4.1.2.3 DRR Planning and Implementation

(1) Development of Tsunami Master Plan 2012 (BNPB)

It was fortunate that the 2012 Indian Ocean Earthquakes (11-Apr-2012, offshore Aceh, M8.6/M8.2) did not generate any major tsunami. However, it revealed some fundamental issues at the local government level, such as the absence of emergency preparedness, inappropriate propagation of disaster information and early warning, lack of clearly defined decision-making process, and insufficient evacuation routes and facilities. The earthquake was strong enough to trigger tsunami early warning of InaTEWS (though there was no major tsunami in reality), which caused panic or a chaotic situation in Aceh and Padang. Many people evacuated using cars, causing a significant traffic jam. If any major tsunami had occurred, they could not have succeeded to evacuate and there would have been a number of victims. Fortunately, the warning

Based on the lessons learned from this event, BNPB developed the Tsunami Master Plan (2012-2014), which aimed to implement tsunami hazard analysis, tsunami DRR planning at local government levels, improvement in transmission of tsunami early warning, appropriate evacuation instruction, enhancement of warning systems, construction of tsunami evacuation route and facilities (TES), and promotion of community disaster risk management.

In the Tsunami Master Plan, the areas of high tsunami risk were identified based on the calculations of potential tsunami heights with a 500-year return period for each Kabupaten / Kota. The plan aimed to focus on these high-risk areas to implement most effective countermeasures such as tsunami DRR planning and evacuation planning. Although it was a very good plan, the only limited part has been implemented.

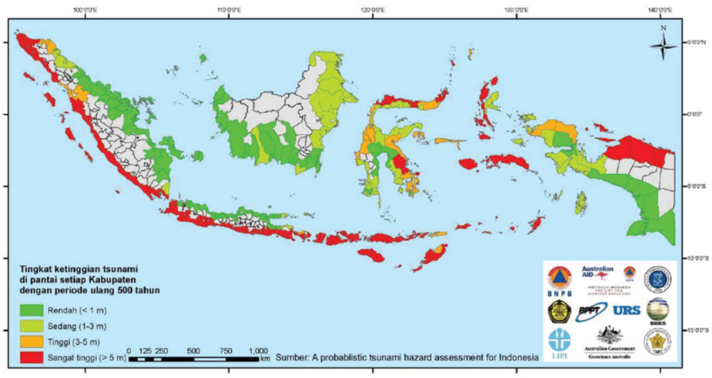


Figure 4-7 Tsunami Hazard Map 2012 (Tsunami Height by Kabupaten / Kota with 500-year return period)[88]

The Tsunami Master Plan defined three levels of budgets, i.e. (1) budget for implementing all required actions, (2) budget required for implementing priority actions, and (3) available budget. For example, the required number of Temporary Evacuation Shelter (TES) for Tsunami was 2,200, while the number of TES that could be constructed within the available budget was 216 (112+104). Please see the Table below.

Table 4-7 TES Construction Plan in Tsunami Master Plan

Unit: Million Rupiah	Target	2012	2013	2014	Total
Necessary Funding	2,200 TES	9,000	3,000,000	7,991,000	11,000,000
Priority Funding	700 TES	9,000	1,750,000	1,750,00	3,509,000
Available Funding	112 (2013) / 104 (2014)	9,000	560,000	520,000	1,089,000

Even though all the planned TES within the available budget had been constructed, they would only correspond to circa 10% of the required number in Indonesia. According to BNPB, BNPB does not know

[88] Tsunami Master Plan 2012

how many TES have been constructed, since the responsibility was transferred to PUPR through the MoU signed between BNPB and PUPR.

According to the information available on the Internet (see Figure above), 9 TES were constructed by the 2014 budget (press release on April 23rd, 2015 for the completion of 5 TES[89]), and another 30 TES were planned in 2015. However, it is unlikely that those 30 TES have been constructed, as the Tsunami Master Plan (2012-2014) was not continued or succeeded by any new formal plan. If only 9 TES have been constructed under the Tsunami Master Plan, it is way far from the planned 216 and still more from the required number of 2,200.

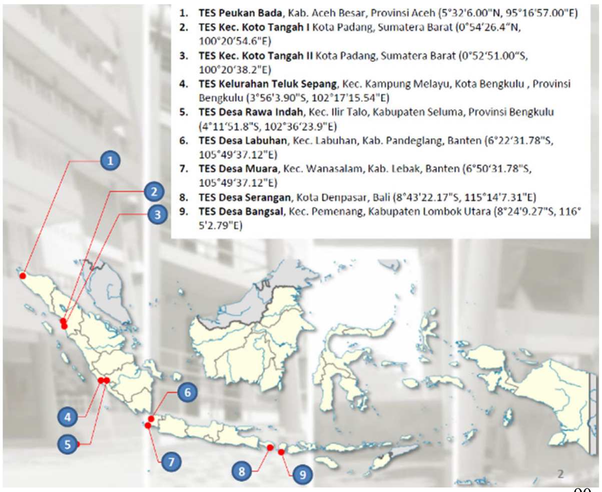


Figure 4-8 TES Construction Sites (2014 Budget)[90]

(2) Development of BMKG InaTEWS

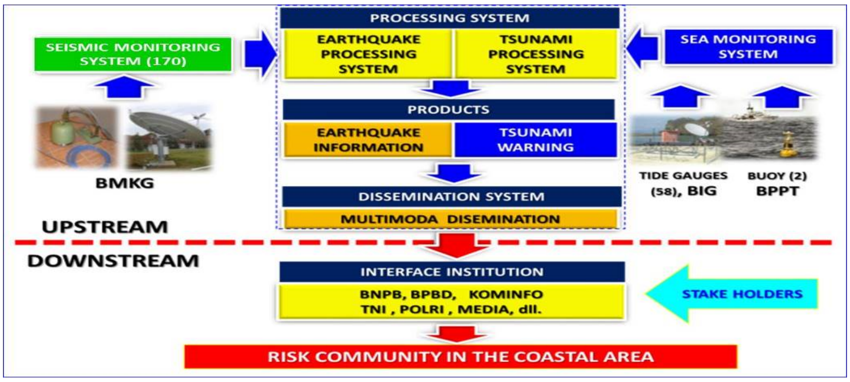
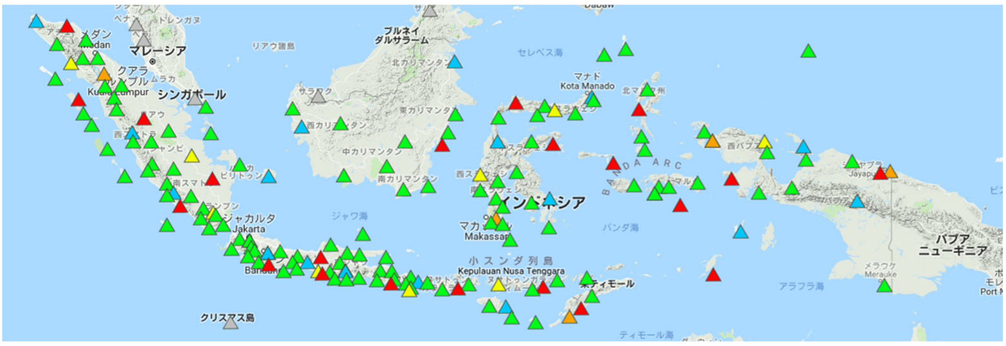


Figure 4-9 Outline of InaTEWS

InaTEWS is an automated system that gathers, integrates and analyzes the earthquake and tsunami observation data, and gives flash disaster report and early warning accordingly. BMKG has developed a Standard of Operation (SOP) for the appropriate use and operation of InaTEWS. The components of InaTEWS have been developed with the support of donors.

- Earthquake Observation Network (seismometer etc.): Germany, China, Japan[91], France[92]
- Tsunami Observation Network (tidal gauge, buoy etc.): Germany, USA
- Analysis System[93]: Germany

[89] https://www.pu.go.id/berita/view/9491/tempat-evakuasi-sementara-tsunami-padang-diresmikan
[90] Development of TES 2015 Fiscal Year (Pembangunan Tempat Evakuasi Sementara (TES) Tahun Anggaran 2015
[91] Japan Indonesia Seismic Network (JISNET) supported by National Research Institute for Earth Science and Disaster Resilience (NIED), and procurement and installation of seismometers by JICA "The Project for Improvement of Equipment for Disaster Risk Management"
[92] France supported the integration of earthquake observation network
[93] Developed based on the prototype, German Indonesian Tsunami Early Warning System: GITEWS



(Installed by ▲:Indonesia, ▲:Japan, ▲:Germany, ▲:CTBTO, ▲:China)

Figure 4-10 Earthquake Observation Network of Indonesia

As shown in the Figure above, the earthquake observation network is not dense enough in the eastern area of Indonesia. Today, there is not enough capacity to detect, as quickly as intended, the earthquakes originated in the north of Papua at the boundary of Oceanic and Indian Australian plates or those around the Sulawesi Island affected by the Philippine Sea plate. The insufficient number of observation points may deteriorate not only the time required to calculate various earthquake parameters (epicenter, magnitude, ShakeMap, focal mechanism, etc.) but also the accuracy of the calculations.

(3) Safe School Program (Ministry of Education and Culture / BNPB)

Promoting disaster prevention and risk reduction at school has been one of the most important policies in Indonesia, supported by the World Bank, UNDP, UNICEF and other donors. In 2006, the Consortium for Disaster Education (CDE) was established with the support of UN OCHA. Mainstreaming DRR in the education sector was addressed in the Circular Letter[94], following the Law No. 24/2007 on Disaster Management in 2007 and the establishment of BNPB in 2008. Indonesia participated in One Million Safe Schools and Hospitals Initiative (UNISDR) and officially launched “Safe Schools / Madrasahs from Disasters” (SMAB, hereinafter referred as “Safe School Program”) [95] in 2012. In the same year, it was piloted in 210 schools in five Provinces, and the Disaster Safe School Roadmap 2015-2019 was developed in 2015. In 2017, SPAB National Secretariat (responsible for special education including DRR education) was established in the Ministry of Education and Culture to promote the Safe School Program. SPAB is managed by two leaders, one assigned from the Ministry of Education and Culture and another from BNPB, so that BNPB can fully support this program and any other activities related to disaster management.

The Safe School Program consists of three pillars, (1) Safe Learning Facilities, (2) School Disaster Management, and (3) Risk Reduction and Resilience Education. Through the implementation of an integrated program for disaster safe school, students or children are expected to act as agents for dispersing knowledge on disaster management widely over generations from children to their parents, next parents (grown-up children) to their children, which will certainly contribute to a resilient society.

