



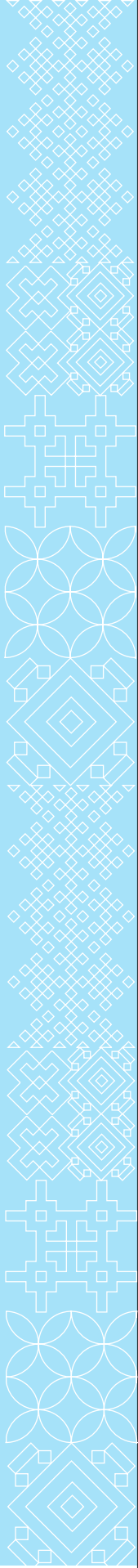


# STRENGTHENING THE DISASTER RESILIENCE OF INDONESIAN CITIES – A POLICY NOTE



Urban floods have significant impacts on the livelihoods and mobility of Indonesians, affecting access to employment opportunities and disrupting local economies. (photos: Dani Daniar, Jakarta)





## Acknowledgement

This note was prepared by World Bank staff and consultants as input into the Bank's Indonesia Urbanization Flagship report, *Time to ACT: Realizing Indonesia's Urban Potential*, which can be accessed here: <https://openknowledge.worldbank.org/handle/10986/31304>. The World Bank team was led by Jolanta Kryspin-Watson, Lead Disaster Risk Management Specialist, Jian Yun, Infrastructure Specialist, Zuzana Stanton-Geddes, Disaster Risk Management Specialist, and Gian Sandosh Semadeni, Disaster Risk Management Consultant. The paper was peer reviewed by World Bank staff including Alanna Simpson, Senior Disaster Risk Management Specialist, Abigail Baca, Senior Financial Officer, and Brenden Jongman, Young Professional.

The background work, including technical analysis of flood risk, for this report received financial support from the Swiss State Secretariat for Economic Affairs (SECO) through the World Bank Indonesia Sustainable Urbanization (IDSUN) Multi-Donor Trust Fund.

The findings, interpretations, and conclusions expressed do not necessarily reflect the views of the World Bank, its Board of Executive Directors, or the governments they represent. The World Bank does not guarantee the accuracy of the data included in this work.

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## Executive Summary

Indonesia's rapid urbanization opens doors for a variety of benefits: increasing prosperity through economic specialization, creating livable cities with diverse economic drivers and vibrant public spaces, and supporting a more inclusive society by facilitating more efficient public services. However, urban development also bears certain risks, including growing exposure of assets and people to disaster risk. It is estimated that some 110 million people, approximately 42 percent of the population, across approximately 60 Indonesian cities are exposed to natural hazards (Gunawan et al. 2015). The number is expected to increase due to urban population growth and associated transformation of the built and natural environment, projected effects of climate change, and more widespread land subsidence.

The objective of this policy note is to influence the ongoing discussion on how urbanization can contribute to improving disaster resilience. Particularly, this note seeks to raise awareness of some of the opportunities to reduce the vulnerability of Indonesian cities and their dwellers. This note argues that the vulnerability of Indonesian cities and their inhabitants can be reduced by improving access to quality disaster and climate risk information applied in planning, improving the structural integrity of urban infrastructure, enhanced early warning and emergency management systems, and strengthening the capacity of communities and subnational governments to manage disaster risks. Policy reforms, investments in disaster risk management, and better institutional coordination are needed to minimize loss of life, reduce damage to assets and economy, and protect and further enhance prosperity, inclusiveness and livability of Indonesia's cities.

## 1. Introduction

### 1.1 Why is disaster resilience important for Indonesia?

Indonesia is one of the most disaster-prone countries in the world, frequently exposed to a range of hazards. Over sixty percent of Indonesia's districts are exposed to a high risk of flooding. Located in the Pacific Ring of Fire with 127 active volcanoes, Indonesia also faces high seismic, tsunami and volcanic risk. Disasters impact people as well as the economy in Indonesia. Living in hazardous areas, lacking access to basic services, and having limited assets and financial resources, the poor and vulnerable bear the brunt of disaster impacts. The 2004 Aceh earthquake and Indian Ocean tsunami remains one of the deadliest events ever experienced (see Box 1). Over the last 15 years, Indonesia has suffered losses of approximately \$16.8 billion due to disaster events (CRED 2018)<sup>1</sup>. Rapid development and climate change are increasing Indonesia's exposure and vulnerability to disaster risk, particularly flood and seismic risk, and these trends have implications for the safety, livability and prosperity of communities across the country.

<sup>1</sup> Includes only direct damage to property, crops, and livestock. Figures for each disaster corresponds to the damage value at the event year. The damage data is not inflation adjusted.



### **BOX 1 2004 Indian Ocean Earthquake and Tsunami**

On December 26, 2004, a magnitude 9.3 earthquake near the Aceh province triggered a tsunami reaching up to 35 meters height that reached 15 countries bordering the Indian Ocean. The disaster event caused almost 230,000 fatalities, affected more than 2.5 million people, and caused almost \$11.4 billion in damage. Indonesia was the country worst affected by the disaster event, causing over 130,000 fatalities and damaging or destroying around 250,000 houses in Aceh province alone. Over one third of inhabitants in Banda Aceh City, the capital of Aceh province, lost their lives. Land title registers, documents, and property markers were also destroyed by the tsunami.

*Source: World Bank. 2011. Lessons from the Reconstruction of Post-Tsunami Aceh: Build Back Better Through Ensuring Women are at the Center of Reconstruction of Land and Property. Washington D.C.: World Bank.*

Disaster risk is a critical public policy consideration and Indonesia has many strides to strengthen its resilience. Following the devastating 2004 Indian Ocean Earthquake and Tsunami, the need to improve understanding and awareness of disasters became apparent. Since then, various legal and institutional arrangements pertaining to disaster risk management (DRM) have seen significant progress, with the Law on Disaster Management (UU 24-2007) and the Spatial Planning Law (UU 26-2007) both approved in 2007 (see Box 2). The National Disaster Management Authority (Badan Nasional Penanggulangan Bencana - BNPB) was established in 2008, with a mandate to improve coordination of DRM responsibilities between government agencies, non government organizations (NGOs), international partners, and other stakeholders. The country has developed internationally-recognized good practices in emergency response and community-based post-disaster recovery. However, challenges remain including coordination, human resources and technical capacity, systematic consideration of risk into development, resilience of infrastructure, and establishing sustainable and efficient financing mechanisms related to both risk reduction as well as preparedness and recovery.

### **BOX 2 Legal, institutional arrangements and budgetary related to disaster risk management**

The Law on Disaster Management 2007 outlines responsibilities amongst various stakeholders before, during, and after a disaster. While a variety of national and local agencies are responsible for the implementation of the legal framework and institutional arrangements, BNPB and subnational disaster management agencies (Badan Penanggulangan Bencana Daerah – BPBD) in provincial and district level governments play a coordination role on various aspects of DRM. Within the context of urban development, the Spatial Planning Law 2007 is particularly relevant. It supports the country's medium- and long term development planning and includes various key DRM aspects, including requiring open spaces for evacuation and creating protected zones for areas prone to natural disasters. Regarding the budgeting of DRM activities, the Ministry of Finance assigns national budget resources to both BNPB and directly to line ministries, and also has a contingency budget in place for unexpected emergencies such as disaster events. A similar budgeting approach is taken by the local governments for their DRM related expenditures.



