2,937	519,865	303,107	43,099	866,071	869,008	18.55%
20	West Kalimantan	-	-	-	-	-	-	-	-	-	0.00%
21	Central Kalimantan	-	-	-	-	-	-	-	-	-	0.00%
22	South Kalimantan	-	-	-	-	-	-	-	-	-	0.00%
23	East Kalimantan	-	-	-	-	994	408	20	1,422	1,422	0.04%
24	North Sulawesi	5,356	5,212	761	11,329	187,748	176,213	20,552	384,513	395,842	17.43%
25	Central Sulawesi	74,150	36,694	4,802	115,645	202,981	109,241	15,048	327,269	442,915	16.81%
26	South Sulawesi	14,196	7,655	926	22,777	196,118	195,781	22,021	413,920	436,697	5.44%
27	Southeast Sulawesi	4,160	1,458	190	5,808	45,794	20,197	2,572	68,564	74,372	3.33%
28	Gorontalo	233	159	17	408	98,019	57,146	9,726	164,891	165,299	15.89%
29	West Sulawesi	51,739	34,820	4,317	90,876	82,989	37,682	4,903	125,573	216,449	18.68%
30	Maluku	33,015	19,700	1,945	54,661	118,170	57,795	5,602	181,567	236,228	15.40%
31	North Maluku	9,523	3,832	267	13,622	111,123	43,131	5,299	159,554	173,176	16.68%
32	West Papua	25,515	6,933	830	33,278	42,856	10,960	970	54,785	88,063	11.58%
33	Papua	85,652	12,134	1,214	99,001	172,093	30,672	3,776	206,541	305,542	10.78%
	Total	740,372	398,221	49,434	1,188,025	13,398,843	11,619,695	1,045,772	26,064,311	27,252,337	64.00%

Apendix 3. Total population Exposed to Medium and High Classes Tsunami Hazards

No	Province	Population Exposure Hazard Class						Total	% Exposed
		High			Moderate				
		Male	Female	Total High	Male	Female	Total Moderate		
1	Aceh	107,396	101,408	208,804	39,071	37,983	77,053	285,857	6.36%
2	North Sumatera	32,720	32,488	65,208	19,411	19,347	38,759	103,966	0.80%
3	West Sumatera	111,459	114,191	225,650	46,975	47,786	94,761	320,410	6.61%
4	Riau			-			-	-	0.00%
5	Jambi			-			-	-	0.00%
6	South Sumatera			-			-	-	0.00%
7	Bengkulu	24,595	23,370	47,965	27,645	26,740	54,385	102,351	5.97%
8	Lampung	7,599	7,064	14,663	19,802	18,881	38,684	53,347	0.70%
9	Bangka Belitung Islands			-			-	-	0.00%
10	Riau Islands			-			-	-	0.00%
11	DKI Jakarta			-			-	-	0.00%
12	West Java	46,382	46,352	92,734	21,833	21,930	43,763	136,497	0.32%
13	Central Java	435,237	429,847	865,084	79,576	79,172	158,749	1,023,832	3.16%
14	Yogyakarta	44,918	46,587	91,505	13,320	13,643	26,963	118,469	3.43%
15	East Java	82,966	85,448	168,414	41,211	42,585	83,796	252,210	0.67%
16	Banten	118,240	111,203	229,443	47,731	44,821	92,552	321,996	3.03%
17	Bali	85,024	81,061	166,084	31,351	29,773	61,124	227,209	5.84%
18	West Nusa Tenggara	46,478	47,863	94,341	18,311	18,735	37,046	131,387	2.92%
19	East Nusa Tenggara	5,057	5,294	10,351	13,678	13,972	27,650	38,001	0.81%
20	West Kalimantan			-			-	-	0.00%
21	Central Kalimantan	-	-	-			-	-	0.00%
22	South Kalimantan	-	-	-			-	-	0.00%
23	East Kalimantan	-	-	-			-	-	0.00%
24	North Sulawesi	8,410	8,071	16,481	5,774	5,756	11,530	28,011	1.23%
25	Central Sulawesi	8,560	8,121	16,681	6,116	6,043	12,159	28,840	1.09%
26	South Sulawesi	287,199	302,087	589,287	7,660	7,977	15,638	604,924	7.53%
27	Southeast Sulawesi	10,031	10,184	20,215	5,575	5,616	11,192	31,407	1.41%
28	Gorontalo	328	338	666	4,770	4,770	9,540	10,206	0.98%
29	West Sulawesi	16,856	17,080	33,937	8,067	7,904	15,971	49,908	4.31%
30	Maluku	70,364	68,607	138,972	34,270	33,942	68,212	207,184	13.51%
31	North Maluku	18,745	18,034	36,779	14,127	13,617	27,743	64,522	6.22%
32	West Papua	1,026	934	1,961	15,039	13,978	29,017	30,978	4.07%
33	Papua	3,894	3,459	7,353	15,032	14,157	29,189	36,542	1.29%
	Total	1,573,485	1,569,093	3,142,578	536,346	529,130	1,065,476	4,208,054	0.82%

Apendix 4. Total vulnerable groups Exposed to Medium and High Classes Tsunami Hazards