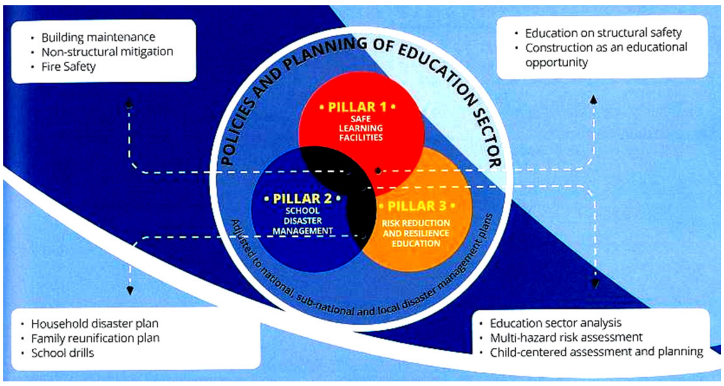


Figure 4-11 Three Pillars of Safe School Program

94 Circular Letter No.70a/SE/MPN/2010 related to Mainstreaming Disaster Risk Reduction in the Education Sector
95 BNPB Chief Regulation No.4/2012 Guideline for Implementation of Safe School

As of 2017, the Safe School Program had been initiated in less than 10% of all schools in Indonesia. The implementation has been started mainly from Pillar (2) or (3), and Pillar (1), which includes ensuring earthquake resistance of school buildings, is still a way forward. According to Professor Oktari at Syiah Kuala University / TDMRC, school deans have considerable authority in Indonesia, and therefore implementing Safe School Program heavily depends on their will to promote it. Another barrier for promoting and continuing the program is the lack of knowledge and capacity of the teachers on disaster management. Prof. Oktari emphasizes the importance of involving various stakeholders of the community in the program, in order to increase awareness and ensure its continuity.

According to the SPAB National Secretariat of Ministry of Education and Culture, most of the school buildings in Indonesia have been constructed in the 1980s. At that time, the constructions did not consider earthquake resistance. In order to achieve the global target "(d) Reduce damage to important infrastructure and interruption of critical services" of Sendai Framework for DRR, increasing seismic resistance capacities of the school buildings is an urgent matter.

(4) Improve Vulnerable Housing Conditions of Low-income Population "One Million Housing Program" (PUPR)

As of today, it is still difficult to find in Indonesia any significant DRR investments especially in structural measures for reducing earthquake and tsunami risks, such as the construction of tsunami protection dike, and seismic strengthening of building structures. Under such situation, there is one notable program, the "One Million Housing Program" that is aimed at improving housing conditions of the low-income group, strongly supported by President Jokowi as one of his promises during the presidential elections. PUPR implements the program, in accordance with the RPJMN2015-2019, by providing public housing and supporting house construction for the low-income population.

In general, the housing conditions and environment of the low-income group are marginal, and those houses are typically vulnerable to earthquake and tsunami disasters, not complying with the requirements of the building laws and regulations, and with the design codes and standards. Supplying public rental houses and apartments standardized by PUPR (prototyping of standardized housing for reducing construction and maintenance costs) can ensure compliance with the legal requirements. The stimulant aid to improve self-help houses (typically non-engineered houses) is a financial aid for purchasing construction materials, which is funded by PUPR and distributed through the relevant local governments. The house constructions are expected to be done in accordance with the requirements of the local building regulations (Building PERDA) since local facilitators will be assigned to monitor the process of the stimulant aid.

Table 4-8 Governing Laws and Regulations of "One Million Housing Program"

Governing Laws and Regulations	Outline
PUPR Ministerial Regulation No. 1/PRT/M/2018 on Flat Provision	Provide public rental housing. Construction based on PUPR standards.
PUPR Ministerial Regulation No. 20/PRT/M/2017 on Special Houses Provision	Provide housing (standardized house of $28m^2$ or $36m^2$) to the people who require special attention, such as border guards, fishing people, people affected by disaster or conflict, and people living in a remote area.
PUPR Ministerial Regulation No. 7/PRT/M/2018 on Self-Help Houses Provision	Stimulant aid to improve unsuitable housing conditions and environment of self-help or self-build houses
PUPR Ministerial Regulation No. 26/PRT/M/2016 on Housing Subsidy	Subsidy to a bank loan for housing for low-income people
PUPR Ministerial Regulation No. 3/PRT/M/2018 on Public Facilities Aid for MBR Residence	Support improvement of housing infrastructure (sanitation, water supply, wastewater, access road, waste management)

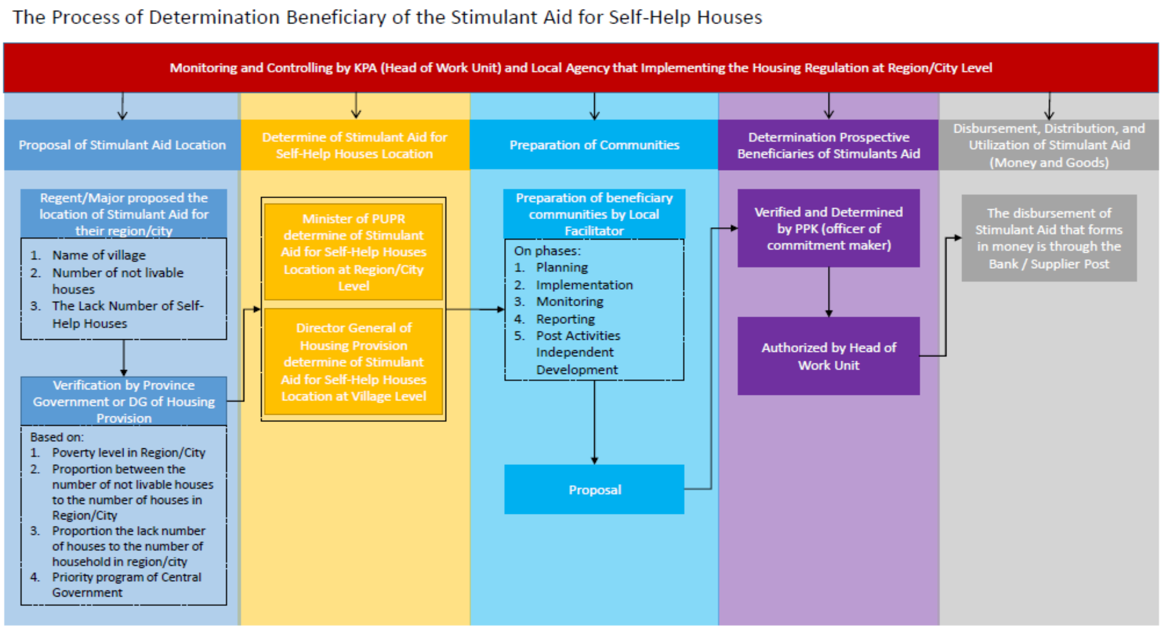
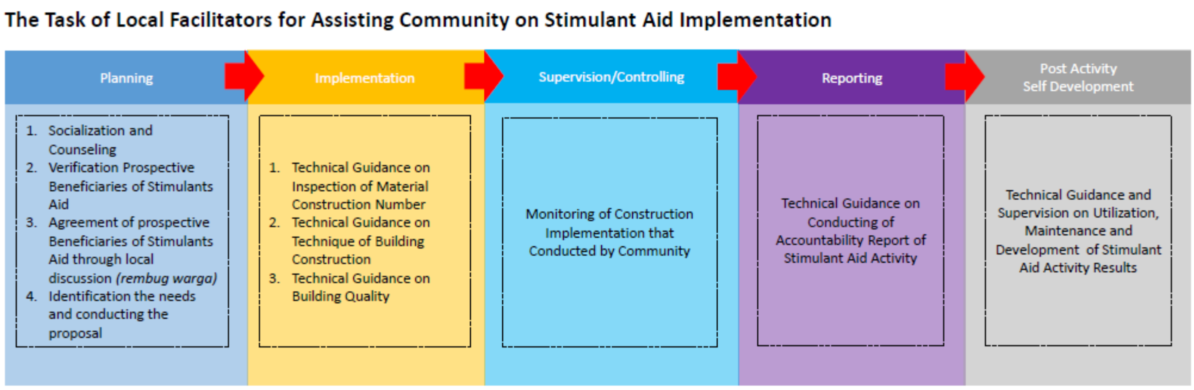


Figure 4-12 Process of Stimulant Aid for Self-Help Houses

However, it is concerned that house construction may not be done in the appropriate manner, in any region where Building PERDA is not yet issued or formalized, or in case that the assigned facilitator does not have sufficient technical knowledge. It is desirable that PUPR takes initiative for capacity development of facilitators, and provides necessary technical support to the local governments.



Source: Clause 18 of PUPR Minister Regulation No. 7 year 2018 concerning Stimulant Aid for Self-Help Housing *(Bantuan Stimulan Perumahan Swadaya)*

Figure 4-13 Role of Facilitator of Stimulant Aid for Self-Help Houses

The Housing Subsidy for the low-income group is a financial aid that the government provides to the banks so that the banks can then offer bank loans for housing with favorable life and rate to low-income people. Although the government or PUPR does not have any direct control on the house construction in this subsidy scheme, the banks that provide housing loan under this scheme are required to perform inspection on major structural elements (floor, ceiling, wall, etc.), to verify reliability of construction and compliance to safety requirements, and to check housing infrastructures (power supply, water supply and wastewater, access road). According to PUPR, those inspection and verification are typically outsourced to the housing developers who construct the houses, since the banks do not have any internal resources to perform such technical works. In order to optimize this scheme for enhancing the resilience of housing in Indonesia, it is desired that capacity development for third party inspectors is implemented at local levels, and that additional framework and measures are established for ensuring the quality of houses constructed under this scheme.