## 1.2 Why is disaster resilience important for Indonesia's cities?

The process of urbanization opens the door for a variety of benefits, for example by reducing the fixed costs per person of new disaster-resilient infrastructure. Rapid or poorly planned urban development also bears certain risks, including growing exposure of assets (such as residential housing and critical urban infrastructure) and people to disaster risk. Some 110 million people, approximately 42 percent of the population, across roughly 60 Indonesian cities are exposed to natural hazards (Gunawan et al. 2015). This number is expected to increase with urban population growth, inadequate regulation of urban development, projected effects of climate change, and increased occurrences of land subsidence. To minimize these risks of urbanization, disaster mitigation efforts must be scaled up across institutions, infrastructure, the economy and society. Investing in disaster resilience can bring many benefits to Indonesia, including minimizing loss of life, reducing disaster effects on assets and the economy, ensuring business continuity, and protecting and further enhancing prosperity, inclusiveness and livability of Indonesia's cities.

## 1.3 What is the objective of this note?

The Government of Indonesia is developing a new regulatory framework to incorporate disaster risk reduction into spatial plans. This marks a pivotal step in Indonesia's DRM efforts and emphasizes the importance of risk informed planning to enhance urban disaster resilience. This development also poses an opportune moment to consider how urbanization relates to disaster resilience, what balance needs to be struck between risk reduction, preparedness and recovery, while also considering what are the key implications for policy-makers. In line with this, the objective of this note is to review ongoing and future trends relevant to disaster risk and propose key actions that could be taken to increase urban resilience. There is significant scope for urban development to harness its potential for increasing prosperity through economic specialization, creating livable and sustainable cities with diverse economic drivers and vibrant public spaces, and supporting a more inclusive society by facilitating more efficient public services.

## 1.4 Methodology

The contents of this note draw on the knowledge gathered through ongoing World Bank engagement in Indonesia, a rapid desk review of existing literature, and limited consultations with stakeholders including the BNPB, the Ministry of National Development Planning/National Development Planning Agency (BAPPENAS), the Ministry for Public Works and Housing (PUPR), and the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN), as well as representatives from Indonesian cities of Ambon, Bima, Manado, Mataram, Medan, Padang, Pekanbaru, and Pontianak. For the flood risk analysis, BNPB hazard maps were overlaid with Deltares Aqueduct global models. Disaster data is largely based on the Indonesia Disaster Data Information (DIBI) database, which has been maintained by BNPB since 2008 and was developed through a project introduced by the United Nations Development Program (UNDP) in 2006. EM-DAT, an internationally recognized and publicly available database maintained by the Université Catholique de Louvain in Belgium, was also drawn upon for data on economic damages.

# 2. Understanding Risks and Trends Facing Cities

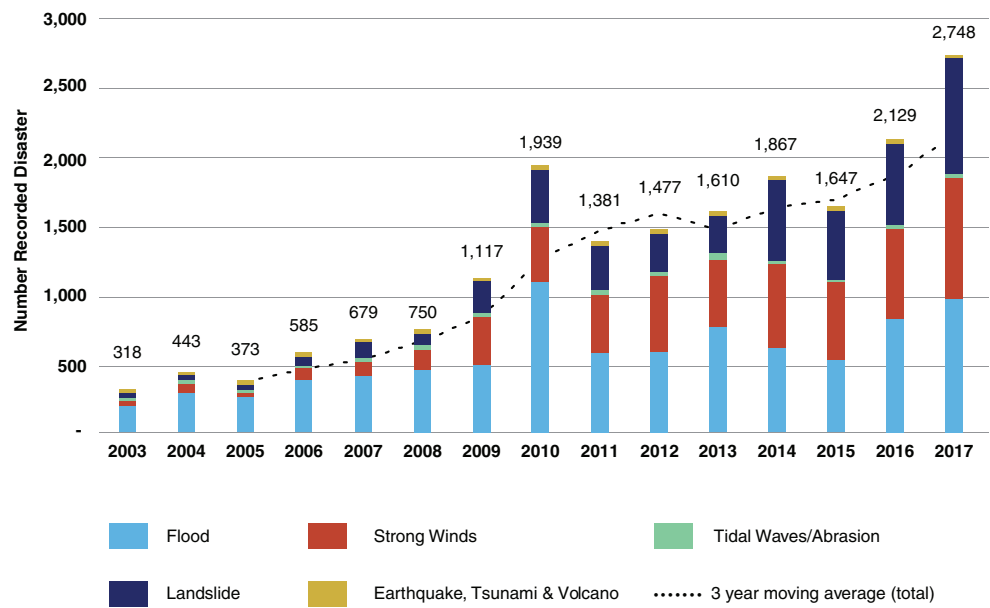
## 2.1 How exposed are Indonesian cities to disasters?

Indonesian cities face a range of natural hazards, particularly floods, earthquakes and tsunami, volcanic activity, landslides, storms and fires (CRED 2018).<sup>2</sup> Over the past 15 years, a total of 4,856 disasters across Indonesia's twenty-eight multi- and





single-district metropolitan areas (World Bank 2019), or approximately 25 percent of all disaster events in Indonesia, were recorded in the Indonesia Disaster Data Information (DiBi) database, maintained by the National Disaster Management Authority (Badan Nasional Penanggulangan Bencana – BNPB). Figure 1 highlights the regular occurrence of floods in the country while also drawing attention to an increase in the frequency of natural hazards over the last decade. With 1,101 events, 2010 features as the year with the most flooding occurrences in recent history for the country, while the average between 2010–2017 stands at 747 events per year. Strong winds, a localized, tornado-like phenomena, show a steady increase over the years, with the number of events more than doubling from 404 in 2010 to 886 in 2017. In comparison, geophysical events are a significantly rarer disruption to public life in Indonesia. However, with an average of 14 significant earthquakes or tsunamis and 5 volcanic events per year, such disasters still pose a threat to Indonesia and cause larger losses of human life.



Source: Calculations based on BNPB's DiBi database.

Note: Improvements to data quality from 2008 onwards has contributed to a higher number of recorded events. The method applied to record the number of events deviates between geophysical and hydrological hazard, contributing to the higher flood frequency. The moving average is the arithmetic mean of the total number of disaster for 3 years. For example, the first data point is the average of 2003 – 2005.