No	Province	Population Vulnerable Groups Hazard Class								Total	% Exposed
		High				Moderate					
		Under Five Children	Elderly	Disability	Total High	Under Five Children	Elderly	Disability	Total Moderate		
1	Aceh	29,564	12,296	1,453	43,314	10,612	5,380	678	16,670	59,984	1.33%
2	North Sumatera	10,183	3,942	632	14,758	4,403	1,715	282	6,401	21,159	0.16%
3	West Sumatera	24,584	18,941	2,270	45,796	11,005	8,080	1,038	20,123	65,919	1.36%
4	Riau	-	-	-	-	-	-	-	-	-	0.00%
5	Jambi	-	-	-	-	-	-	-	-	-	0.00%
6	South Sumatera	-	-	-	-	-	-	-	-	-	0.00%
7	Bengkulu	4,619	2,223	340	7,181	4,145	2,101	335	6,581	13,762	0.80%
8	Lampung	1,288	916	88	2,292	2,446	1,822	154	4,421	6,714	0.09%
9	Bangka Belitung Islands	-	-	-	-	-	-	-	-	-	0.00%
10	Riau Islands	-	-	-	-	-	-	-	-	-	0.00%
11	DKI Jakarta	-	-	-	-	-	-	-	-	-	0.00%
12	West Java	4,948	6,027	513	11,488	1,850	2,278	193	4,322	15,809	0.04%
13	Central Jawa	52,453	66,291	5,049	123,793	9,361	13,323	989	23,673	147,467	0.46%
14	DI Yogyakarta	4,460	9,680	828	14,968	818	1,770	150	2,738	17,705	0.51%
15	East Jawa	7,771	12,391	894	21,056	3,385	5,433	381	9,199	30,255	0.08%
16	Banten	19,238	11,237	1,067	31,542	7,526	4,189	412	12,127	43,668	0.41%
17	Bali	14,288	7,042	466	21,796	5,153	2,796	194	8,143	29,939	0.77%
18	West Nusa Tenggara	8,632	5,644	666	14,942	2,428	1,474	174	4,076	19,019	0.42%
19	East Nusa Tenggara	1,369	882	99	2,350	2,342	1,515	173	4,030	6,380	0.14%
20	West Kalimantan	-	-	-	-	-	-	-	-	-	0.00%
21	Central Kalimantan	-	-	-	-	3	1	0	4	4	0.00%
22	South Kalimantan	-	-	-	-	974	509	56	1,538	1,538	0.04%
23	East Kalimantan	-	-	-	-	3,546	1,326	169	5,041	5,041	0.14%
24	North Sulawesi	2,157	1,646	245	4,048	124	123	17	264	4,312	0.19%
25	Central Sulawesi	2,089	1,276	174	3,538	305	191	25	521	4,059	0.15%
26	South Sulawesi	69,955	48,782	5,703	124,441	2,024	1,491	212	3,727	128,168	1.60%
27	Southeast Sulawesi	3,239	1,472	200	4,912	313	176	25	513	5,425	0.24%
28	Gorontalo	285	150	29	464	-	-	-	-	464	0.04%
29	West Sulawesi	4,452	3,054	340	7,846	961	424	43	1,427	9,273	0.80%
30	Maluku	17,048	7,805	649	25,502	8,035	4,351	414	12,800	38,303	2.50%
31	North Maluku	5,993	2,200	242	8,435	4,649	1,896	231	6,776	15,212	1.47%
32	West Papua	528	122	13	663	4,798	1,195	125	6,118	6,780	0.89%
33	Papua	744	267	22	1,034	2,136	696	75	2,908	3,942	0.14%
	Total	289,887	224,286	21,982	536,159	93,342	64,255	6,545	164,141	700,301	1.60%

Apendix 5. Total population Exposed to Medium and High Classes Volcanic Eruption Hazards

No.	Province	Population Exposure Hazard Class						Total	% Exposed
		High			Moderate				
		Male	Female	Total High	Male	Female	Total Moderate		
1.	Aceh	7,818	6,986	14,804	21,527	20,058	41,585	56,389	1.25%
2.	Sumatera Utara	10,763	10,759	21,522	20,934	21,016	41,950	63,472	0.49%
3.	Sumatera Barat	35,929	37,983	73,912	82,399	85,449	167,848	241,760	4.99%
4.	Riau	-	-	-	-	-	-	-	0.00%
5.	Jambi	-	-	-	-	-	-	-	0.00%
6.	Sumatera Selatan	7,712	7,259	14,971	11,670	10,990	22,660	37,631	0.51%
7.	Bengkulu	6,112	5,713	11,825	16,525	15,570	32,095	43,920	2.56%
8.	Lampung	-	-	-	-	-	-	-	0.00%
9.	Kep. Bangka Belitung	-	-	-	-	-	-	-	0.00%
10.	Kepulauan Riau	-	-	-	-	-	-	-	0.00%
11.	DKI Jakarta	-	-	-	-	-	-	-	0.00%
12.	Jawa Barat	122,989	117,777	240,766	456,959	441,102	898,061	1,138,827	2.65%
13.	Jawa Tengah	65,879	64,703	130,582	195,908	192,174	388,082	518,664	1.60%
14.	DI Yogyakarta	33,921	34,676	68,597	50,353	51,536	101,889	170,486	4.93%
15.	Jawa Timur	120,117	121,291	241,408	304,661	307,560	612,221	853,629	2.28%
16.	Banten	-	-	-	-	-	-	-	0.00%
17.	Bali	15,801	15,399	31,200	80,274	78,994	159,268	190,468	4.90%
18.	Nusa Tenggara Barat	10,479	10,824	21,303	46,098	50,479	96,577	117,880	2.62%
19.	Nusa Tenggara Timur	39,574	45,365	84,939	70,580	78,745	149,325	234,264	5.00%
20.	Kalimantan Barat	-	-	-	-	-	-	-	0.00%
21.	Kalimantan Tengah	-	-	-	-	-	-	-	0.00%
22.	Kalimantan Selatan	-	-	-	-	-	-	-	0.00%
23.	Kalimantan Timur	-	-	-	-	-	-	-	0.00%
24.	Sulawesi Utara	36,117	35,461	71,578	83,503	80,643	164,146	235,724	10.38%
25.	Sulawesi Tengah	194	184	378	194	184	378	756	0.03%
26.	Sulawesi Selatan	-	-	-	-	-	-	-	0.00%
27.	Sulawesi Tenggara	-	-	-	-	-	-	-	0.00%
28.	Gorontalo	-	-	-	-	-	-	-	0.00%
29.	Sulawesi Barat	-	-	-	-	-	-	-	0.00%
30.	Maluku	1,802	1,773	3,575	2,288	2,248	4,536	8,111	0.53%
31.	Maluku Utara	12,500	12,055	24,555	29,522	28,306	57,828	82,383	7.94%
32.	Papua Barat	-	-	-	-	-	-	-	0.00%
33.	Papua	-	-	-	-	-	-	-	0.00%
	Total	527,707	528,208	1,055,915	1,473,395	1,465,054	2,938,449	3,994,364	1.68%