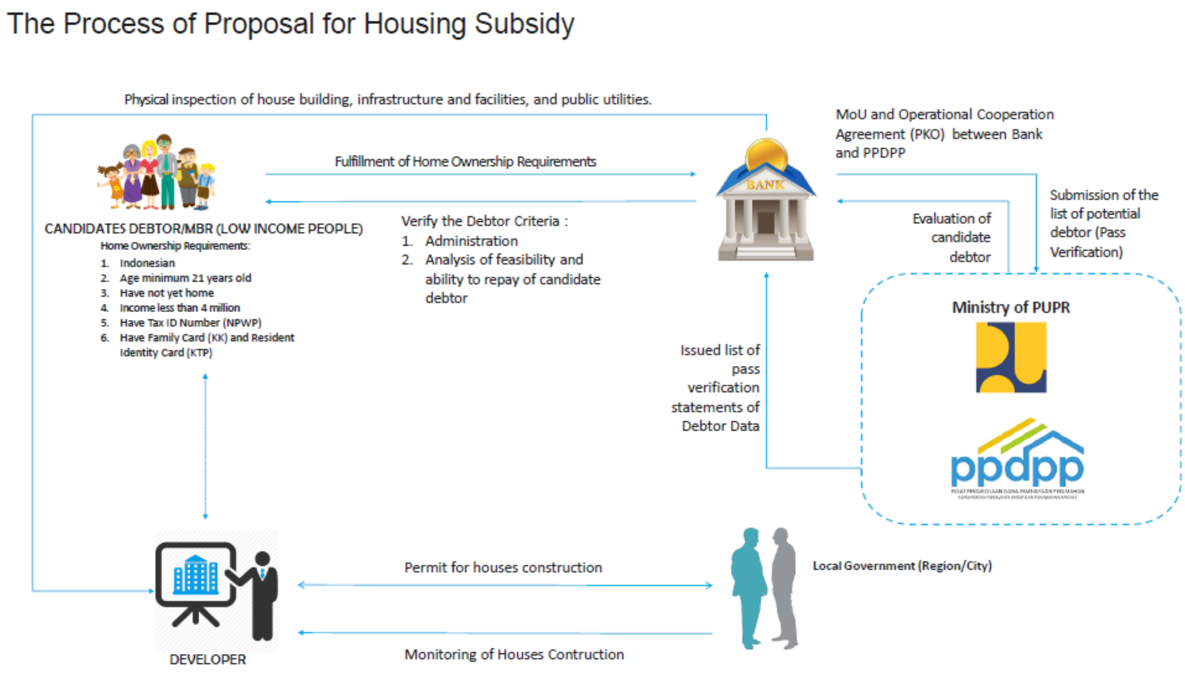


Figure 4-14 Subsidized Housing Loan for Low-Income Group

According to MAIPARK (Indonesian reinsurance company), it is mandatory for building owners or occupants to purchase fire insurance. It is also desirable that any program or framework for promoting earthquake insurance is established (e.g. make earthquake insurance mandatory for getting housing loan).

(5) Practicing "Build Back Better"

"Build Back Better" is practiced for earthquake and tsunami disasters in Indonesia, taking advantage of financial and technical aids from various donors for rehabilitation and reconstruction. In this section, four earthquakes and/or tsunami disasters after 2004 are selected, especially in view of good preparation for the next disaster.

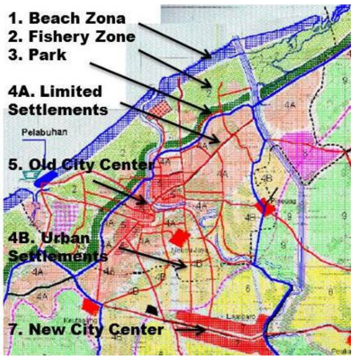
1) Indian Ocean Earthquake and Tsunami (December 26th, 2004)

InaTEWS, an observation and warning system for earthquake and tsunami disasters in Indonesia, was developed after the distractive 2004 Indian Ocean Earthquake and Tsunami, with the support of various donors. The system collects, integrates and analyze seismic wave records acquired from the earthquake observation networks immediately after the event, and then calculates major earthquake parameters such as epicenter and magnitude. The system stores the results or scenarios of pre-calculated simulations to identify the relationship between the parameters of potential seismic sources and the tsunamis that can be induced by those seismic sources. Once the system detects any earthquake and calculates its source parameters, it refers to the pre-calculated scenarios to find the most relevant one, estimates the potential of tsunami accordingly, and gives early warning.

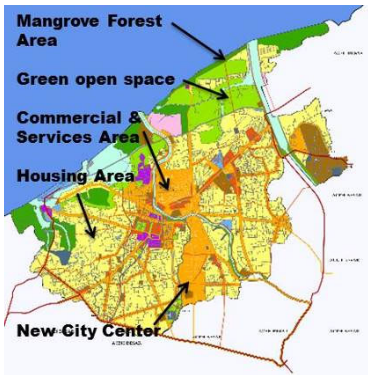
For the rehabilitation and reconstruction of Aceh and Nias devastated by the tsunami, the Agency for the Rehabilitation and Reconstruction of Aceh and Nias (BRR: Badan Rehabilitasi dan Rekonstruksi NAD-Nias) was established. While BRR developed the "Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias, Province of North Sumatera", the city of Banda Aceh also developed the "Urgent Rehabilitation and Reconstruction Plan for Banda Aceh City" with the support of JICA. The JICA team proposed a spatial plan to conserve the coastal area as a buffer zone for tsunami, based on the experiences and best practices in Japan for the rehabilitation and reconstruction after numbers of tsunami disasters. This idea was reflected in the spatial and land-use plans of the BRR's Master Plan, restricting development in the coastal areas (see Figure below).

Regarding the rehabilitation and reconstruction of the infrastructures, roads for evacuation and emergency were constructed, which enabled evacuation and passage of emergency vehicles in case of emergency or disaster. Temporary Evacuation Shelters (TES) for tsunami were also constructed in the coastal area, aiming to reconstruct a tsunami resilient city.

2005 BRR Master Plan(Spatial plan)



2005 BRR Master Plan (Land-use plan)



2009 Spatial Plan of Banda Aceh 2009-2029 (Land-use plan)

Figure 4-15 Build Back Better Planning of Banda-Aceh

Although the City of Banda Aceh (BAPPEDA Kota) continues to restrict development in the coastal areas, leading the development of a new city center toward the inland area, relocation of the residents from the coastal areas to inland has not been progressed as expected. It is a great concern that the Protected Area, where development is restricted, is apparently shrinking toward the coast in the land-use plan for the Spatial Plan 2009-2029 of Banda Aceh (RTRW: Rencana Tata Ruang Wilayah, see Figure above), and development is now allowed in the areas closer to the coastline (i.e. inundated areas of 2004 Tsunami) than it was initially planned.

Table 4-9 Land-use Classification in Spatial Plan of Banda Aceh

Spatial Classification	Land-use Classification
Protected Area	Local Protected Area
	Nature Reserve Area
	Cultural Heritage Area
	Disaster Prone Area
	Green Open Space
Cultivation Area	Housing Area
	Commercial Area and Commercial Services
	Office Area
	Tourism Area
	Fishing and Fishing Area
	Central Sports Center
	Public Service Area
	Port Area
	Small Industrial Area
	Non-Green Open Space
	Sector Space for Informal

Land-use classifications in the Spatial Plan of Banda Aceh 2009-2029 are shown in the Table above. Although "Disaster Prone Area" is listed under "Protected Area", there is no area allocated to "Disaster Prone Area" in the land-use plan for the Spatial Plan of Banda Aceh. According to the Spatial Plan of Banda Aceh, development is allowed even in "Disaster Prone Area", under the condition that there are sufficient infrastructures for emergency and evacuation, such as escape roads and evacuation facilities (e.g. TES). This seems reasonable but in reality settlement in the tsunami-prone areas (i.e. coastal areas) is continuously increasing, without sufficient evacuation capacities. Evacuation shelters should be thus installed in the coastal areas with the highest priority.

Another notable action was the establishment of the Tsunami and Disaster Mitigation Research Center (TDMRC) based on the Syiah Kuala University in Banda Aceh. BRR aimed to create in Aceh a center of excellence for tsunami disaster research to reduce tsunami disaster risks not only in Aceh but in all over Indonesia.

The establishment of the Tsunami Museum in Aceh was also a unique and important action taken for sharing memories and lessons learned of the 2004 Tsunami with the people in the other regions in Indonesia and even with the people all over the world, and for transmitting them to the next generations. There are some other tsunami memorials in Banda Aceh, such as the landed boiler ship, the fishing boat landed on a house, and the Tsunami Memorial Poles constructed with the support of Japan. The tsunami memorials will be described in detail in the later section summarizing the challenges in Aceh, and the Tsunami Memorial Poles will be detailed in the next section, JICA's Cooperation.

2) Yogyakarta Earthquake (May 27th, 2006)

There were more than 50,000 deaths in the 2006 Yogyakarta Earthquake. It was presumably the collapsed non-engineered houses (vulnerable to seismic shaking) that caused most of those victims. Although this earthquake was a shallow crustal earthquake (10-15km deep), the size or magnitude was M6.3, which could be considered rather moderate[96].

At the time of the earthquake, the Building Law (Law No.28 / 2002) had been already in place, and the Indonesian Building Seismic Design Code (SNI 1726:2002) had also been developed. If the collapsed houses were designed according to the requirements of the law and the code, they could have not collapsed, even though they could have been damaged to a certain extent. However, the Building Law only defines the basic requirements, leaving it to the local governments to implement the building construction permit process and administration governed by the local building laws and regulations. At that time, building permit process was not fully established at the local level, which became a priority issue together with the needs for capacity development both in the central and local governments.

Since 2007, the central government (PUPR) and the local governments have been working on the capacity development of building administration and enforcement, taking advantage of the JICA's cooperation, "The Project on Building Administration and Enforcement Capacity Development for Seismic Resilience (Phase I: 2007-2011, Phase II: 2011-2014)". "Key Requirements" were developed for non-engineered buildings to be attached to the local building law (Building PERDA), which schematically show structural specifications or details, aiming at enhancing seismic resistance capacity and reducing vulnerability.

These efforts resulted in the technical guidance on building permit and administration, PUPR Ministerial Regulation No.5 / 2016 (and its revision by Regulation No.6 / 2017), though there is still a lot to be tackled regarding the building administration and enforcement capacity at the local government level.

3) Sumatra Earthquake (September 30th, 2009)

The 2009 Sumatra Earthquake (M7.5) was not the major one expected in the seismic gap at the interplate along the Sunda Straight offshore Padang and was an intraplate earthquake occurred within the oceanic plate. Nevertheless, it caused significant damages in Padang City. Especially the school buildings constructed before 1980 were heavily damaged, and therefore it was desired that those buildings should be reconstructed

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96 The magnitude of the 1995 Kobe Earthquake, which caused more than 6,000 deaths, was M7.3

with much higher seismic resistance capacity since they were also expected to serve as evacuation shelters in case of emergency and disaster.

Although the PUPR Ministerial Regulation No45/PRT/M/2007 stipulates that any public buildings (including school buildings) constructed under the government budget must comply with the PUPR codes and standards, this had not strictly been followed and thus the school buildings had not been designed and constructed to be seismic resistant, since there was a lack of communication and coordination between the Ministry of Education (now Ministry of Education and Culture) responsible for school facilities and the PUPR responsible for public buildings and seismic design codes[97].

JICA provided a Grant Aid for the reconstruction of 10 schools (7 elementary and 3 junior high), which considered not only the Indonesia seismic design codes but also the Japanese ones in order to design and reconstruct them to a higher seismic and quality standard. This school design was also aimed to be applied as a prototype to the school constructions in any other regions, however, such practice was not mentioned during the interview with the Ministry of Education and Culture during this survey. Presumably, a wide application across the country has been difficult, since seismic hazards are different from region to region and thus the design cannot be fully standardized. Moreover, it requires specialists or experts on seismic engineering for promoting the prototype design, which should have made more difficult to realize it, as it is also stated in the JICA report (referred in the footnote) that there wasn't any expert on seismic engineering in the Ministry of Education. The role of BNPB as the national disaster agency is very important here, for coordinating between the Ministry of Education, and the PUPR that holds various specialists and engineers in construction.