The cities of Jakarta, Bandung and Surakarta alone account for 39 percent of the disasters impacting metropolitan areas, with all three far exceeding the average of 173 events between 2003 and 2017 (see Figure 2). Floods dominate the natural hazard figures in most metropolitan areas, often accounting for almost half of all events occurred. Indonesian metropolitan areas experience pluvial flooding (linked to heavy rainfall events, storm water runoff, and drainage systems overflow), fluvial flooding (linked to upstream rainfall, flash floods and overflowing river), and coastal flooding (linked to extreme offshore weather events. Mataram is an example of many cities in Indonesia affected by different types of flooding (Box 3). Cities experiencing high frequency of flood disaster include Pasuruan, Mojokerto, and Surabaya where floods represent 79, 70, and 63 percent of all their disaster events respectively. Cities such as Magelang and Yogyakarta have experienced the lowest frequency of flooding with only 14 and 20 percent respectively of their overall disasters. Due to the country's location in highly seismically-active areas, all metropolitan areas (except for those in Kalimantan) are highly exposed to geophysical hazards. With approximately five major events each, Sukabumi, Bandung and Yogyakarta were the metropolitan areas most prone to geophysical disasters, though other cities such as Padang have been exposed to significant geophysical events during this period.

<sup>2</sup> This includes geophysical hazards (earthquakes, volcanic activity, dry landslides and land subsidence), hydrological hazards (floods, flash floods, storm surges/coastal floods, and wet landslides), meteorological hazards (tropical cyclones and storms).

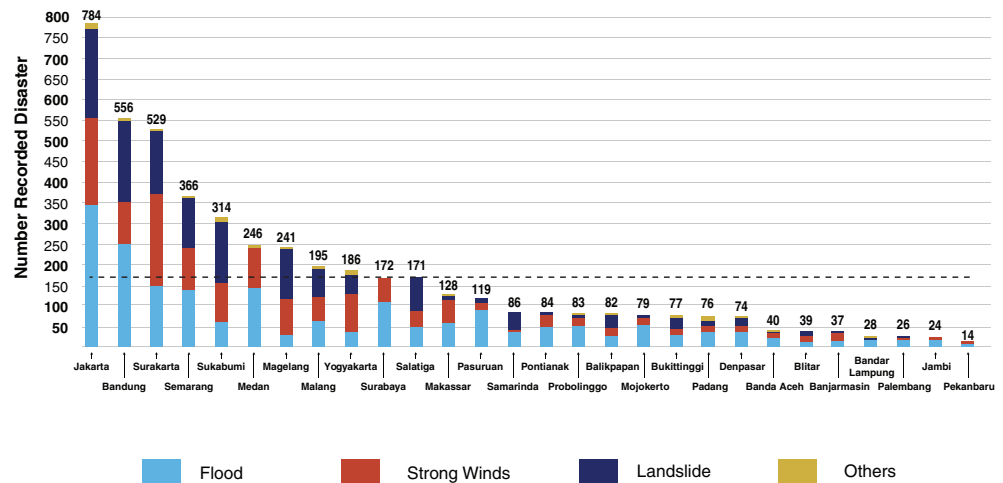




### BOX 3 Floods of Many Kinds – The Example of Mataram City

With a population of around 400,000 people, Mataram City (West Nusa Tenggara) has developed around four major rivers: Sungai Jangkok, Sungai Ancar, Sungai Midang, and Sungai Unus, passing through the city from the slopes of Mount Rinjani. Pluvial flooding develops into severe inundation of streets and ground floor building spaces, coastal flooding is linked to low lying land along coastlines that are exposed frequently to high tides, and fluvial flooding occurs when the rivers overflow during rainfall events. Riparian settlements have encroached river banks and coastal areas, poor quality design of water infrastructure systems, and impeded drainage flows further exacerbate the flood events. In March 2018, Mataram over 1,000 houses were inundated by flash floods.

Source: Authors, and <http://www.thejakartapost.com/news/2018/03/06/more-than-1000-houses-inundated-as-flash-floods-hit-west-nusa-tenggara.html>.



Source: Calculations based on BNPB's DIBI database.

Note: The 28 multi- and single district metropolitan areas are defined in World Bank 2019 (upcoming). The selection is based on a minimum population and density threshold per district as well as daily commuting flows between districts "Others" includes Tidal Waves/Abrasion, Earthquake / Tsunami and Volcanic Activity.

## 2.2 What has been the impact?

EM-DAT, an international disaster event database, indicates that events between 2003 - 2017 caused total damages of approximately \$16.8 billion.<sup>3</sup> This figure is driven by several severe earthquake/tsunamis and flood events. Based on DIBI data, hydrological and meteorological disasters are the most frequent and affect the highest number of people. Such disasters have negative impact on the prosperity and livability of metro areas, often disrupting public and economic life. The impact of the 2017 floods in Jakarta is described in Box 4. However, less frequent but more severe geophysical events can have more devastating effects on the population (see Figure 3Error! Reference source not found.), recording by far the highest number of fatalities since 2003. In addition to their impact on the urban population, such events cause significant destruction to housing and infrastructure, inflicting severe economic damage to metro areas. In fact, the damages caused by earthquakes and tsunamis over the last 15 years are about two times as high as for floods (CRED 2018).<sup>4</sup>

<sup>3</sup> Includes only direct damage to property, crops, and livestock. Figures for each disaster corresponds to the damage value at the event year. The damage data is not inflation adjusted.

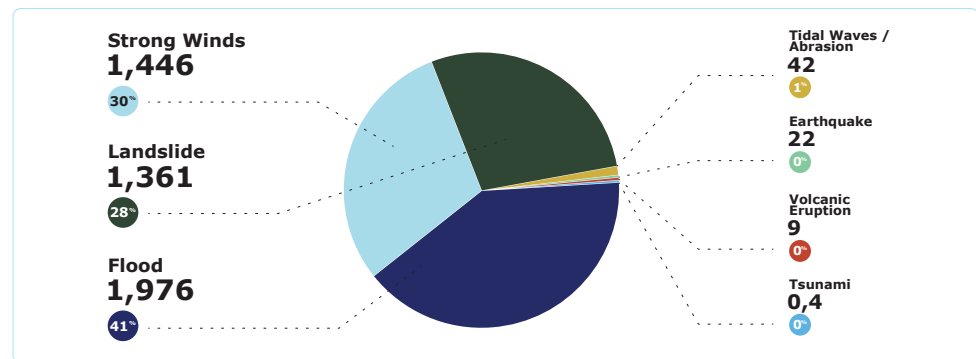
<sup>4</sup> \$11 billion is recorded for earthquakes / tsunamis and \$5.5 billion for floods. Damage data for some events might not be included.