Apendix 6. Total vulnerable groups Exposed to Medium and High Classes Volcanic Eruption Hazards

No	Province	Population Vulnerable Groups Hazard Class								Total	% Exposed
		High				Moderate					
		Under Five Children	Elderly	Disability	Total High	Under Five Children	Elderly	Disability	Total Moderate		
1	Aceh	1,878	707	1,586	4,171	4,899	2,200	4,181	11,280	15,451	0.34%
2	Sumatera Utara	2,402	1,863	2,060	6,325	4,813	3,496	3,910	12,219	18,544	0.14%
3	Sumatera Barat	7,131	7,695	14,909	29,735	16,896	15,964	43,227	76,087	105,822	2.18%
4	Riau	-	-	-	-	-	-	-	-	-	0.00%
5	Jambi	-	-	-	-	-	-	-	-	-	0.00%
6	Sumatera Selatan	1,460	1,204	2,062	4,726	2,266	1,793	2,843	6,902	11,628	0.16%
7	Bengkulu	1,161	855	1,520	3,536	3,191	2,179	3,876	9,246	12,782	0.75%
8	Lampung	-	-	-	-	-	-	-	-	-	0.00%
9	Kep, Bangka Belitung	-	-	-	-	-	-	-	-	-	0.00%
10	Kepulauan Riau	-	-	-	-	-	-	-	-	-	0.00%
11	DKI Jakarta	-	-	-	-	-	-	-	-	-	0.00%
12	Jawa Barat	24,155	17,532	26,991	68,678	91,263	66,902	109,557	267,722	336,400	0.78%
13	Jawa Tengah	11,591	14,389	39,717	65,697	34,222	40,873	106,395	181,490	247,187	0.76%
14	DI Yogyakarta	5,474	9,436	13,447	28,357	8,126	14,129	18,317	40,572	68,929	1.99%
15	Jawa Timur	19,552	27,382	88,478	135,412	48,119	68,927	200,329	317,375	452,787	1.21%
16	Banten	-	-	-	-	-	-	-	-	-	0.00%
17	Bali	3,357	2,895	12,373	18,625	14,837	20,340	87,116	122,293	140,918	3.62%
18	Nusa Tenggara Barat	2,670	1,299	9,623	13,592	11,333	6,685	44,282	62,300	75,892	1.69%
19	Nusa Tenggara Timur	9,655	11,115	21,157	41,927	17,116	17,448	34,421	68,985	110,912	2.37%
20	Kalimantan Barat	-	-	-	-	-	-	-	-	-	0.00%
21	Kalimantan Tengah	-	-	-	-	-	-	-	-	-	0.00%
22	Kalimantan Selatan	-	-	-	-	-	-	-	-	-	0.00%
23	Kalimantan Timur	-	-	-	-	-	-	-	-	-	0.00%
24	Sulawesi Utara	5,778	7,451	2,539	15,768	13,605	15,591	8,924	38,120	53,888	2.37%
25	Sulawesi Tengah	36	15	5	56	36	15	5	56	112	0.00%
26	Sulawesi Selatan	-	-	-	-	-	-	-	-	-	0.00%
27	Sulawesi Tenggara	-	-	-	-	-	-	-	-	-	0.00%
28	Gorontalo	-	-	-	-	-	-	-	-	-	0.00%
29	Sulawesi Barat	-	-	-	-	-	-	-	-	-	0.00%
30	Maluku	448	262	362	1,072	606	328	421	1,355	2,427	0.16%
31	Maluku Utara	2,817	1,342	2,792	6,951	6,382	3,085	6,054	15,521	22,472	2.16%
32	Papua Barat	-	-	-	-	-	-	-	-	-	0.00%
33	Papua	-	-	-	-	-	-	-	-	-	0.00%
	Total	99,565	105,442	239,621	444,628	277,710	279,955	673,858	1,231,523	1,676,151	0.71%