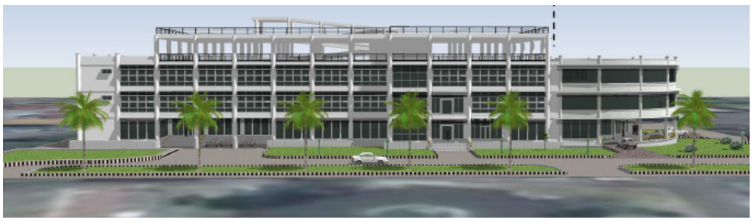
	
Base isolation building for Governor Office of West Sumatra Province[98]	Base isolation building for Dinas PU Office of West Sumatra Province[99]

Figure 4-16 Public Buildings with Base isolation Structure Constructed after Off Smatra Island Earthquake

Following the earthquake, the Government of West Sumatra Province designed and constructed base isolation buildings (which have very high performance against earthquake) for the offices of the Governors and Dinas PU. The top floor and the roof of the Governor's office building, and the roof of the Dinas PU building were designed to function as a tsunami evacuation shelter. The NPO "Engineers Without Borders – Japan" provided technical supports for the advanced design and technology of base isolation structure, referring to the Japanese design codes and standards for base isolation structure. The Japanese technologies were applied, using the base isolation systems (multi-layer rubber bearings) that were made in Japan.

According to BNPB, some other measures were also implemented to enhance the resilience or seismic capacity of hospital and bridge for evacuation. As already described, a great earthquake may likely be imminent at the interplate of offshore Padang, and therefore those activities to enhance the resilience or seismic capacity should be continued in an organized manner.

[97] "School construction design and construction supervision manual"in"The project for safe school reconstruction in devastated areas of earthquake in offshore of Padang in west Sumatra region in the Republic of Indonesia", 2011 August, JICA
[98] "Recovery Cooperation for Padang Earthquake Damage by Seismic Isolation Buildings Design" , Engineers without Boarder, Japan, Takayuki Teramoto and Toshio Okoshi
[99] https://stirrrd.org/2015/02/12/base-isolation-training-padang/

4) Aceh (Pidie Jaya) Earthquake (December 7th, 2016)

The 2016 Aceh Earthquake in Pidie Jaya caused significant damage again for its size (M6.5). For the rehabilitation and reconstruction, good cooperation and coordination were observed this time between BNPB, PUPR, Ministry of Education and Culture and Ministry of Health. 20 schools (of which 10 are with the support of donors), a mosque, a market, a university and a hospital are being reconstructed (as of January 24th, 2018, construction progress of mosque, market and university is 35.51%, progress of hospital is 18.97%).

This time compared to the reconstruction after the 2009 Sumatra Earthquake, there seems a significant improvement in the inter-organizational cooperation under the lead and coordination by BNPB and PUPR. It is highly expected that BNPB, as the national disaster agency, coordinates between central government agencies, ministries and local governments, and leads not only post-disaster activities (i.e. rehabilitation and reconstruction projects), but also pre-disaster activities (i.e. disaster prevention and preparedness, DRR projects), to promote the pre-disaster investments in DRR.

4.1.2.4 DRR Budget

The DRR budget in Indonesia from 2011 to 2012 is reportedly around 0.7% of the total government budget or about 1% of the central government budget[100]. Although the DRR budget was not categorized by disaster type (flood, tsunami, earthquake, landslide, etc.), a major part was used at that time for flood control projects undertaken by PUPR and Ministry of Forestry. The investment for earthquake and tsunami disasters did not seem to have a high share. It is desired that BNPB takes initiative to optimize budget line items so that DRR budgets can be easily aggregated, grasped and monitored by disaster type.

4.1.3 Cooperation by JICA

This section summarizes the aid and cooperation of the Government of Japan, mostly provided through JICA, especially after the 2014 Indian Ocean Tsunami, regarding earthquake and tsunami DRR. Major JICA support projects are already described in the previous section. Based on the JICA's track records in Indonesia, the direction of the JICA's cooperation can be summarized as follows.

The Government of Japan and JICA have been providing emergency assistance, through Technical Cooperation, ODA Loan and Grant Aid, for the rehabilitation and reconstruction after a major earthquake and/or tsunami disasters in Indonesia. From around 2007, the assistance is expanding especially in disaster prevention and preparedness, shifting the focus from post-disaster to pre-disaster (see Table below). The preventive disaster management, which Japan had been practicing since long, became international trends, with the adaptation of the 2005 Hyogo Framework for Action and the 2015 Sendai Framework for DRR. The JICA's cooperation can be characterized in line with these trends, taking the initiative to promote disaster prevention and DRR for the earthquake and tsunami disasters in Indonesia.

Table 4-10 JICA Cooperation on Earthquake & Tsunami

Project Name	Type	Period
Assistance for Rehabilitation and Reconstruction		
Emergency Grant Aid in Response to Sumatra Earthquake and Indian Ocean Tsunami	Grant	2004
The Study on the Urgent Rehabilitation and Reconstruction Support Program for Aceh Province and Affected Areas in North Sumatra	TC	2005
Urgent Rehabilitation and Reconstruction Plan for Banda Aceh City	TC	2005-2006
Central Jawa and DIY Earthquake Reconstruction Program Advisory Team	TC	2006-2007
Project for the Reconstruction for the Area Affected by the Earthquake in Yogyakarta and Central Java	Grant	2006
Emergency Grant Aid in Response to Earthquake Disaster in Central Java, Republic of Indonesia	Grant	2006
Aceh Reconstruction Project	Loan	2007
The Project for Improvement of Bridges in Nias Island (Detailed Design)	Grant	2008

100 "Preliminary Examination of Existing Methodologies for Allocating and Tracking National Government Budget for Disaster Risk Reduction (DRR) in Indonesia", Herry Darwanto, January 2012

Project Name	Type	Period
Urgent Project on Reconstruction of Schools considering Quake-resistance and Community Based Disaster Risk Management in the Province of West Sumatra in the Republic of Indonesia	TC	2009-2011
Project for Post-earthquake Rehabilitation of Water Resource Management Facilities in Padang	TC	2010-2011
The Project for Improvement of Bridges in Nias Island	Grant	2010
The Project for Safe School Reconstruction in Devastated Areas of Earthquake in Offshore of Padang in West Sumatra Region	Grant	2010
Emergency Grant Aid for the Earthquake off the Mentawai Islands, West Sumatra Province and the Eruptions of Mt. Merapi on Central Java Island in Indonesia	Grant	2010
Assistance for Disaster Prevention and Preparedness		
Project on Capacity Development for National Center of Tsunami Early Warning System	TC	2007-2009
The Project on Building Administration and Enforcement Capacity Development for Seismic Resilience	TC	2007-2011
Project on Building Administration and Enforcement Capacity Development for Seismic Resilience Phase 2	TC	2011-2014
Multi-disciplinary Hazard Reduction from Earthquakes and Volcanoes in Indonesia	TC	2008-2012
The Project for Enhancement of the Disaster Management Capacity of BNPB and BPBD	TC	2011-2015
The Project for Improvement of Equipment for Disaster Risk Management	Grant	2013-
Project for Earthquake Safer Built Environment employing PP-Band Mesh Seismic Retrofit(PPBM)Technology for Masonry Housin	TC	2014-2017
Community-Based Mutual Reconstruction Acceleration Program by Utilization of Local Resources in Banda Aceh City and Higashimatsushima City	TC	2013-2015
Banda Aceh and Higashimatsushima Mutual Reconstruction Project: Community Economic Empowerment for Local Disaster Mitigation	TC	2015-2018
Disaster Education by Utilizing Traditional Dance "MAENA" of Nias Island	TC	2016-2018

There is another interesting grant project from the Government of Japan. A Grant Assistance for Grassroots Human Security Project, "Project for Supporting Education of Tsunami Disaster Prevention in Nanggroe Aceh Darussalam" [101], was implemented by an Indonesian NGO "Yayasan Umi Abasia" under the technical guidance of the Kyoto University, Japan. In this project, 85 Tsunami Memorial Poles, representing the tsunami inundation height of each place, were constructed, which was inspired by the stone monuments commemorating tsunami disasters in Japan. The project included the implementation of disaster education as well. The aim is to be well prepared for the next mega-disaster, through the transmission of disaster awareness from generation to generation by visualizing the effect of the disaster using those monumental poles.

Table 4-11 Typical Epigraph of Tsunami Memorial Pole

Date	December 26th, 2004
Tsunami Inundation Depth (i.e. pole height)	[Example] 1.52 m
Distance from Coastline	[Example] 3.90 km
Tsunami Arrival Time	[Example] 8:40
Time from earthquake occurrence to tsunami arrival	[Example] 40 minutes
This monument was built in order to commemorate tsunami victims and to warn the residents, especially those in the next generations, of natural disasters that could happen in the future. It was constructed with the support of the people of Japan.	

It has been practiced in Japan since long to build stone monuments commemorating tsunami disasters at the highest points of the tsunami inundation, in order to transmit the lessons learned to the next generations (show and warn that any location lower than these points are prone to the tsunami). However, it is not always easy to pass the memory of a huge but less-frequent disaster down to the generations, during the return period of such an event, which is typically in hundreds or even thousands of years. For addressing this concern, the Tsunami Memorial Poles in this cooperation project were constructed in the prominent places where people gather, i.e. about a half within the premises of schools, 25% in the premises of mosques or meunasahs, and

[101] "Disaster risk reduction through application of methods for preventing fading away of disaster memory – from Kobe to Aceh, and to Padang", Megumi Sugimoto

others in the premises of other public facilities. It is expected especially at those schools that the memory of tsunami will be transmitted over the generations within the community by telling the story about the Tsunami Memorial Poles to the students.

The survey team visited 7 Tsunami Memorial Poles. We observed that some of them are not well maintained and some degradation was found. In order to pass the story of the tsunami down to the generations for hundreds and thousands of years from now, it is strongly desired that the poles should be appropriately maintained, and continue to be used for periodical campaigns and activities for raising disaster awareness at school and within the community.

Figure 4-17 Tsunami Memorial Poles Built at Banda-Aceh

4.1.4 Cooperation by Other Donors

Major cooperation projects from other donors are already described in the section for the effort of the Government of Indonesia. In this section, recent cooperation projects from other donors are summarized in the Table below. Projects for emergency assistance or assistance of rehabilitation and reconstruction are not included due to limitations of space.