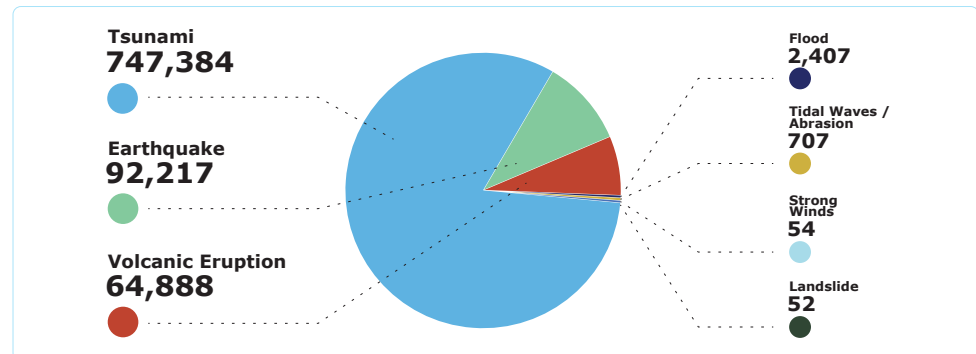
The natural disasters that Indonesia experienced in 2018 caused the most loss of life in over a decade, particularly because of three major geophysical events. First, in July and August 2018, West Nusa Tenggara (NTB) province suffered a series of major earthquakes, the most significant occurring on 5 August 2018 measuring magnitude (M)7.0, which caused 561 fatalities and displaced over 396,000 people<sup>5</sup>, damaging almost 110,000 houses, and causing approximately US\$854 million<sup>6</sup> in damages and losses. Second, in September 2018, a M7.5 earthquake with an epicenter located 81 kilometres north of Palu City in Central Sulawesi caused strong ground shaking and tsunamis that led to 4,402 fatalities<sup>7</sup>, approximately 170,000 displaced people<sup>8</sup>, and US\$1.3 billion<sup>9</sup> in economic losses estimated at 13.7 percent of regional GDP.<sup>10</sup> Third, in December 2018, the eruption and subsequent partial collapse of Anak Krakatau Volcano led to a tsunami that affected coastal settlements in Banten and Lampung provinces along Sunda Strait, causing 437 fatalities and displacing almost 34,000 people.<sup>11</sup>

Figure 3. Indonesia's metro areas face several different disaster types

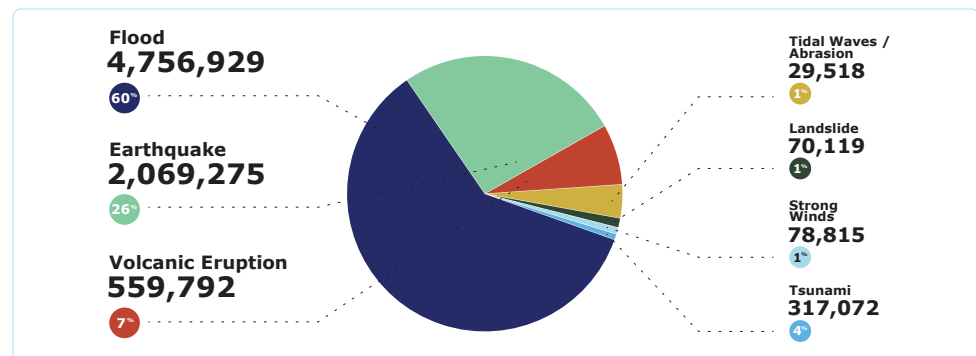
### Disaster types



### People affected per event by disaster type



### People affected by disaster type



Source: Calculations based on data from BNPB's Disaster Data Information (DIBI) database.  
Note: The 28 multi- and single district metropolitan areas are defined in the Indonesian Urbanization Flagship Report (World Bank 2019, upcoming). The selection is based on a minimum population and density threshold per district as well as daily commuting flows between districts. People affected includes fatalities, missing persons, injured, people impacted and displaced.

<sup>5</sup> Government of Indonesia. 2018. NTB Rehabilitation and Reconstruction Action Plan. Executive Summary.

<sup>6</sup> Presentation of Coordination and Assistance Team for Post-Disaster Recovery and Redevelopment in Central Sulawesi and NTB.

<sup>7</sup> United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). 2018. Update. December 20.

<sup>8</sup> Central Sulawesi Center of Disaster Data and Information. 2019.

<sup>9</sup> Government of Indonesia. 2018. Master Plan for Central Sulawesi Rehabilitation and Reconstruction, draft version 5.0.

<sup>10</sup> Processed from estimated Central Sulawesi RGDP 2017 by National Statistical Bureau. 2018.

<sup>11</sup> UNOCHA. 2019. Update, January 3. Tourism infrastructure sustained major damages include 92 hotels and 60 culinary stalls.





#### BOX 4 An inundated capital - the 2007 Floods in Jakarta

The greater metropolitan area of Jakarta is home to over 30 million people and is the political center and economic hub of the nation. Parts of Jakarta already lie below the sea level and 10 million residents are at risk of urban flooding, coastal erosion, and sea level rise. Furthermore, extensive groundwater extraction by large urban developments, including residential complexes, shopping malls and industrial developments, is causing significant land subsidence. Large areas of the city are flooded each year during the rainy season (November to April) and flooding was especially severe in February 2007, during which 36 percent of the city was inundated, at up to seven meters in some parts. This disaster event caused 70 deaths, affected 2.6 million people including displacing 340,000 residents from their houses, and led to approximately \$900 million in damages. Further economic losses were attributed to loss of work and school days due to city-wide disruption (including the closure of Jakarta's international airport for three days), and health costs due to an outbreak of dengue fever and diarrhea. The Provincial Government of Jakarta has, with the support of the World Bank, been working to remove some of the factors which contributed to the scale of the 2007 floods. To date, over 3 million cubic meters of dredge material has been removed from floodways and canals, and around 52 kilometers of embankment have been repaired or constructed.

Source: BNPB and World Bank 2012, <http://projects.worldbank.org/P111034/jakarta-urgent-flood-mitigation-project?lang=en>.

### 2.3 A look ahead?

It is expected that by 2055, approximately 64 percent of Indonesia's population will be living in seismic hazard zones, up from 53 percent in 2016, with the largest increase in exposure being across Java island (Deltares 2018). However, whilst the risk of seismic hazards can be modelled and calculated, the exact timing and severity of tectonic plate movements cannot be predicted. Based on probabilistic loss models, there is a 2 percent chance each year of a significant earthquake event occurring that causes damages of around US\$1.3 billion (World Bank 2011). Furthermore, secondary hazards including tsunamis and soil liquefaction also pose significant threats to cities located in districts with high seismic risk. The approximately 127 active volcanoes in Indonesia can also affect urban areas through lahar flows or by causing indirectly economic damage triggered by air traffic disruptions (Llewellyn 2018) particularly for major hubs such as Bali.