Apendix 7. Total population Exposed to Medium and High Classes Flood Hazards

No	Province	Population Exposure Hazard Class						Total	% Exposed
		High			Moderate				
		Male	Female	Total High	Male	Female	Total Moderate		
1	Aceh	834,426	834,923	1,669,349	160,616	164,435	325,051	1,994,400	44.38%
2	North Sumatera	1,315,663	1,289,631	2,605,294	186,076	184,590	370,666	2,975,960	22.92%
3	West Sumatera	131,167	131,784	262,951	25,232	25,248	50,480	313,432	6.47%
4	Riau	650,052	616,447	1,266,499	303,066	283,464	586,530	1,853,029	33.46%
5	Jambi	260,379	251,081	511,460	71,155	67,552	138,707	650,167	21.03%
6	South Sumatera	1,010,420	981,664	1,992,084	181,301	174,829	356,131	2,348,214	31.52%
7	Bengkulu	75,146	72,826	147,971	65,976	65,287	131,263	279,235	16.28%
8	Lampung	260,473	242,484	502,957	74,529	69,713	144,242	647,199	8.51%
9	Bangka Belitung Islands	21,513	19,921	41,434	14,164	13,063	27,227	68,662	5.61%
10	Riau Islands	-	-	-	-	-	-	-	0.00%
11	DKI Jakarta	2,139,318	2,082,651	4,221,969	345,203	340,413	685,616	4,907,584	51.08%
12	West Java	3,369,713	3,218,395	6,588,108	1,438,016	1,379,082	2,817,098	9,405,206	21.85%
13	Central Java	4,001,431	4,042,400	8,043,832	818,258	818,300	1,636,558	9,680,389	29.89%
14	DI Yogyakarta	82,130	84,736	166,865	40,829	41,901	82,730	249,596	7.22%
15	East Java	7,762,466	7,936,961	15,699,428	1,453,279	1,477,649	2,930,928	18,630,356	49.71%
16	Banten	649,232	615,783	1,265,015	204,979	193,734	398,713	1,663,728	15.65%
17	Bali	-	-	-	-	-	-	-	0.00%
18	West Nusa Tenggara	160,258	164,302	324,560	22,113	22,671	44,784	369,343	8.21%
19	East Nusa Tenggara	70,086	72,091	142,177	67,210	67,538	134,749	276,926	5.91%
20	West Kalimantan	715,634	704,777	1,420,411	314,610	306,569	621,179	2,041,590	46.44%
21	Central Kalimantan	339,099	324,993	664,092	148,703	137,175	285,878	949,970	42.94%
22	South Kalimantan	963,622	959,534	1,923,156	41,422	39,725	81,147	2,004,303	55.27%
23	East Kalimantan	381,066	346,997	728,063	204,629	187,456	392,085	1,120,148	31.53%
24	North Sulawesi	2,778	2,630	5,408	3,278	3,102	6,380	11,788	0.52%
25	Central Sulawesi	1,363	1,309	2,671	7,233	6,938	14,170	16,841	0.64%
26	South Sulawesi	1,500	1,613	3,113	15,024	16,025	31,049	34,162	0.43%
27	Southeast Sulawesi	1,608	1,598	3,207	8,628	8,486	17,114	20,321	0.91%
28	Gorontalo	65	63	128	343	331	674	802	0.08%
29	West Sulawesi	636	697	1,333	2,039	2,101	4,140	5,473	0.47%
30	Maluku	9,048	8,839	17,888	203,976	200,441	404,418	422,305	27.54%
31	North Maluku	14,439	13,530	27,969	6,221	5,796	12,018	39,986	3.85%
32	West Papua	64,448	57,454	121,902	21,384	18,848	40,233	162,135	21.32%
33	Papua	241,136	212,911	454,047	84,344	75,290	159,634	613,680	21.66%
	Total	25,530,315	25,295,025	50,825,341	6,533,836	6,397,752	12,931,592	63,756,930	26.80%

Apendix 8. Total vulnerable groups Exposed to Medium and High Classes Flood Hazards

No	Province	Population Vulnerable Groups Hazard Class								Total	% Exposed
		High				Moderate					
		Under Five Children	Elderly	Disability	Total HIgh	Under Five Children	Elderly	Disability	Total Moderate		
1	Aceh	178,175	99,029	14,123	291,327	34,859	21,134	3,155	59,148	350,475	7.80%
2	North Sumatera	297,977	140,402	16,654	455,033	42,741	20,875	2,437	66,052	521,085	4.01%
3	West Sumatera	26,833	17,692	2,434	46,959	5,567	3,808	542	9,917	56,876	1.17%
4	Riau	142,580	53,280	6,402	202,262	72,524	21,811	3,055	97,390	299,652	5.41%
5	Jambi	50,706	31,859	3,227	85,792	15,192	6,437	801	22,431	108,223	3.50%
6	South Sumatera	201,739	123,396	13,665	338,800	36,862	23,380	2,629	62,871	401,671	5.39%
7	Bengkulu	14,984	7,748	1,119	23,852	12,672	6,435	935	20,042	43,894	2.56%
8	Lampung	50,737	32,968	2,845	86,551	14,185	10,555	928	25,669	112,220	1.47%
9	Bangka Belitung Islands	4,193	2,572	314	7,079	2,800	1,581	195	4,577	11,656	0.95%
10	Riau Islands	-	-	-	-	-	-	-	-	-	0.00%
11	DKI Jakarta	362,711	209,278	19,616	591,606	54,482	45,828	3,780	104,090	695,696	7.24%
12	West Java	612,536	447,467	43,336	1,103,339	260,998	189,324	18,816	469,137	1,572,476	3.65%
13	Central Java	681,436	745,851	55,382	1,482,669	146,173	153,506	12,510	312,189	1,794,858	5.54%
14	DI Yogyakarta	12,861	24,943	2,301	40,106	6,275	11,264	973	18,513	58,619	1.70%
15	East Java	1,246,197	1,481,897	118,468	2,846,562	231,537	345,670	26,496	603,704	3,450,266	9.21%
16	Banten	121,044	60,151	6,106	187,300	39,730	18,658	1,907	60,296	247,596	2.33%
17	Bali	-	-	-	-	-	-	-	-	-	0.00%
18	West Nusa Tenggara	31,681	20,285	2,397	54,363	4,652	3,007	311	7,971	62,334	1.39%
19	East Nusa Tenggara	17,882	11,017	1,341	30,239	17,246	9,187	1,353	27,786	58,025	1.24%
20	West Kalimantan	145,749	92,066	10,702	248,518	61,689	38,442	4,496	104,627	353,145	8.03%
21	Central Kalimantan	65,161	36,794	4,556	106,511	29,958	13,222	1,817	44,997	151,508	6.85%
22	South Kalimantan	182,011	116,741	13,372	312,124	8,104	4,554	522	13,181	325,304	8.97%
23	East Kalimantan	78,614	29,608	3,559	111,782	41,573	16,023	1,744	59,340	171,122	4.82%
24	North Sulawesi	414	718	57	1,189	466	849	66	1,381	2,570	0.11%
25	Central Sulawesi	256	120	14	390	1,394	730	87	2,211	2,602	0.10%
26	South Sulawesi	312	281	32	625	3,052	2,796	316	6,164	6,790	0.08%
27	Southeast Sulawesi	382	185	28	595	2,027	1,037	137	3,201	3,796	0.17%
28	Gorontalo	14	7	2	23	73	38	9	121	144	0.01%
29	West Sulawesi	144	120	13	277	476	297	33	806	1,083	0.09%
30	Maluku	1,937	1,069	99	3,105	47,996	25,895	2,529	76,420	79,524	5.19%
31	North Maluku	3,565	1,271	126	4,962	1,526	503	62	2,091	7,053	0.68%
32	West Papua	15,886	3,736	386	20,008	4,704	1,457	141	6,301	26,310	3.46%
33	Papua	59,250	11,161	1,066	71,477	18,500	4,877	524	23,900	95,377	3.37%
	Total	4,607,967	3,803,712	343,742	8,755,425	1,220,033	1,003,180	93,306	2,316,524	11,071,950	26.00%