Table 4-12 Other Donors' Cooperation on Earthquake & Tsunami

Donor	Project
BGR[102] (Germany)	Georisk-Project (2006-2009) The objective of the Georisk-Project is to develop and test a practical geological risk methodology study and to support the implementation of the findings of these geological risk mitigation strategies at the national, provincial and local levels for the long term and short term.
MFAT[103] (New Zealand)	Strengthened Indonesia Resilience: Reducing Risks from Disasters (StIRRRD) project (2014-) GNS Science is working with the University of Gadjah Mada on this $7.6 million project in ten districts in Eastern Indonesia.
	Implementing a Better Warehousing and Logistics Management Initiative with Beca New Zealand, the Indonesian Red Cross and New Zealand Red Cross
	2015-2017 $1.5 million, two-year project to develop an all-of-government framework for disaster response for Indonesia in conjunction with Indonesia's disaster planning agency and ANZDEC New Zealand
USAID	InAWARE: Disaster Management Early Warning and Decision Support Capacity Enhancement Project in Indonesia (2013-2016, 2016-2018) Underfunding from the U.S. Agency for International Development (USAID) Office for Foreign Disaster Assistance (OFDA), Pacific Disaster Center (PDC) is providing Technical Assistance to the Government of Indonesia's National Agency for Disaster Management (BNPB) to improve early warning and disaster management decision making outcomes. The project provides a web-based Decision Support System (DSS) for use by disaster managers at national and provincial levels.
IOM	Strengthening Disaster Risk Reduction Capacity and Promoting Community Resilience in Aceh (2012-2014) The objective is to contribute to the Government of Indonesia's initiatives to address the risk reduction efforts and assisting vulnerable communities in Indonesia. Activities include: Establish Community Forum, Development of Community Risk Map, Training for Government Officials, Awareness-raising Activities, Rapid Response to Natural Disaster
	Strengthening Disaster Risk Reduction Capacity and Promoting Community Resilience in West Java

102 Federal Institute for Geosciences and Natural Resources
103 Ministry of Foreign Affairs and Trade

Donor	Project
	Emergency Operations Centres for Enhanced Disaster Preparedness and Response Capacity The objective is to strengthen disaster coordination and response preparedness capacity in two selected provinces in eastern Indonesia. Activities include EOC Construction, Information and Communication Technology set-up, Training and outreach activities.
DFAT[104] / AusAID	AIFDR (Australia-Indonesia Facility for Disaster Reduction) - Risk and Vulnerability Program (2008-2015) Major achievements include: ✧ Facilitation of Indonesia's first 'best practice' national earthquake hazard map in 2010 ✧ Technical support to Badan Geologi to prepare real-time volcanic ash models ✧ Establishment of the GREAT program at the Institute of Technology (ITB) in Bandung ✧ InaSAFE tool exploits the investment in science to develop data for disaster management planning and response
	Australia-Indonesia Partnership on Disaster Risk Management (2015-2018) ✧ Keep supporting the InaSAFE program through DMInnovation. ✧ Conduct Technical Cooperation Project with BNPB in South Sulawesi and East Nusa Tenggara, with following activities: a) facilitation & advocating on disaster-related regulations (DM Plan, Contingency Plan. Etc.), b) Strengthening the role of Pusdalops (EOC) and c)Institutional Capacity enhancement of BPBD South Sulawesi and East Nusa Tenggara (NTT)
WB / GFDRR	Scaling Up Safe School Facilities in Indonesia[105] (2015-2017) Building capacity to support the implementation of a safer schools program. Collaboration with the Ministry of Education and BNPB has resulted in the development of a safe school risk map. This map will assist the government in prioritizing the rehabilitation of school buildings in high-risk areas and the integration of resilience elements in education infrastructure. A school vulnerability assessment instrument has been developed to assess the damage levels of existing elementary school buildings.
UNDP	Safer Communities through Disaster Risk Reduction (2007-2013, 2013-2016) Major achievements include: ✧ Formulation of National Disaster Management Plan 2010-2014 and National Action Plan on Disaster Risk Reduction 2010-2012 ✧ Formulation of Disaster Management Minimum Service Standard (Standar Pelayanan Minimal Penanggulangan Bencana/SPM PB) that assists local governments in planning and budgeting DRR programs ✧ Prioritize disaster management in Indonesia's Mid-Term Development Plan (RPJM) 2010-2014 and RPJMN 2015- 2019 ✧ Helping the Ministry of Education (MOE) formulate the National Strategy on Disaster Education ✧ Setting up a national Indonesian Disaster Information and Database (Data dan Informasi Bencana Indonesia-DIBI) ✧ Linking policy work at the national level with demonstration projects in eight target provinces and one target city ✧ Formulation of climate vulnerability indicators and gender-responsive guidelines to assess urban climate risks
	Strengthening School Preparedness for Tsunamis in Asia and Pacific (2017/06/01– 2018/11/30) Partnering with the Government of Japan in 18 Asia-Pacific countries, the United Nations Development Programme supports 90 schools to assess their tsunami risks, design emergency procedures and evacuation plans, and carry out tsunami awareness education and safety drills. The regional project contributes to the achievement of the Sendai Framework's seven targets to reduce lives lost, numbers of people affected, and economic damage from natural and human-induced hazards.

104 Department of Foreign Affairs and Trade
105 The Global Program for Safer Schools (GPSS) aims to boost and facilitate informed, large-scale investments for the safety and resilience of new and existing school infrastructure at risk from natural hazards, contributing to high-quality learning environments. The focus is primarily on public school infrastructure in developing countries.

4.1.5 Evaluation of Disaster Risks and Identified Challenges

4.1.5.1 Identified Challenges for Earthquake and Tsunami

The present state for earthquake and tsunami DRR in Indonesia has been analyzed in the previous sections. In this section, ten challenges are identified in four areas, namely "Disaster Information", "Governance", "Disaster Risk Reduction (DRR)" and "Disaster Preparedness and Build Back Better (BBB)".

Table 4-13 Challenges on Earthquake and Tsunami

Area	Challenges for Earthquake &Tsunami Disaster
Disaster Information (Understand Disaster Risk & Share Information)	1. Earthquake & tsunami observation network still remains at a bare minimum level 2. Mechanism of earthquake & tsunami disaster risk is not well understood 3. There is no legal framework or formal organization to perform regular nation-wide research on earthquake & tsunami 4. There is no analysis model or data available for local governments, which can be used for earthquake & tsunami DRR planning
Governance (Strengthen Governance for Disaster Risk Management)	5. DRR measures specific to the earthquake and tsunami disasters are not progressing, due to lack of dedicated policies and plans to earthquake or tsunami 6. There is no mechanism for reflecting the latest results and findings of earthquake and tsunami research into DRR policies 7. DRR policies, plans and projects are often ad-hoc and weak in continuity
Disaster Risk Reduction (DRR Investment for Resilience)	8. Empowerment of building construction permit process is insufficient due to weak governance for building administration 9. Mainstreaming of DRR in insufficient due to weak cooperation between ministries or government agencies
Disaster Preparedness & BBB	10. Transmitting and sharing disaster memories beyond time and space constraints are of importance

(1) Disaster Information (Understand Disaster Risk & Share Information)

«Challenge 1» Earthquake & tsunami observation network still remains at a bare minimum level

Following the 2004 Indian Ocean Tsunami, the earthquake and tsunami observation network have been established, for the development of earthquake and tsunami early warning system, InaTEWS. However, the current network is still at a minimum level to operate the early warning system. The density of the earthquake observation network is especially low in the eastern part of Indonesia, and thus it requires a longer time to detect earthquakes in this area and to calculate the earthquake parameters. The eastern part of Indonesia is prone to earthquake and tsunami, and enhancement of the observation capacity there is an urgent matter.

Improving density of the nation-wide observation network will definitely contribute to the shortening of calculation time, to a better understanding of source parameters and geological conditions, and to unraveling the mechanism of earthquake.

«Challenge 2» Mechanism of earthquake & tsunami disaster risk is not well understood

Even today, the mechanism of earthquake and tsunami remains to be completely elucidated. It is still difficult to predict the exact time and place of an earthquake or tsunami event. It is thus crucial in terms of earthquake and tsunami DRR to enhance basic research on earthquake and tsunami, to promote elucidation of phenomenon and mechanism, and to have people understand of the necessity and importance of the research as well as its latest findings.

Regarding earthquake, attention should be given not only to interplate earthquakes (those occur at plate boundary typically along ocean trench) but also to intraplate earthquakes (those occur within the plate, such as inland active faults) to identify potential sources and evaluate their seismicity. It is important as well to make people aware of any active faults near their place of life. Regarding Tsunami, attention should be given not only to those induced by earthquakes, but also those due to other causes, such as volcano eruption or landslide. Understanding tsunami risk and the importance of evacuation is key to saving lives.

«Challenge 3» There is no legal framework or formal organization to perform regular nation-wide research on earthquake & tsunami

As already described, it is necessary that basic research on earthquake and tsunami should nationally and continuously be conducted. There isn't any legal framework or formal organization in Indonesia to promote research activities as a national DRR policy.

The 2010 seismic hazard map of Indonesia was incorporated in the Indonesian building seismic design code of 2012. The map was updated in 2017, and the seismic code is under preparation for revision. The 2017 update was initiated by the stakeholders in different government agencies and realized based on the ad hoc PUPR ministerial regulation. This kind of update should be implemented regularly and continuously for reflecting the most recent findings of the basic studies, under a permanent framework or organization. It is recommended that the government formalize this process and further promote fundamental research and studies on earthquake and tsunami.

«Challenge 4» There is no analysis model or data available for local governments, which can be used for earthquake & tsunami DRR planning

As stated in the former section (Effort of Government of Indonesia), central government agencies such as BNPB have been developed several systems or databases for sharing disaster risk information (e.g. InaRISK, Risk Index). However, those systems or information have not been utilized by the local government for their risk assessment and DRR planning at local levels.

During our survey in Banda Aceh, we could not find any examples that the local governments in Aceh had utilized the data and information prepared by the central government for their DRR planning, except that BAPPEDA of Aceh Province sets the Risk Index (developed by BNPB) as an indicator or target for DRR.

Major reasons of this gap could be 1) local governments and BPBD are not aware of the existence of such information and database, 2) even knowing the existence, there is a lack of knowledge and capacity at local levels for utilizing the information, and 3) the available data and information do not meet the need of local governments.

(2) Governance (Strengthen Governance for Disaster Risk Management)

«Challenge 5» DRR measures specific to earthquake and tsunami disasters are not progressing, due to lack of dedicated policies and plans to earthquake or tsunami

The Government of Indonesia developed the "Disaster Management Policies and Strategies 2015-2019" following the "National Disaster Management Plan 2010-2014". The National Medium Term Development Plan (RPJMN) is developed for each presidential term. The RPJMN 2015-2019 clearly shows a policy direction toward DRR thanks to the BNPB's lobbying.

The "Disaster Management Policies and Strategies 2015-2019" is aligned with the RPJMN 2015-2019, representing BNPB's DRR policies. It addresses 1) DRR to support sustainable development at central and local governments, 2) reduction of disaster vulnerabilities, 3) enhancement of disaster management capacity, and 4) identification of priority regions. Although local DRR planning in line with this national plan has been promoted, it is now only 30% of all Kabupaten / Kota that has developed their DRR plans. In general, DRR measures of the local governments are mainly non-structural measures due to the budget limitations, and large DRR investments including structural measures are not common at local levels.