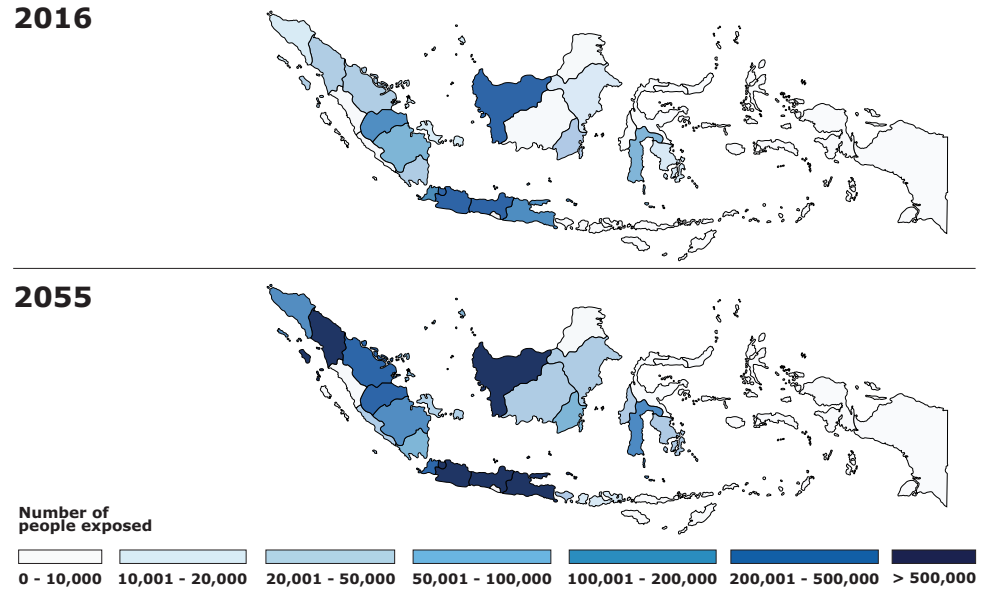
Today, many Indonesian metro areas already experience pluvial flooding linked to heavy rainfall events, storm water runoff, and drainage system overflow; fluvial flooding linked to upstream rainfall, flash floods, and overflowing rivers; and coastal flooding linked to extreme offshore weather events and high tides; or a combination of the various flood types (Box 3). It is expected that fluvial flooding will put an estimated 75 percent more Indonesians at risk by 2055 (figure 5), mainly driven by population growth (47 percent), with climate change having a lower impact (19 percent). Along Indonesia's coastline, with some 8,000 inhabited islands, cities will be even more exposed to coastal flooding due to projected sea level rises. There will be an estimated increase in 73 percent of Indonesians living in coastal flood hazard zones by 2055, with 36 percent stemming from population growth and 26 percent due to the effects of climate change (figure 4) (Deltares 2018). Within Asia, Java is seen as one the regions most affected by increasing surface temperature and the changing rainfall patterns that are expected to follow (Willner et al 2018). A closer look into the key drivers is included in the next section.

<sup>12</sup> The damage estimate is based on 2009 price level, no information on the exchange rates was provided.

<sup>13</sup> The calculation was conducted for a 2011 publication and no information on the exchange rates was provided. This figure represents the Probable Maximum Loss for the Government of Indonesia with a 50-year return period. The actuarial methods are based on loss data between 2000 and 2009 which were used to fit a parametric distribution. The upward linear trend captures increases in asset exposure, better damage reposting systems etc.



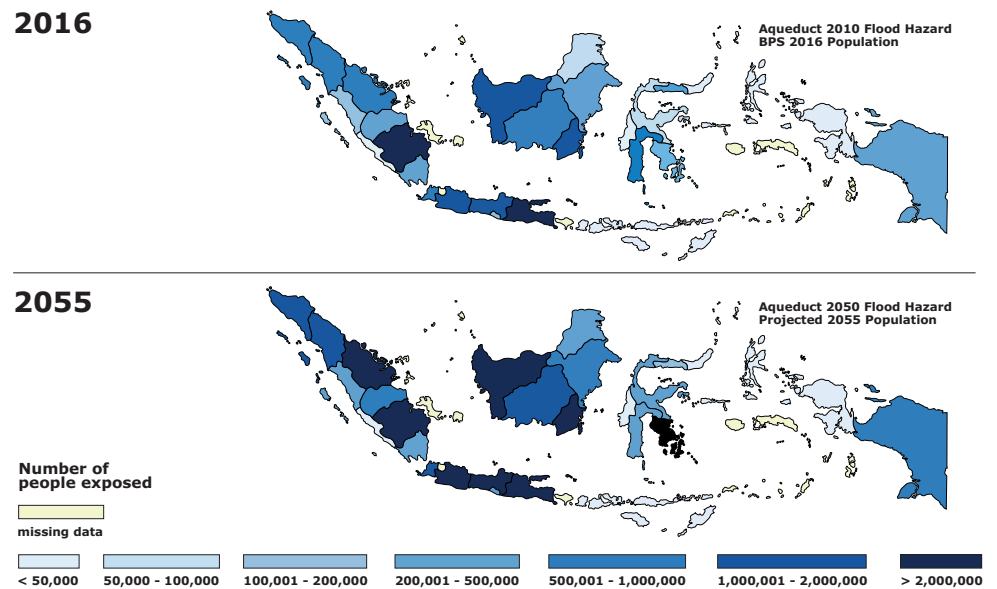
Figure 4. The number of people exposed to coastal flooding will increase significantly between 2016 and 2055



Source: Calculations based on BNPB hazard maps overlaid with Aqeduct global models, prepared by Deltares.

Notes: These maps show the combined effect of urban growth and climate change using the Badan Pusat Statistik (BPS) 2016 and 2055 (projected) population figures in combination with the Aqeduct coastal flood hazard maps. The dynamic interactive vulnerability assessment projects sea level rises on a regional level only (island groups), which limits the usefulness for smaller islands and watersheds. The models used for coastal flooding do not consider expected future land subsidence and land use change. People exposed includes all residents living in urban flood zones.

Figure 5. There will be a substantial increase in the number of people exposed to fluvial flooding between 2016 and 2055



Source: Calculations based on BNPB hazard maps overlaid with Aqeduct global models, prepared by Deltares.

Notes: These maps show the combined effect of urban growth and climate change using the Badan Pusat Statistik (BPS) 2016 and 2055 population figures in combination with the Aqeduct river flood hazard maps. The flood maps apply very coarse rainfall-runoff grid cells of about 55 by 55 kilometers, which limits their usefulness for smaller islands and small rivers. The results of the future flood hazard maps are based on significant uncertainty regarding the impact of climate change on peak precipitation levels in Indonesia. People exposed includes all residents living in urban flood zones.





## 2.4 What are the three key drivers behind urban disaster risk?

Unplanned or poorly planned urbanization: Large-scale urban development—often planned and regulated inadequately—has increased the vulnerability of cities to natural hazards, particularly flooding and earthquakes. Urbanization, linked to natural population growth and rural-to-urban transformation, has increased exposure of cities to natural hazards. Urban population growth is a key driving factor, estimated to increase flood risk by 36 to 47 percent (Deltares 2018). New urban migrants and settlements are often forced into vulnerable areas such as flood-prone land and steep hillside slopes (Lloyd's 2018). Additionally, poor quality infrastructure is constructed in hazard-prone areas with inadequate consideration of, or compliance with, risk informed planning regulations and urban design codes. This leads to buildings and urban infrastructure not being able to withstand damaging geotechnical and hydrometeorological forces. Many Indonesian cities suffer from watershed degradation, reduced hydraulic capacity of drainage systems, and an increase in non absorptive surfaces, causing more prolonged flooding of urban areas (Gencer 2013). Pluvial flooding is particularly exacerbated by urban developments that often create additional surface water runoff during intense rainfall events and do not absorb storm water on site. Medan is an example of many Indonesian cities where urban growth rate outpacing increases in urban livability and disaster resilience capacity (see Box 5).