Apendix 9. Total population Exposed to Medium and High Classes Landslide Hazards

No	Province	Population Exposure Hazard Class						Total	% Exposed
		High			Moderate				
		Male	Female	Total High	Male	Female	Total Moderate		
1	Aceh	66,243	65,128	131,371	568,977	569,360	1,138,337	1,269,708	28.25%
2	North Sumatera	154,338	159,046	313,384	876,291	884,195	1,760,486	2,073,870	15.97%
3	West Sumatera	108,142	109,232	217,374	585,510	593,243	1,178,753	1,396,127	28.80%
4	Riau	460	445	905	76,803	71,549	148,352	149,257	2.69%
5	Jambi	7,837	7,833	15,670	107,648	106,276	213,924	229,594	7.42%
6	South Sumatera	22,716	20,903	43,619	187,671	174,096	361,767	405,386	5.44%
7	Bengkulu	69,927	67,328	137,255	209,542	197,772	407,314	544,569	31.74%
8	Lampung	37,953	34,960	72,912	435,898	403,276	839,175	912,087	11.99%
9	Bangka Belitung Islands	-	-	-	44,300	40,772	85,072	85,072	6.95%
10	Riau Islands	-	-	-	67,085	63,152	130,237	130,237	7.76%
11	DKI Jakarta	-	-	-	-	-	-	-	0.00%
12	West Java	499,596	484,261	983,857	3,972,157	3,844,418	7,816,574	8,800,432	20.44%
13	Central Java	292,395	293,505	585,900	1,961,959	1,972,856	3,934,815	4,520,715	13.96%
14	DI Yogyakarta	47,735	49,397	97,132	119,439	124,758	244,197	341,329	9.87%
15	East Java	189,772	194,746	384,518	1,665,254	1,709,188	3,374,443	3,758,961	10.03%
16	Banten	21,903	20,628	42,531	221,455	209,977	431,432	473,963	4.46%
17	Bali	34,856	34,585	69,441	374,561	375,662	750,223	819,664	21.07%
18	West Nusa Tenggara	123,351	131,047	254,398	1,598,525	1,706,549	3,305,075	3,559,473	79.10%
19	East Nusa Tenggara	197,426	202,627	400,053	1,093,963	1,124,154	2,218,117	2,618,170	55.90%
20	West Kalimantan	2,886	2,684	5,570	145,646	134,856	280,501	286,072	6.51%
21	Central Kalimantan	-	-	-	27,959	25,076	53,035	53,035	2.40%
22	South Kalimantan	1,879	1,799	3,678	99,768	93,986	193,754	197,432	5.44%
23	East Kalimantan	-	-	-	84,195	72,018	156,213	156,213	4.40%
24	North Sulawesi	20,420	19,107	39,526	437,768	417,510	855,278	894,804	39.41%
25	Central Sulawesi	125,999	118,968	244,967	754,585	717,903	1,472,489	1,717,455	65.18%
26	South Sulawesi	134,551	133,191	267,742	621,336	639,295	1,260,631	1,528,373	19.02%
27	Southeast Sulawesi	4,848	4,485	9,333	248,622	238,638	487,259	496,593	22.24%
28	Gorontalo	5,122	4,934	10,056	135,431	131,872	267,303	277,359	26.66%
29	West Sulawesi	13,540	12,845	26,386	204,169	200,539	404,707	431,093	37.21%
30	Maluku	11,203	10,472	21,675	93,783	88,811	182,593	204,268	13.32%
31	North Maluku	-	-	-	108,034	102,723	210,756	210,756	20.30%
32	West Papua	19,507	17,790	37,297	237,172	212,530	449,702	487,000	64.04%
33	Papua	224,465	198,149	422,614	767,669	680,095	1,447,765	1,870,378	66.01%
	Total	2,439,070	2,400,095	4,839,164	18,133,175	17,927,105	36,060,279	40,899,445	17.20%

Apendix 10. Total vulnerable groups Exposed to Medium and High Classes Landslide Hazards