In 2012, BNPB led the development of "Tsunami Master Plan 2012-2014", addressing tsunami hazard assessment, promotion of tsunami DRR planning at local levels, improvement of transmission of early warning, improvement of tsunami evacuation process and evacuation directive, enhancement of early warning equipment, construction of tsunami evacuation roads and facilities (TES), and promotion of community DRR. This was a very effective and strategically important plan for encouraging tsunami DRR planning to the areas prone to tsunami across Indonesia. Regrettably, the plan was only partially implemented due to the lack of budget.

It is generally not a common practice in Indonesia to develop DRR policies and plans that are specific to a certain type of disaster. In the context of emergency response, standardization of operational processes is effective for prompt and efficient actions, regardless of the type of disaster. In contrast, there are wide varieties and differences in the policies and measures for disaster preparedness and DRR depending on the nature or type of disaster, which necessitate dedicated policies and plans for each disaster type. Developing DRR plans by disaster type accelerates the implementation of DRR countermeasures specific to the concerned disaster.

«Challenge 6» There is no mechanism for reflecting the latest results and findings of earthquake and tsunami research into DRR policies

Related to Challenge 3 "There is no legal framework or formal organization to perform regular nation-wide research on earthquake & tsunami", there is no mechanism in Indonesia to reflect the outcome of those studies into DRR policies. For example, the most up to date knowledge in seismic hazard should immediately be incorporated into the seismic design codes, or DRR investment and implementation of countermeasures should be prioritized in the areas where any major earthquake or tsunami is considered imminent. In order to realize effective and timely DRR actions, a formal and permanent structure for linking the research and the DRR policy is indispensable.

«Challenge 7» DRR policies, plans and projects are often ad-hoc and weak in continuity

Although the Tsunami Master Plan 2012-2014 was a dedicated plan for tsunami disaster, it has only partially been implemented and no succeeding plan has been developed. DRR policy programs in Indonesia seem at random and weak in stability and continuity. The majority of the coastline in Indonesia is subjected to high tsunami risk. It is urgent to develop tsunami evacuation plans and to construct sufficient evacuation roads and facilities.

It takes a long time to make buildings and infrastructures resilient and resistant to earthquakes. After the 2009 Sumatra Earthquake (offshore Padang), some programs and measures for "Build Back Better (BBB)" were implemented to increase the resilience, such as the reconstruction of school buildings to high seismic capacity (supported by JICA) and construction of base isolation buildings for the local government. These, however, remain as rehabilitation and reconstruction activities and have not evolved to steady and continuous DRR activities for resilience. In terms of earthquake risk and vulnerability of buildings and infrastructures, it is necessary to develop a long term vision and roadmap toward risk reduction and building national resilience, and short to medium term rolling action plans for ensuring the continuity.

(3) Disaster Risk Reduction (DRR Investment for Resilience)

«Challenge 8» Empowerment of building construction permit process is insufficient due to weak governance for building administration

Application of seismic design codes through the administration process for building construction permit is one of the most effective measures for making building resilient and resistant against earthquake. Seismic design codes have been developed in Indonesia as part of Indonesian Standard (SNI), and the legal framework for building construction permit is being established at the central and local government levels. However, there are still not a few buildings in Indonesia constructed without having permits. The capacity for implementing, operating and governing the building permit process is not sufficient in the local governments.

The best way to enhance the governing power or capacity is not necessary to realize the thorough operation of the permit process by introducing or strengthening penalties. It is more essential that all the stakeholders are involved for better understanding and awareness of the process, through capacity development of the civil service responsible for the building administration, raising awareness of the users (i.e. citizens) about the purpose, outline and benefit of the permit process, and giving assistance or incentives for the users to follow the process.

Regarding public facilities, such as government facilities, schools, medical facilities, and infrastructures, it is the responsibility of the central and local governments to ensure that appropriate seismic design codes and standards are developed, and public buildings and facilities are constructed in compliance with them. PUPR develops and updates seismic design codes and standards in Indonesia. It is still not a common practice in Indonesia to upgrade or strengthen the existing buildings and facilities that have been designed and constructed to the requirements of the older seismic codes, in order to satisfy the new requirements of the updated codes. For pursuing the resilience of public facilities and infrastructures, a clear plan is indispensable for seismic strengthening of the older facilities to build national resilience, accompanied by numerical targets or quantitative monitoring indicators.

«Challenge 9» Mainstreaming of DRR in insufficient due to weak cooperation between ministries or government agencies

There are only a few examples that BNPB, as the national or central disaster management agency, promotes DRR policies of the other ministries or agencies, or at least influence them on the policymaking related to DRR. An exceptional example is a cooperation between BNPB and the Ministry of Education and Culture on the Safe School Program to improve disaster risk management at school.

As described, PUPR is implementing “One Million Housing Program”, providing various supports for housing, to improve the living conditions and environment of the low-income population. It is expected that this program contributes to the improvement of earthquake resistance capacities of vulnerable houses, through the supply of rental apartments constructed with the PUPR standards, and the support to purchase proper construction materials for major structures (floor, roof, walls etc.) to self-help (self-build) houses that are non-engineered (typically vulnerable due to use of inappropriate materials and construction methods).

However, regrettably, a viewpoint of DRR is not clearly declared in this program, and BNPB is not involved. It is desired that BNPB collaborates with PUPR on this program to make it one of the national policies for DRR and resilience, which will be a very good example of mainstreaming DRR and enhance propagation effects of the DRR policies.

It is normally impossible to eliminate risks for earthquake and tsunami, and thus there are always residual risks even after reducing risks. One of the effective measures is disaster risk financing (including insurance) that compensates financial losses due to earthquake or tsunami (e.g. building damages). It could be one of the options for earthquake risk management to introduce a governmental earthquake insurance scheme in Indonesia, considering the amount of exposure to earthquake risk. It is ideal that BNPB, in collaboration with the Ministry of Finance and OJK, starts discussions on the possibility for such an insurance scheme

(4) Disaster Preparedness & Build Back Better

«Challenge 10» Transmitting and sharing disaster memories beyond time and space constraints are of importance

Indonesia has experienced a number of mega-disasters, needless to say, such as the 2004 Indian Ocean Tsunami. Such mega-disasters typically have return periods of hundreds or thousands of years. Once it happens, it is after several generations that a similar mega-disaster occurs at the same location. This is why learning disaster experiences of previous generations and other places is crucial. It is indispensable for that purpose to transmit and share experiences and memories of a mega-disaster beyond time (i.e. generation) and space (i.e. place or location).

Having said that, it is not always easy to pass the memories of disasters down to the generations, and share the experiences beyond time. Japanese people well know from experience that disaster memories fade away as time goes by and it is also difficult to experience the disasters in other places. The 1995 Kobe Earthquake in Japan occurred on the 17th of January just one year after the Northridge Earthquake in the United States (17th of January, 1994). The collapsed highway in Los Angeles did not trigger any actions or measures in Japan, and a year later we saw similar scenery in Kobe. In the 2004 Sumatra Earthquake and Indian Ocean Tsunami, we learned that an M9 level earthquake could occur along the Sunda Straight, which had been judged unlikely considering the age of the plates and the subduction speed. The seismic sources along the Japan Trench had been also believed unlikely to generate a mega-earthquake of M9 based on the same logic. The 2004 event in Indonesia did not change the evaluation of maximum earthquake in this region in Japan. The 2011 devastating Tohoku Earthquake and Tsunami occurred 7 years after the 2004 Indian Ocean Tsunami. Determined strategy and concrete mechanism are needed in order to share disaster memories beyond locations and generations.

4.1.5.2 Identified Challenges on Localities

Based on the analysis of the present state for Earthquake and Tsunami DRR in Banda Aceh, four challenges have been identified.

Table 4-14 Challenges of Banda-Aceh

Challenges for Banda Aceh
«Challenge of Aceh 1» Incomplete Tsunami Evacuation Plan
«Challenge of Aceh 2» Earthquake risk in Aceh and a long way to earthquake resilience
«Challenge of Aceh 3» Limited capacity of BPBD to promote DRR
«Challenge of Aceh 4» Share and transmission of disaster memory

«Challenge of Aceh 1» Incomplete Tsunami Evacuation Plan

The city of Banda Aceh is located in a plane field without having any steep slope. It requires a certain amount of time to evacuate in case of a tsunami from the areas along with the coast to the elevated places. Therefore, construction of Temporary Evacuation Shelter (TES) for a tsunami is indispensable in the coastal areas in Banda Aceh. Four TES were constructed after the 2004 Indian Ocean Tsunami, out of which three TES as community buildings in support of JICA, and one as a TDRMC building by the Agency for the Rehabilitation and Reconstruction of Aceh and Nias (BRR). There are two other TES, i.e. six in total, in Banda Aceh[106]. The Aceh Tsunami Museum opened in 2009 is also equipped with the functionality of TES, and one TES using steel structures constructed in the premise of BPBD Kota Banda Aceh with the support of Nippon Steel & Sumikin Metal Products Co., Ltd.

			
TES supported by JICA	TDMRC	Aceh Tsunami Museum	TES by Nippon Steel & Sumikin Metal Products

Figure 4-18 Tsunami Evacuation Shelters (TES) Built at Banda Aceh

[106] The Islamic Boarding School, where JICA Survey Team observed earthquake and tsunami evacuation drill held on the 19th of February 2018 supported by UNDP/JICA Partnership Fund, was (re-)constructed with the aid of the Government of Swiss Federation. There are signs of being designated as evacuation shelter for tsunami.

There are signs installed all over Banda Aceh showing directions and routes for evacuation, which guide people firstly to the temporary evacuation places (e.g. TES) for an immediate escape from the tsunami, and to the final evacuation points located about 5-6 km away from the coastline after the danger of tsunami is left.

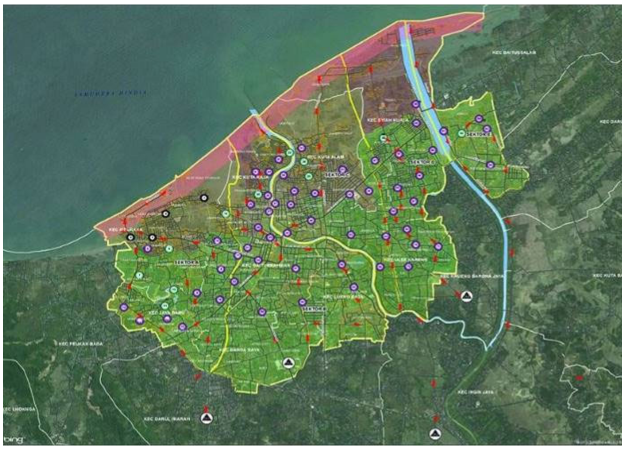


Figure 4-19 Tsunami Evacuation Map of Banda Aceh

In the above Tsunami Evacuation Map, black circles indicate "Existing TES", green circles do "Proposed TES" and purple circles do "Proposed land or place". The four black circles are the three TES constructed with the support of JICA and the one by BRR. All others are still under planning (i.e. only "proposed"), revealing that there is not sufficient capacity for temporary evacuation, especially in the coastal areas. The JICA Survey[107] in 2017 also estimated that the number of dead and injured would reach 25,000 in Banda Aceh and Aceh Besar, with the assumption that the 2004 Indian Ocean Tsunami occurred today, even if people had taken appropriate evacuation actions. Unfortunately, the tsunami evacuation plan of Banda Aceh is based on a wishful assumption on facility planning and should be considered incomplete or even defective.