### BOX 5

#### Rapid development in Medan creates increasing urban disaster risk

New urban developments in Medan are encroaching on natural retention areas (marshes), and drainage channels are too narrow to withstand significant flood events, despite city-wide efforts to increase retention and detention capacity. Illegal dumping of waste, partly due to a lack of community awareness of its consequences, also exacerbates urban flooding issues in the city. Furthermore, the poor-quality of informal housing settlements along Medan's river banks and drainage channels, often constructed without building permits and occupancy certificates, increases the seismic risk of residents and building occupants. At least once a year, impeded drainage leads to flood depths of 40 centimeters and up to 60 centimeters at a four-year frequency. Floods are of flash nature, lasting for one up to three hours. The surrounding area of Medan is further influenced by the rivers Belawan and Denai. The city has further developed along Deli River, downstream of the Deli-Babura confluence, towards the sea and Medan / Belawan Port. In the downstream part of Deli River, floods affect the riparian settlements. In the coastal zone, floods are experienced under the influence of tides, storm surges and monsoon wind set-up and the river discharges. The city is considering options to mitigate flood risks, such as through the development of a reservoir along Babura River, in the Tanah Karo catchment area, which would enable the diversion of floods around Medan city, creating more retention space, or the construction of a sea dike to protect the coastal zone.

<sup>14</sup> The urban population is projected to grow from 115 million people in 2016 to 189 million in 2055 (77 percent of the total population). Urban areas are projected to grow by 44 percent, from 17,000 square kilometers in 2016 to 24,000 in 2055.





*Photos: Clockwise: new large-scale urban developments in Medan; illegal rubbish dumping in drainage channels; new drainage infrastructure improvements. Photos taken by the World Bank.*

**Land subsidence and environmental degradation:** Land subsidence is increasing the risk of flooding in major metro and urban areas located along rivers or coastlines, such as Jakarta, Bandung, Semarang, Medan and Lhokseumawe. Land subsidence is occurring rapidly due to groundwater extraction (often illegal) for industrial land use, gas extraction, and natural processes (Chaussard et al 2013). Jakarta and Bandung are sinking at alarming rates of 7.2 centimeters per year (Deltares 2018). Medan is expected to be below relative sea level within the next 60 years whilst parts of North Jakarta are already below sea level. Environmental degradation and deforestation associated with inadequately managed urban population growth, land shortage, and commercial activities, are major contributors to pluvial floods and landslides. This is typical for cities that are expanding into adjacent mountainous areas, as observed in cities such as Ambon and Manado. The loss of uphill or coastal forest is especially detrimental to a city's flood resilience.

**Climate change:** Expected sea level rise, changing precipitation patterns, and more intense storms will increase disaster risk across Indonesian metro and urban areas. Sea level rise could threaten 42 million Indonesians who live less than 10 meters above sea level. A fifty centimeter rise in sea level, combined with land subsidence in Jakarta Bay, could permanently inundate densely-populated areas of Jakarta and Bekasi that house over 270,000 residents (World Bank 2011). Where peak precipitation rates increase due to climate change and large scale climate systems (such as the El Niño), the risk of flooding will increase, although the exact impacts are not clear (Deltares 2018).





## 3. Policy Challenges and Opportunities

### 3.1 Rethink urban development to address key challenges

With a potential urban population of 214 million people in 2050, Indonesian cities are set to experience more rapid urban development and building construction. To prevent cities from becoming disaster hotspots, the focus needs to be on preventing increased disaster risk for new development, as well as reducing disaster risk for existing and ongoing development. Unless there is improved regulation of developments in flood-prone land, better storm water management practices, incentivization opportunities for developers, and a reduction in impermeable surfaces (e.g., concrete and asphalt), urban flood risk will likely increase. Indonesian cities are also becoming increasingly more prone to seismic risk, unless risk is reduced in comprehensive manner for high-risk areas and infrastructure. Furthermore, local government agencies need more technical expertise and human resources to administer and regulate the wide range of risk informed urban planning/design and building construction systems and standards, many of which are already in place. A recent baseline study of urban flood risk in 30 Indonesian cities conducted by the World Bank indicated that many cities face similar challenges including:



City drainage systems and flood mitigation or flood control infrastructure have insufficient capacity to mitigate lower probability but higher severity events, such as the 1 in 20 year or greater storm event. Drainage infrastructure design is already outdated and cannot handle peak flows during heavy rainfall events; this will be further exacerbated in cities expecting increasing rainfall due to climate change.



Cities rely heavily on budget allocations from the central government to finance resilience building initiatives, including both structural and non structural measures. The government will need to further explore innovative financing options with private sector and community stakeholders, and task developers with more responsibility to mitigate urban flood risk through developer fees, charges, levies, and incentive programs.



Cities noted their limited technical capacity to implement appropriate mitigation measures, and opportunities for stronger collaboration between national and subnational agencies, including river basin authorities. Cities also need more specific, scientific and quantified disaster risk information to understand significant disaster impacts and reduce the risk of such events.

### 3.2 What can be done? Actions for urban disaster resilience

National and subnational governments are already applying many good practices in urban disaster risk management across Indonesian cities (see Boxes 8 and 9) have made significant advances since the 2004 Indian Ocean Tsunami to increase disaster resilience. However, greater coordinated effort and innovative approaches are needed as the Government of Indonesia redefines its national DRM priorities in long term disaster risk management planning and resilience building. Improved planning and institutions in metro and urban areas and more resilient infrastructure to cope with increasing disaster risks are needed. The quality of urbanization is critical and can be improved by incorporating disaster mitigation needs across institutions, infrastructure, economy, and society through the following 10 steps:

<sup>15</sup> the 95 percent interval in Badan Pusat Statistik (BPS) projections suggests that the 2050 population of Indonesia will be around 320 million people, with roughly 214 million living in cities



## Institutions

- 01 Align development and DRM strategies, with dedicated resources:** Building green, disaster and climate-resilient cities is a key direction for national urban development policy under Indonesia's National Medium term Development Plan 2015–19 (RPJMN). The Government's 30 year disaster management master plan aims to reduce the number of cities with high disaster risk from 75 percent to 40-45 percent by 2045. Providing dedicated resources with a sustainable financing strategy, incentives and mechanisms to address these goals (see example of Bolivia in Box 6) will help to increase urban resilience to shocks and economic disruption and create multifunctional resilient green spaces enhancing urban prosperity and livability.
- 02 Improve coordination between agencies involved in urban planning and DRM:** Better agency coordination is needed for the developing city resilience master plans, improving disaster and spatial data, and updating of public infrastructure and spatial plans. Agencies are encouraged to allow transparent access to key risk information, such as hazard risk, damage estimates, and emergency scenarios. This information is crucial to citywide risk-informed planning and communicating disaster risk to the community, as well as improving the quality of risk information.
- 03 Invest in institutional and human capacity:** Local government agencies in metro and urban areas experience challenges in building and retaining the technical capacity to accommodate growing populations. The need is just as pressing for policies and practices for resilience. Government agencies could introduce certification and incentives for staff to improve skills, particularly on risk-informed spatial planning, enforcement of zoning regulations and building codes, resilient designs, technical engineering, retrofitting, and disaster risk management. Professional organizations could also be encouraged to certify designers and developers.