No	Province	Population Vulnerable Groups Hazard Class								Total	% Exposed
		High				Moderate					
		Under Five Children	Elderly	Disability	Total High	Under Five Children	Elderly	Disability	Total Moderate		
1	Aceh	14,713	8,269	1,187	24,168	125,328	69,545	10,841	205,714	229,882	5.11%
2	North Sumatera	40,207	17,200	2,504	59,912	213,663	114,749	13,668	342,080	401,992	3.10%
3	West Sumatera	23,042	14,895	1,979	39,916	125,861	92,432	11,569	229,862	269,778	5.57%
4	Riau	97	49	15	161	17,834	6,655	1,054	25,543	25,704	0.46%
5	Jambi	1,657	1,047	167	2,872	21,458	15,273	2,095	38,827	41,698	1.35%
6	South Sumatera	4,877	2,548	293	7,717	37,993	24,798	2,646	65,437	73,154	0.98%
7	Bengkulu	13,750	8,463	1,002	23,215	42,274	25,394	3,203	70,871	94,086	5.48%
8	Lampung	7,375	5,017	516	12,909	84,259	55,119	5,579	144,958	157,867	2.07%
9	Bangka Belitung Islands	-	-	-	-	9,213	4,723	570	14,506	14,506	1.19%
10	Riau Islands	-	-	-	-	16,732	3,695	494	20,922	20,922	1.25%
11	DKI Jakarta	-	-	-	-	-	-	-	-	-	0.00%
12	West Java	95,286	83,136	7,376	185,798	760,500	638,201	55,254	1,453,954	1,639,753	3.81%
13	Central Java	51,553	61,547	4,426	117,526	334,230	438,871	31,865	804,966	922,491	2.85%
14	DI Yogyakarta	7,212	15,415	1,169	23,796	17,955	40,739	3,257	61,951	85,747	2.48%
15	East Java	27,581	52,238	3,845	83,664	256,868	396,772	28,048	681,689	765,352	2.04%
16	Banten	4,214	2,554	198	6,966	43,034	27,110	2,543	72,687	79,653	0.75%
17	Bali	6,256	8,335	646	15,237	63,437	91,951	7,153	162,541	177,778	4.57%
18	West Nusa Tenggara	27,143	19,006	2,105	48,254	347,353	240,965	26,486	614,804	663,058	14.73%
19	East Nusa Tenggara	51,781	31,889	4,945	88,615	272,678	171,144	24,879	468,702	557,317	11.90%
20	West Kalimantan	570	294	58	922	29,675	15,329	2,249	47,253	48,175	1.10%
21	Central Kalimantan	-	-	-	-	6,294	2,470	327	9,092	9,092	0.41%
22	South Kalimantan	415	218	27	660	21,689	10,118	1,175	32,982	33,642	0.93%
23	East Kalimantan	-	-	-	-	17,476	7,292	952	25,720	25,720	0.72%
24	North Sulawesi	3,513	3,760	341	7,615	75,758	76,138	8,214	160,110	167,725	7.39%
25	Central Sulawesi	26,141	15,133	1,937	43,211	160,613	83,115	11,227	254,955	298,165	11.32%
26	South Sulawesi	29,398	24,385	3,041	56,825	127,485	118,488	13,615	259,588	316,413	3.94%
27	SoutheastSulawesi	1,077	496	63	1,636	57,469	22,816	3,185	83,470	85,106	3.81%
28	Gorontalo	1,066	598	83	1,747	28,139	16,170	2,756	47,066	48,813	4.69%
29	West Sulawesi	3,303	1,639	359	5,301	48,641	24,713	3,127	76,481	81,782	7.06%
30	Maluku	2,881	1,155	124	4,159	24,131	10,432	1,022	35,585	39,744	2.59%
31	North Maluku	-	-	-	-	25,707	10,198	1,225	37,130	37,130	3.58%
32	West Papua	4,363	1,150	104	5,617	54,435	13,576	1,451	69,463	75,080	9.87%
33	Papua	39,189	5,818	646	45,652	149,719	23,097	2,844	175,660	221,312	7.81%
	Total	488,660	386,254	39,156	914,071	3,617,901	2,892,088	284,573	6,794,569	7,708,637	18.00%

Apendix 11. Total population Exposed to Medium and High Classes Extreme Waves & Abrasion Hazards

No	Province	Population Exposure Hazard Class						Total	% Exposed
		High			Moderate				
		Male	Female	Total High	Male	Female	Total Moderate		
1	Aceh	14,452	14,216	28,668	119,961	118,950	238,911	267,579	5.95%
2	North Sumatera	4,036	4,082	8,117	110,603	108,791	219,395	227,512	1.75%
3	West Sumatera Barat	2,280	2,109	4,388	58,535	59,476	118,011	122,399	2.53%
4	Riau	-	-	-	48,025	45,647	93,672	93,672	1.69%
5	Jambi	-	-	-	6,778	6,612	13,390	13,390	0.43%
6	South Sumatera	29	26	54	4,729	4,418	9,147	9,201	0.12%
7	Bengkulu	1,316	1,230	2,547	21,058	20,572	41,630	44,176	2.58%
8	Lampung	7,692	6,897	14,589	70,797	65,857	136,654	151,242	1.99%
9	Bangka Belitung Islands	-	-	-	26,654	24,755	51,409	51,409	4.20%
10	Riau Islands	15,148	14,068	29,216	223,109	211,218	434,327	463,543	27.61%
11	DKI Jakarta	356,076	349,415	705,492	899	862	1,762	707,253	7.36%
12	West Java	152,334	145,135	297,469	218,191	206,987	425,178	722,647	1.68%
13	Jawa Tengah	95,148	97,851	192,999	629,728	626,698	1,256,426	1,449,425	4.48%
14	DI Yogyakarta	243	253	496	46,923	49,636	96,559	97,055	2.81%
15	Jawa Timur	175,904	180,888	356,793	1,056,981	1,100,006	2,156,987	2,513,780	6.71%
16	Banten	117,553	111,443	228,996	127,804	120,083	247,887	476,883	4.49%
17	Bali	34,027	32,989	67,016	305,349	296,937	602,286	669,302	17.20%
18	Nusa Tenggara Barat	293,710	302,105	595,815	16,794	17,242	34,036	629,852	14.00%
19	Nusa Tenggara Timur	2,929	3,093	6,022	3,722	3,925	7,647	13,669	0.29%
20	Kalimantan Barat	158,983	159,188	318,171	95,253	91,604	186,857	505,028	11.49%
21	Kalimantan Tengah	15,631	15,138	30,769	46,586	42,804	89,390	120,159	5.43%
22	Kalimantan Selatan	40,095	38,071	78,166	90,026	84,480	174,506	252,673	6.97%
23	Kalimantan Timur	3,992	3,619	7,611	338,066	299,135	637,201	644,812	18.15%
24	Sulawesi Utara	28,492	27,554	56,045	47,237	46,149	93,386	149,431	6.58%
25	Sulawesi Tengah	15,150	14,706	29,857	39,856	38,296	78,152	108,009	4.10%
26	Sulawesi Selatan	14,169	14,974	29,143	85,586	89,896	175,482	204,625	2.55%
27	Sulawesi Tenggara	26,737	28,446	55,183	33,985	34,435	68,420	123,603	5.54%
28	Gorontalo	676	642	1,317	7,523	7,294	14,816	16,134	1.55%
29	Sulawesi Barat	2,655	2,537	5,192	20,433	21,249	41,682	46,874	4.05%
30	Maluku	20,885	20,976	41,861	3,656	3,591	7,247	49,108	3.20%
31	Maluku Utara	2,546	2,468	5,014	64,383	62,131	126,515	131,528	12.67%
32	Papua Barat	9,731	8,604	18,335	32,315	28,908	61,224	79,559	10.46%
33	Papua	79	62	141	3,257	2,973	6,230	6,371	0.22%
	Total	1,612,698	1,602,785	3,215,482	4,004,802	3,941,617	7,946,422	11,161,903	4.70%