In case that sufficient budget is not available to construct new TES, there is a possibility to utilize existing buildings as evacuation shelters, though any legal framework or system for such purpose has not been established yet in Indonesia. Under the current situation, a large number of people will not be able to evacuate to safe places before a tsunami arrives, even if all of the residents take appropriate evacuation actions based on the early warning from InaTEWS. There is still a high possibility of recording numerous victims, once a large scale tsunami occurs along the coast of Indonesia.

During our site visit, we found several school buildings reconstructed with the support of donors (e.g. Swiss Federation) or private companies (e.g. Manulife Insurance, Pirelli) that seemed to have good earthquake resistance capacities. Some of them seemed designated as TES for tsunami, though it was not clearly indicated by any signs visible from outside of the school. It is expected that those school buildings with multiple floor levels and high seismic capacity can be potentially utilized as evacuation shelters. According to TDMRC, there are 36 schools that can be possibly used as TES in Banda Aceh.

BPBD Kota Banda Aceh is considering the construction of three TES in three Kecamatan (Kuta Raja, Kuta Alam, Syiah Kuala) along the coast, i.e. one TES in each Kecamatan, since all the existing four TES built with the support of JICA and BRR are located in the same coastal Kecamatan, i.e. Meuraxa. BPBD Kota Banda Aceh was established based on the fire department and therefore does not have its proper office building. They also consider constructing their own office building that is equipped with the function of TES.

In the course of rehabilitation and reconstruction from the 2004 Indian Ocean Tsunami, the first priority was to respect the human rights and to give people the freedom to select their own place to live. There were thus

107 Data Collection Survey for DRM Sector in Aceh Province (Geospatial Analysis), Feb. 2017, JICA, PT. Nusantara Secom InfoTech

no rigorous restrictions on the settlement in the coastal areas, though development was restricted in those areas subjected to tsunami risks[108]. There was an attempt by the local governments to limit settlement in the coastal areas by purchasing lands, which has not been successful. It was thus planned that TES should be constructed in the coastal areas for the purpose of vertical evacuation so that the residents there would be able to temporarily evacuate to those shelters immediately after any earthquakes that could generate tsunamis.

In the Spatial Plan of Banda Aceh 2009-2029, construction of large commercial complex and school is restricted in the coastal areas, in order to guide the development of a new city center in the inland area far enough from the coast. For stimulating this movement, the government offices are being relocated from the coastal areas to the inland area.

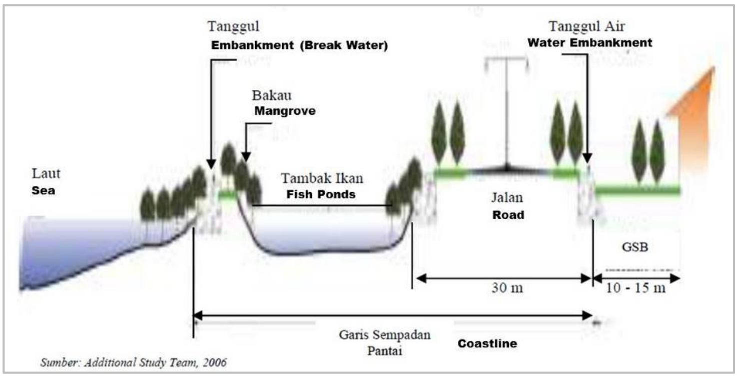


Figure 4-20 Improvement Plan for Coastal Areas of Banda Aceh considering Tsunami DRR (Spatial Plan of Banda Aceh 2009-2029)

As shown above, the Spatial Plan of Banda Aceh has adopted a concept of multi-layer protection which was initially proposed by JICA in the reconstruction plan of the 2004 Indian Ocean Tsunami, considering attenuation of tsunami through multiple buffer zones, i.e. breakwater at the coastline, mangrove forest around fish ponds, and elevated road (embankment).

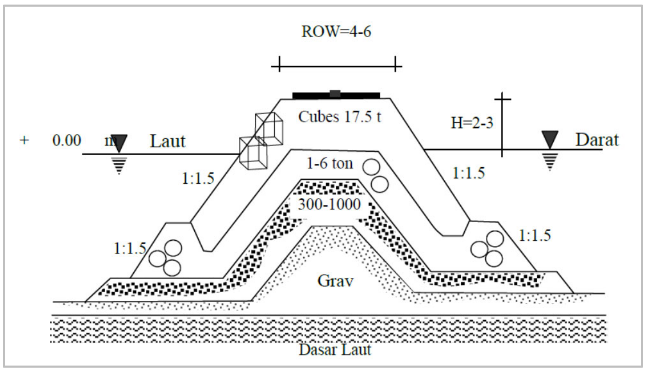


Figure 4-21 Cross-section View of Break Water (Spatial Plan of Banda Aceh 2009-2029)

The Spatial Plan of Banda Aceh 2009-2029 succeeds in the rehabilitation and reconstruction plan of the 2004 Indian Ocean Tsunami. During the site visit, we could see the breakwater along the coastline and some mangrove forests around the ponds (please see photos below).

108 "Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and The Islands of Nias, Province of North Sumatera", April 2005

	
Break Water	Mangrove Forest

Figure 4-22 Break Water and Mangrove Forest

The coastal part of the ring road surrounding the city of Banda Aceh is currently under planning. As described, it is also considered to elevate this road and make it function as embankment or dike to mitigate tsunami inundation risk. TDMRC performed a simulation to verify the effect of this embankment, which turned out to be effective.

It may be true in theory that the probability of an earthquake and tsunami having a similar magnitude with the 2004 event has been significantly lowered in Aceh at this moment of time. However, the present situation in Aceh can be described as unfinished “Build Back Better (BBB)”. If we wait until the next devastating tsunami as it stands now, the memory of tsunami will fade away without implementing any further DRR measures, and one day when the past disaster is totally forgotten, the next mega-event will arrive. It is absolutely necessary now to develop a long term DRR plan and steadily implement the DRR measure and actions, which will definitely contribute to the enhancement of DRR capacity not only in Aceh but also in Indonesia, and to the building of national resilience, in accordance with the Sendai Framework for DRR.

«Challenge of Aceh 2» Earthquake risk in Aceh and a long way to earthquake resilience

There have been several inland earthquakes recently occurred in Aceh Province caused by the crustal faults or active faults within the continental plate. Some of these seismic sources were not even known until recently (e.g. 2016 Aceh / Pidie Jaya Earthquake). Damages and losses due to these earthquakes were rather significant for their moderate sizes with the magnitudes less than M6.5, e.g. 2013 Aceh (Takengon) Earthquake (M6.1) and 2016 Aceh (Pidie Jaya) Earthquake (M6.5), revealing the high vulnerability of the buildings in the region. There are two active faults, i.e. Aceh-North and Seulimeum-South (see Figure below), running near the city of Banda Aceh. DRR measures should be urgently implemented in Banda Aceh, which may include the establishment and thorough implementation of building construction permit process to enhance the seismic performance of buildings, and seismic strengthening of public facilities, such as government offices, schools, medical facilities and infrastructures.

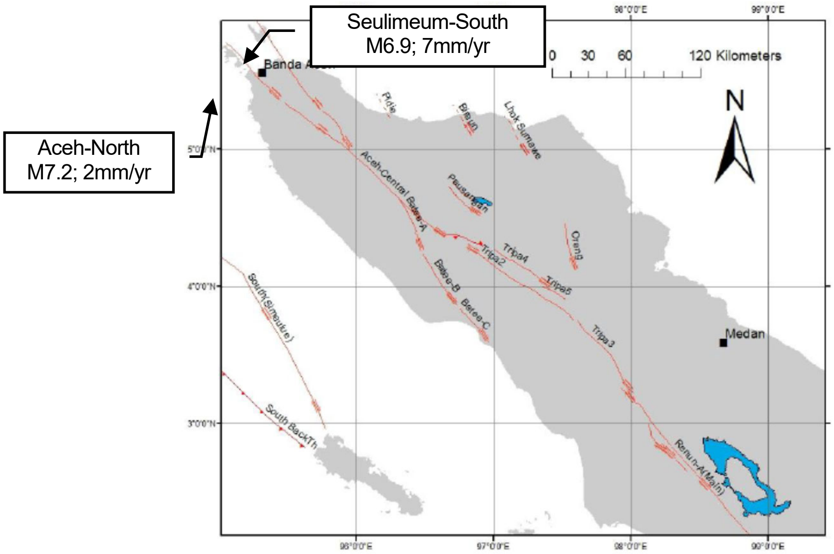


Figure 4-23 Fault Map around Aceh

The latest seismic hazard map in 2017 reflects the findings of the most recent research and survey on the active faults. The seismic hazard level[109] in Banda Aceh has been increased to 0.7-0.9g in the 2017 map compared to 0.5-0.6 in the 2010 map[110] (see Figure below). At the time when the latest 2017 map is incorporated in the seismic design code in the near future, even the buildings designed and constructed in compliance with the current seismic code (SNI1726:2012) may be found unsatisfactory to the requirements of the update code. There will be soon a need for standards and guidelines on seismic evaluation and strengthening methods, in order to assess seismic capacity or performance of existing buildings that have been constructed according to the older versions of seismic design codes or constructed without obtaining a building permit (IMB) and to strengthen them if required.