### **BOX 6** Bolivia: Giving national priority to institutionalize a comprehensive DRM system

In Bolivia, the 2006 National Development Plan established DRM as a priority for the country's long-term development strategy. Accordingly, the Ministry of Development Planning is in charge of the risk reduction agenda while the disaster management agenda is overseen by the Vice Ministry of Civil Defense (VIDECI). Whereas VIDECEI defines policies and strategies to implement disaster preparedness measures like early warning systems and improve emergency response coordination and actions, the Ministry of Development Planning defines policies and strategies to plan risk management in the medium and long term, within the framework of the integrated planning, land use planning and public investment systems. In addition, the DRM Law of 2014 requires all public institutions at all levels of government to incorporate DRM considerations into their development strategies, land use and sectoral plans. In 2015, a DRM Development Policy Credit and Loan was approved by the World Bank in the amount of US\$200 million, to help the country to continue advance national disaster resilience agenda by: (i) strengthening Bolivia's institutional and legal framework for disaster risk management and climate change adaptation including ensuring DRM is considered in the national and local planning and process investment process, (ii) improving institutional coordination for emergency management and response, and (iii) reducing the fiscal impact and improving Bolivia's capacity to respond financially to disasters associated with adverse natural event.





## Planning and Infrastructure

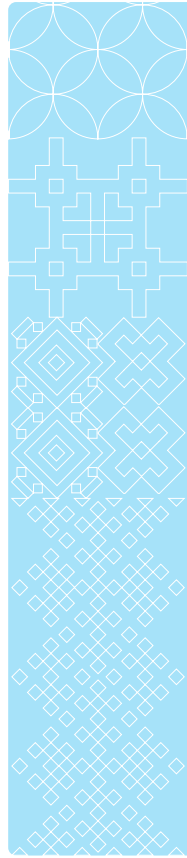
**04 Scale up risk informed spatial planning and building codes incorporating disaster risk reduction:** Planning and designing resilient metro and urban areas will help to avoid the loss of lives and assets (including residential housing and critical urban infrastructure) and prevent major disruptions to urban services and economic activities when a hazard strikes. Local governments could consider for example water-sensitive urban design strategies (WSUD), seismic strengthening, and design for emergency or disaster situations (e.g., evacuation routes and safe spaces, multi functional public buildings) to strengthen cities' resilience. The Ministry of Spatial Planning/National Land Agency (ATR/BPN) has developed a national program to support the inclusion of disaster risk reduction principles in district level spatial plans. Flood modelling for Indonesian cities show that rigorously enforced spatial planning can reduce flood exposure by 50 to 84 percent, being particularly effective in cities with rapid urban expansion (Muis et al. 2015). As Indonesian metro and urban areas prepare detailed spatial planning in the next years, there is an opportunity to further integrate resilience measures into urban planning and development, while also ensure that new building code standards stipulate disaster risk reduction measures (Box 7).

**05 Reform enforcement of permit and construction processes:** Local governments could be supported to strengthen building permit issuance and compliance processes to ensure that development follows risk-informed planning, design, and construction methods. Following natural disasters, a “build back better” approach to reconstruction efforts should be adopted, ensuring that damaged assets strengthen their resilience against future events. Clear assigned responsibilities in a transparent system, with human resources trained and certified to monitor compliance, are essential to safeguard urban lives and mitigate urban economic losses due to damaged houses and public buildings.

### **BOX 7 Opportunities for risk-informed spatial planning**

Risk-based land use planning helps guide people and assets out of/within hazard-prone zones, by informing the location, type, design, quality, and timing of development (Jha et al 2015). Zoning enables cities to identify safer areas, regulate land use, set regulations on location, bulk, height, shape, and use of structures in each zone, and identify building codes by design type and purpose of structure (World Bank 2013). Adequate regulations need to be prepared and the relevant spatial plans updated to include the relevant disaster risk information (Jha et al 2012). In Indonesia, following the 2006 Java earthquake and the Mount Merapi eruption in 2010, the World Bank supported risk-sensitive land use planning and resettlements. Detailed analysis identified zones and groups of vulnerable populations to guide resettlement and resilient reconstruction. Development, including housing construction, was not allowed in some zones; in other zones, partial resettlement was permitted; and in yet other areas, efforts focused on strengthening the preparedness of population. Reconstruction and resettlement was implemented through community-driven participatory processes, where community settlement plans were part of regional risk-informed land-use planning (Jha et al 2015). In Indonesia, this approach would require cross-institutional engagement between agencies at the district (kota/kabupaten) level responsible for spatial planning, development planning, public works, housing settlements, and disaster risk management.





New spatial planning approaches such as water sensitive urban design (WSUD) and green and blue infrastructure are being developed in many cities around the world to increase urban flood resilience. WSUD refers to a design approach that regards water (storm water, groundwater, and wastewater) as a resource that can be retained on a site, public space, or open space, for re-use or filtration. Such measures help reduce the stress placed on city drainage infrastructure during intensive rainfall events and can have co-benefits related to maintaining sustainable urban waterways and improving urban amenity. For example, existing public parks can be retrofitted to follow WSUD designs, increasing their absorption rate by installing underground water storage facilities, as demonstrated by the cities of Singapore, Melbourne, and Jinhua. Other cities such as Copenhagen, Rotterdam, and New York have ambitious and innovative city-wide WSUD master plans to improve their flood resilience and mitigate rising sea levels, through strategies such as redesigning public spaces, incorporating flood protection measures into existing infrastructure, and developing WSUD guidelines for new urban developments.

**06 Balance structural and nonstructural investments and standardize approaches with large co-benefits:** Comprehensive strategies combine structural measures (such as drainage infrastructure, seismic resilience, and green infrastructure), and nonstructural measures (such as risk-informed land use planning, building codes, planning policies, hazard monitoring, forecasting, early warning systems, disaster risk financing, community awareness and education, and capacity building). For example, simulations point out that enhanced flood defenses in Indonesian cities could reduce up to 93 percent of the risk, although such measures are likely to be only feasible in high-risk areas (Muis et al. 2015). The World Bank (2012) estimates that upgrading hydrometeorological services in developing countries is one of the most cost-effective solutions with benefit to cost ratios between 4 to 1 and 36 to 1. At the same time, to harness urbanization for improved livability, plans could standardize attractive, green, and resilient cities that incorporate WSUD (Soz et al. 2016). These initiatives may have further benefits such as sustainable tourism, improved mental and physical well-being of the residents, and increased community awareness of urban resilience.

**07 Address both existing and future vulnerability through development planning and investments in infrastructure resilience:** Along with improving planning and practice for future development, it is critical to address the existing vulnerability of existing urban infrastructure stock. Specific activities could include systematic assessment of risk levels in target areas or infrastructure types with prioritization and technical standards and guidelines for city wide retrofitting programs (addressing for example foundations, structural framing, external facades, roofing, interior finishes etc.), integrated building information systems, early warning, awareness programs through community institutions (Box 8), and awareness programs through community institutions, contingency and response arrangement arrangements, and a comprehensive disaster risk finance strategy.