Apendix 12. Total vulnerable groups Exposed to Medium and High Classes Extreme Waves & Abrasion Hazards

No	Province	Population Vulnerable Groups Hazard Class								Total	% Exposed
		High				Moderate					
		Under Five Children	Elderly	Disability	Total High	Under Five Children	Elderly	Disability	Total Moderate		
1	Aceh	3,261	1,629	220	5,110	26,267	12,255	1,758	40,279	45,389	1.01%
2	North Sumatera	1,010	398	90	1,498	25,516	11,500	1,618	38,634	40,132	0.31%
3	West Sumatera	568	220	30	817	10,594	8,328	1,060	19,983	20,800	0.43%
4	Riau	-	-	-	-	9,790	5,185	586	15,561	15,561	0.28%
5	Jambi	-	-	-	-	1,323	871	91	2,285	2,285	0.07%
6	South Sumatera	7	2	0	9	1,017	576	61	1,655	1,664	0.02%
7	Bengkulu	270	169	23	462	4,201	2,386	342	6,929	7,391	0.43%
8	Lampung	1,526	927	105	2,558	13,923	8,059	828	22,811	25,369	0.33%
9	Bangka Belitung Islands	-	-	-	-	5,363	3,109	375	8,847	8,847	0.72%
10	Riau Islands	3,266	1,596	311	5,173	50,451	15,479	1,611	67,541	72,714	4.33%
11	DKI Jakarta	61,262	32,919	3,197	97,378	170	80	9	260	97,638	1.02%
12	West Java	27,243	22,405	2,173	51,821	39,521	32,748	3,341	75,610	127,432	0.30%
13	Central Java	15,873	15,005	1,028	31,906	108,736	111,209	8,745	228,689	260,596	0.80%
14	DI Yogyakarta	39	78	8	126	6,672	17,075	1,297	25,043	25,169	0.73%
15	East Java	28,187	34,398	2,570	65,156	172,076	192,420	15,903	380,400	445,555	1.19%
16	Banten	22,458	12,298	1,306	36,063	25,010	12,549	1,203	38,762	74,825	0.70%
17	Bali	6,140	5,145	381	11,667	53,480	48,471	3,649	105,600	117,267	3.01%
18	West Nusa Tenggara	64,073	39,077	4,590	107,740	3,491	2,091	210	5,792	113,531	2.52%
19	East Nusa Tenggara	725	519	75	1,319	923	656	95	1,674	2,994	0.06%
20	West Kalimantan	34,626	23,341	2,828	60,794	19,673	10,485	1,093	31,251	92,046	2.09%
21	Central Kalimantan	2,971	1,523	137	4,631	9,392	4,469	568	14,429	19,059	0.86%
22	South Kalimantan	8,175	4,406	461	13,041	20,112	9,360	1,107	30,579	43,620	1.20%
23	East Kalimantan	868	321	56	1,245	73,756	22,856	3,125	99,737	100,983	2.84%
24	North Sulawesi	4,761	5,411	862	11,033	8,281	6,337	895	15,514	26,547	1.17%
25	Central Sulawesi	3,508	1,747	252	5,507	8,797	4,246	555	13,598	19,105	0.73%
26	South Sulawesi	3,198	2,130	271	5,599	17,274	12,865	1,561	31,700	37,299	0.46%
27	Southeast Sulawesi	6,769	4,483	567	11,819	8,430	4,090	525	13,044	24,863	1.11%
28	Gorontalo	145	78	11	235	1,573	828	147	2,548	2,783	0.27%
29	West Sulawesi	658	229	29	916	4,760	3,124	381	8,266	9,181	0.79%
30	Maluku	5,027	2,872	284	8,183	929	421	37	1,388	9,570	0.62%
31	North Maluku	674	246	32	952	15,548	6,152	659	22,359	23,312	2.25%
32	West Papua	2,348	575	59	2,982	7,883	2,017	225	10,124	13,106	1.72%
33	Papua	6	1	0	7	758	248	28	1,034	1,041	0.04%
	Total	309,642	214,148	21,956	545,747	755,690	572,545	53,688	1,381,926	1,927,674	4.50%

Appendix 13. Total Population Based on Population Census 2010

Province	Population Number		
	Male	Female	Total
Aceh	2,248,952	2,245,458	4,494,410
North Sumatera	6,483,354	6,498,850	12,982,204
West Sumatera	2,404,377	2,442,532	4,846,909
Riau	2,853,168	2,685,199	5,538,367
Jambi	1,581,110	1,511,155	3,092,265
South Sumatera	3,792,647	3,657,747	7,450,394
Bengkulu	877,159	838,359	1,715,518
Lampung	3,916,622	3,691,783	7,608,405
Bangka Belitung Islands	635,094	588,202	1,223,296
Riau Islands	862,144	817,019	1,679,163
DKI Jakarta	4,870,938	4,736,849	9,607,787
West Java	21,907,040	21,146,692	43,053,732
Central Java	16,091,112	16,291,545	32,382,657
DI Yogyakarta	1,708,910	1,748,581	3,457,491
East Java	18,503,516	18,973,241	37,476,757
Banten	5,439,148	5,193,018	10,632,166
Bali	1,961,348	1,929,409	3,890,757
West Nusa Tenggara	2,183,646	2,316,566	4,500,212
East Nusa Tenggara	2,326,487	2,357,340	4,683,827
West Kalimantan	2,246,903	2,149,080	4,395,983
Central Kalimantan	1,153,743	1,058,346	2,212,089
South Kalimantan	1,836,210	1,790,406	3,626,616
East Kalimantan	1,871,690	1,681,453	3,553,143
North Sulawesi	1,159,903	1,110,693	2,270,596
Central Sulawesi	1,350,844	1,284,165	2,635,009
South Sulawesi	3,924,431	4,110,345	8,034,776
Southeast Sulawesi	1,121,826	1,110,760	2,232,586
Gorontalo	521,914	518,250	1,040,164
West Sulawesi	581,526	577,125	1,158,651
Maluku	775,477	758,029	1,533,506
North Maluku	531,393	506,694	1,038,087
West Papua	402,398	358,024	760,422
Papua	1,505,883	1,327,498	2,833,381
Total	119,630,913	118,010,413	237,641,326

Source: SP 2010

Appendix 14. Total Vulnerable Groups Based on Population Census 2010

Province	Population Vulnerable Groups Exposed to Hazard			
	Under Five Children	Elderly (60 + years)	Disability	Total
Aceh	499,746	266,444	39,750	805,940
North Sumatera	1,459,297	771,608	87,527	2,318,432
West Sumatera	502,431	390,225	48,620	941,276
Riau	679,399	233,109	30,359	942,867
Jambi	322,961	170,532	19,609	513,102
South Sumatera	752,917	458,102	49,290	1,260,309
Bengkulu	170,135	98,079	12,480	280,694
Lampung	727,485	541,898	50,175	1,319,558
Bangka Belitung Islands	121,520	67,882	7,910	197,312
Riau Islands	201,082	56,779	6,567	264,428
DKI Jakarta	838,236	500,946	44,606	1,383,788
West Java	4,155,719	3,050,036	279,211	7,484,966
Central Java	2,660,161	3,298,910	238,475	6,197,546
DI Yogyakarta	256,923	448,223	35,774	740,920
East Jawa	2,852,711	3,832,645	290,529	6,975,885
Banten	1,050,591	488,438	48,595	1,587,624
Bali	335,172	380,636	27,376	743,184
West Nusa Tenggara	473,344	324,391	35,732	833,467
East Nusa Tenggara	583,587	343,004	49,538	976,129
West Kalimantan	463,656	264,322	33,806	761,784
Central Kalimantan	243,084	110,412	14,581	368,077
South Kalimantan	364,516	214,749	24,386	603,651
East Kalimantan	387,123	141,820	17,805	546,748
North Sulawesi	198,925	187,857	22,341	409,123
Central Sulawesi	285,869	150,333	20,451	456,653
South Sulawesi	764,714	649,342	74,650	1,488,706
Southeast Sulawesi	268,549	130,504	16,981	416,034
Gorontalo	100,505	58,602	9,960	169,067
West Sulawesi	145,683	77,338	9,747	232,768
Maluku	160,605	81,524	7,913	250,042
North Maluku	127,566	49,679	5,848	183,093
West Papua	90,991	22,799	2,330	116,120
Papua	310,665	54,397	6,082	371,144
Total	22,555,868	17,915,565	1,669,004	42,140,437

Source: SP 2010

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PART 9

Abbreviations

ADRC : Asian Disaster Reduction Center

API : *Adaptasi Perubahan Iklim* (Climate Change Adaptation)

BIG : *Badan Informasi Geospasial* (Geospatial Information Agency)

BMKG : *Badan Meteorologi Klimatologi dan Geofisika* (Meteorology, Climatology, and Geophysics Agency)

BNPB : *Badan Nasional Penanggulangan Bencana* (National Disaster Management Agency)

BPS : *Badan Pusat Statistik* (Statistics Indonesia)

DIBI : *Data dan Informasi Bencana Indonesia* (Disaster Data and Information)

DISHIDROS : *Dinas Hidrologi dan Oseanografi* (Office of Hydrology and Oceanography)

ESDM : *Energi dan Sumberdaya Mineral* (Energy and Mineral Resources)

IRBI : *Indeks Risiko Bencana Indonesia* (Indonesia Disaster Risk Index)

KRB : *Kawasan Rawan Bencana* (Disaster-Prone Area)

MMI : Modified Mercalli Intensity

PERKA BNPB : *Peraturan Kepala BNPB* (Regulation of Head of BNPB)

PGA : Peak Ground Acceleration

PRB : *Pengurangan Risiko Bencana* (Disaster Risk Reduction)

PU : *Pekerjaan Umum* (Public Works)

PVMBG : *Pusat Vulkanologi dan Mitigasi Bencana Geologi* (Center of Volcanology and Geological Hazard Mitigation)

SNI : *Standar Nasional Indonesia* (Indonesia National Standard)

UNFPA : United Nations Population Fund

UNISDR : United Nations International Strategy for Disaster Reduction

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