### **BOX 8 Building Back Better – Padang City’s retrofitting and awareness initiatives after 2009 earthquake**

Padang City faces frequent seismic activity. On September 30, 2009, a magnitude 7.6 earthquake struck the coast of West Sumatra island, causing 1,115 fatalities, injuring over 3,000 people, and damaging over 144,000 buildings (including 1,100 schools) in three districts, including Padang City. Since this event, the city has committed to delivering a range of seismic awareness and retrofitting programs to enhance their seismic resilience against future events, with a clear vision to develop a “disaster smart city”. In May 2018, the Head of BNPB opened a Disaster Education Park in Padang to promote disaster risk awareness amongst young people through art, knowledge sharing, and interactive exhibits.

Such initiatives have included a school retrofitting program that is strengthening the structural integrity and multi functional purpose of schools across Padang City, including construction of an evacuation shelter on the top of multi story school buildings. Tsunami warning systems, evacuation routes, and evacuation shelters have also been developed. The city’s BPBD agency has also conducted awareness raising programs including the socialization of seismic risk information with affected communities, including a door to door program with approximately 500,000 residents in high risk zones.



*Photos: Left to Right: demarcated tsunami evacuation zones; retrofitted school including evacuation point, emergency siren, and strengthened structure; BPBD coordinates disaster risk information to stakeholders and community. Photos by the World Bank.*

## Society and Finance

- 08 Promote private sector participation in risk reduction through clear roles, incentives and regulation:** The private sector, which often drives new development and redevelopment of land, needs to bear its fair share of responsibilities for urban resilience. Incentives and clear regulations for development projects (such as related to drainage, retention storage or permeability, adherence to building code standards) need to encourage developers to design risk-informed investments. Innovative municipal financing streams for drainage infrastructure and storm water management (e.g., developer levies or fees, incentive schemes, capital works schemes in new developments), programs for retrofitting of critical infrastructure (e.g., incentive or grant schemes, public private partnerships), or land value capture opportunities in the floodplain management and development, could be considered. prosperity and livability.





09

**Invest in communities:** Metro and urban areas offer many economic opportunities. But many people, facing unaffordable housing due to congestion and high prices, have little choice but to live along the river banks or in informal settlements, where disaster risk is highest and housing quality is low. This contributes to the poor's disproportionate vulnerability to disasters, which is undermining the inclusiveness of cities (Hallegatte et al 2017). Communities are key to emergency and response activities (Box 9), and to finding sustainable solutions related to waste management and environmental degradation. National participatory planning processes (musreimbang) could further address the varied needs of diverse community stakeholders. Urban resilience depends on addressing the key issues of communities and the needs of the most vulnerable.

### BOX 9 Community resilience – Bima City's preparedness during the 2016 flash floods

On December 21, 2016, flash floods originating from the Padolo River and the Wawo District inundated large parts of Bima City to heights of up to 3 meters, flooding thousands of houses, and displacing over 115,000 residents, or over two thirds of the city's population at the time. The floods caused over 1 trillion Rupiah in damages but fortunately, an efficient system of trained volunteers from various backgrounds helped to evacuate the affected population and no fatalities occurred. A key strength of the community network was the rapid sharing of information to assist with response actions. After the 2016 flooding, various measures have been taken to improve the city's flood resilience, such as rehabilitation of affected areas, normalization of river channels, relocation of people living in floodplains, improvements to urban infrastructure, river dike enforce, and the sustainable reforestation of land in upstream areas.



*Photos: Left to Right: upstream deforestation exacerbated conditions for flash floods in Bima; river normalization activities are being conducted but informal settlements and illegal rubbish dumping is still prevalent. Photos by The World Bank.*

10

**Pilot innovative programs and utilize new tools:** There is a need for new approaches supported by the central government and implemented at the city level to encourage resilient urban development. Innovations can be applied, with social media and smart technologies supporting risk mitigation, early warning as well as disaster responses. Geographic Information System (GIS) software and new tools such as drone technologies can be instrumental in creating and analyzing spatial data for forecasting, monitoring, and communicating risks (World Bank 2013). Agent-based modelling, which simulates how individuals interact with each other and their environment, could enable human behavior to be integrated into risk assessments, creating more realistic scenarios of the impact of natural disasters (Jongman 2018). Non-proprietary open-source platforms and tools enable pooling, sorting, analyzing and sharing of risk data for disaster planning, preparedness or response (Jha et al 2015). For an example of such tools see Box 10.



## **BOX 10** Indonesia Scenario Assessment for Emergencies (InaSAFE)

InaSAFE is an open-source visualizing and analytical tool for creating impact assessments to inform targeted risk reduction measures. The assessments are based on how a hazard – such as a tsunami, flood, or earthquake – affects populations or buildings. Users can create maps and input and information. InaSAFE was put to the test in contingency planning for the 2012 flood season in Jakarta, and its success provoked a rapid national rollout, along with widespread interest from the international community. Apart from making vertical connections between authorities and communities, tools like InaSAFE can link different groups with the government, namely disaster risk management with planning and development authorities. The tool enables the use of different types of information, including data from OpenStreetMap.

Source: <http://inasafe.org/en/>

## 4. Summary

While urbanization can help Indonesia reach its economic and human development goals—in the context of current and future development, environmental and climate trends—prosperity, inclusiveness and livability gains can only be achieved through sustainable approaches which take into account disaster risks and reduce them. Policy reforms and investments in DRM are needed to minimize loss of life, reduce damage to assets and the economy, and protect prosperity, inclusiveness and livability of Indonesia's cities.

The vulnerability of Indonesian cities and their inhabitants, particularly to different types of hazards, can be reduced by improving access to quality disaster risk information for planning, strengthening the capacity of urban communities and subnational governments, and upgrading the structural integrity and construction quality of urban infrastructure. Several approaches, innovative solutions, and practices are available to Indonesian policy-makers. Key considerations for new development include improved planning and institutions, integrating risk information, and forging strong coordination between urban planning and DRM agencies, reforming the permit and construction processes, strengthening the capacity of urban communities and subnational governments, and involving communities and private sector in both ex-ante systematic risk reduction investments, and disaster preparedness. Upgrading the structural integrity of existing urban infrastructure is required to reduce the existing levels of disaster risk. This can be achieved by adopting a comprehensive strategy to combine structural and non-structural measures in addition to assessing and prioritizing projects supporting resilience. Awareness programs through community institutions and robust contingency arrangements should also be strengthened to deal with the impacts of disasters.

Ultimately, national and city governments need to invest adequate financial resources to reduce disaster risk in high risk areas. These include investments in physical infrastructure, community engagement, early warnings, technical capacities, and of course, development of opportunities for multi stakeholder investments to reduce the growing disaster risk of many Indonesian cities.



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SEPTEMBER 2019

STRENGTHENING THE  
DISASTER RESILIENCE  
OF INDONESIAN CITIES  
- A POLICY NOTE