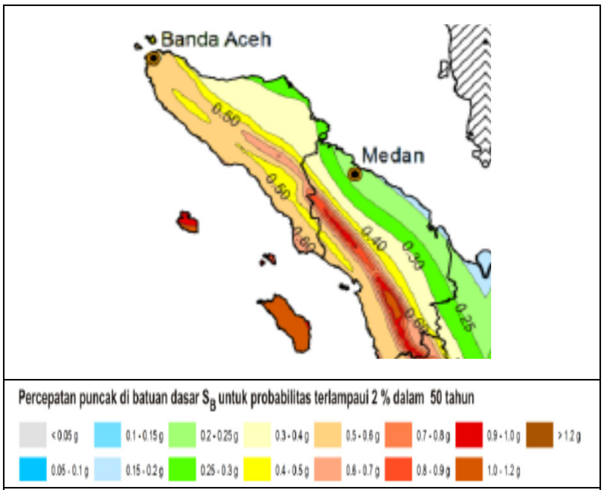


Figure 4-24 2010 Seismic Hazard Map

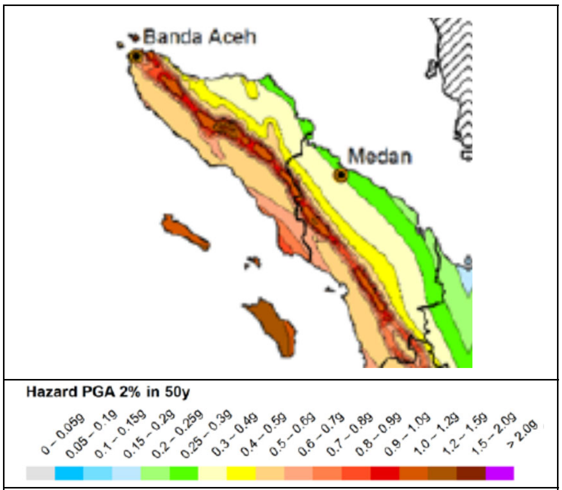


Figure 4-25 2017 Seismic Hazard Map

The Building PERDA (No.10/2004) for Banda Aceh was enacted in 2004, following the Indonesian Building Law (Law No.28/2002) in 2002. This Building PERDA stipulates building administration including construction permit process (IMB), application of Indonesian Standards (SNI) for building design, and implementation of structural design and calculations (i.e. consideration of seismic load). This PERDA was established in 2004 before the Indian Ocean Tsunami. Since then, the PUPR Ministerial Regulation No.5/2016, a technical guideline on building construction permit (revised by PUPR Ministerial Regulation No.6/2017), was enacted in 2016. There is a draft version of the updated Building PERDA for Banda Aceh, incorporating the lessons learned from the Indian Ocean Tsunami and the requirements in the new technical guideline, which has not been approved yet as of April 2018.

«Challenge of Aceh 3» Limited capacity of BPBD to promote DRR

According to Professor Oktari at Syiah Kuala University (and TDMRC) who has been conducting research on school DRR and DRR budget of Banda Aceh[111], DRR budgets of Banda Aceh had been increasing since 2011, the year when BPBD (Kota Banda Aceh) was established. At this stage, the DRR budgets were nearly equal to the budgets for BPBD, and the majority of the budgets were for the activities related to fire prevention, as BPBD was created based on the fire department.

The DRR budget share in 2015 was 0.59% of the total budget. Since the budget amount of Banda Aceh itself was not so large, the DRR budget was mainly used for the normal activities of BPBD and the equipment maintenance. Prof. Oktari also points out that one of the bottlenecks for increasing the DRR budget is the lack of capacity of BPBD staff in formulating DRR policies, programs and projects, and in convincing the decision-makers of the needs to implement them.

109 Maximum acceleration at bedrock with 2% exceeding probability in 50 years
110 SNI 1726:2012
111 "Disaster budgeting of Banda Aceh's local government: Trends and analysis of post-tsunami Aceh 2004", R S Oktari et al, 2017 IOP Conf. Ser.: Earth Environ. Sci. 56 012024

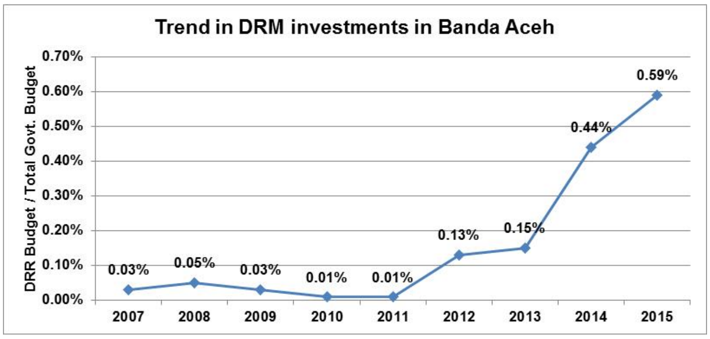


Figure 4-26 Share of DRR Budget in Total Budget of Banda Aceh (Oktari et al)

«Challenge of Aceh 4» Share and transmission of disaster memory

As already mentioned in «Challenges 10», a concrete and stable mechanism needs to be set up for sharing disaster memories and experiences beyond generations and locations. In Banda Aceh, a number of tsunami memorial facilities have been formed in the course of recovery and reconstruction from the 2004 Indian Ocean Tsunami, such as the Tsunami Museum, cemeteries, commemorative facilities, tsunami ruins, etc.

			
Landed power generation ship	Exhibition space in a landed power generation ship	Damaged buildings near TDMRC	The fishing boat landed on residence

Figure 4-27 Major Tsunami Ruins in Banda Aceh

The number of visitors to the Aceh Tsunami Museum is steadily increasing since its opening in 2011. It is becoming a popular place to visit, counting about 700,000 visitors in 2017[112].

The Spatial Plan of Banda Aceh 2009-2029 aims to promote tsunami tourism, designating the coastal area around TDMRC as a tourism area. For Mr. Rahmadhani of the Culture and Tourism Office of Aceh Province, tsunami tourism is not a mere tourism promotion for economic effects. The true meaning is to pass the tsunami experiences and memories down to generations, by keeping them lively through tsunami tourism, and sharing with the world the living experience of rehabilitation and reconstruction from the devastating tsunami[113].

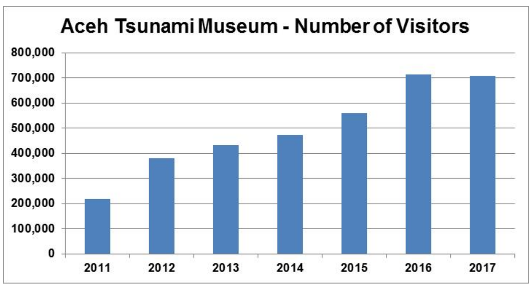


Figure 4-28 Aceh Tsunami Museum Visitors (*Source: Aceh Tsunami Museum*)

112 For comparison, annual visitors to Disaster Reduction and Human Renovation Institution in Kobe isabout 5000,000 according to its annual report

113 CIAS Discussion Paper No.25, "From world famous tsunami devastated area to world famous tsunami tourism center"

The Center for Integrated Area Studies (CIAS), Koto University conducted jointly with TDRMC the project for "Area Studies of Disaster Response (2008-2014)", of which the main target was Aceh with a special focus on the impact of the 2004 Indian Ocean Tsunami. It aimed at showing an alternative paradigm for disaster risk management and humanitarian aid, by employing methodologies to view the area under study stereoscopically in the breath of time and space. This project produced three applications for a smartphone to record the 10 years of rehabilitation and reconstruction from the 2004 tsunami disaster in Aceh, which can be utilized for DRR education and tsunami tourism linking Japan and Indonesia.

Table 4-15 Applications for Recording Aceh Tsunami Reconstruction (CIAS, Koto University)

Application	Outline
Aceh Tsunami Archive	✧ Application storing testimony of tsunami survivors on the digital glove ✧ Experiencing tsunami disaster in three-dimensional expressions, as well as browsing maximum tsunami inundation height and photos taken right after the tsunami ✧ Developed jointly with TDMRC and Prof. Hidenori Watanabe (Tokyo Metropolitan Univ., Japan)
Aceh Tsunami Mobile Museum	✧ Application storing image materials showing landscape change in 10 years from 2004 Indian Ocean Tsunami ✧ Overlaying current and past landscapes based on global positioning information using Augmented Reality (AR) viewing function ✧ Aiming to make the city itself an open museum using mobile terminals ✧ Developed jointly with TDMRC
Aceh Tsunami Devastated Area Memory Hunting	✧ Application for taking a photo of current scenery in the same composition with a photo taken in the past, by overlaying the past photo in semi-transparent display on the camera viewfinder, and for sharing it with other mobile terminals ✧ Aiming to help to form a community to share landscape history, as well as recording landscape change since the tsunami ✧ Developed jointly with TDMRC and Prof. Tomonori Kitamoto (National Institute of Informatics, Japan)

According to the press release from the International Research Institute of Disaster Science (IRIDeS), Tohoku University on the 25th of December 2015[114], the government of Aceh Province (Culture and Tourism Office of Aceh) inaugurated the "Digital Archives of Tsunami in Aceh (DATA)" project, in collaboration with the Syiah Kuala University and IRIDeS, which seems still ongoing today[115].

With all these projects and activities, certain hubs and facilities for tsunami tourism to share and transmit disaster memories have been created in Aceh, however it doesn't seem there is an overall strategy to integrate and synchronize all these discrete facilities and hubs and to appeal to visitors with a clear vision and image of tsunami tourism in Aceh. Aceh is also a place having many attracting aspects in rich natural and cultural environments and with high potential for tourism in general. It is thus desired that a comprehensive development plan, including improvement of infrastructure for tourism, is formulated.

4.2 Meteorology & Early Warning Systems

4.2.1 Characteristics of Recent Meteorology

4.2.1.1 Overview of Meteorology and Early Warning System in Indonesia

In Japan, the development of infrastructure for disaster risk reduction drastically progressed in the period of high economic growth, from the 1950s to 1970s. Since this period, structural measures have continued to progress and socio-economic damage due to disasters that occurred relatively frequently decreased. Conversely, the vulnerability of social infrastructure to large-scale disasters that occur infrequently is increasing. Although it is not economically reasonable to apply structural measures that require a huge budget to large-scale disasters that occur infrequently, on the other hand from the viewpoint of disaster management, it is necessary to take countermeasures to reduce some damages against large-scale disasters. Therefore, to

[114] http://irides.tohoku.ac.jp/media/files/_u/topic/file/20151225_report.pdf
[115] http://irides.tohoku.ac.jp/media/files/_u/topic/file/20161122_report.pdf

mitigate damage to human life in cases of large-scale disasters that exceed the anticipated structural measures from around 2000, forecast and warning system for floods started operation as the first step of disaster risk reduction in Japan. Unlike the introduction of the forecasting and warning system in Japan, in the countries and areas where structural measures for disaster risk reduction are in the developing stages, early warning systems (hereinafter "EWS") generally have relatively lesser time and a small budget for implementation compared to structural measures. Therefore, EWS introduction has widely expanded to reduce the number of casualties which is the most serious damage at the time of a disaster. Also, since implementation time and budget can be relatively small, substantially increasing the availability of and access to multi-hazard EWS and disaster risk information is listed as one of the seven global targets in SFDRR. Indonesia indicates in the guidelines for achieving SFDRR that the development of EWS and strengthening of the observation system and disaster information access[116]are vital.

Indonesia is an island country spreading 5,000 km east to west across the equator. It has a coastline of more than 50,000 km—one of the longest coastlines in the world. Most of the country belongs to the tropical rainforest climate zone, and it is hot and humid throughout the year. The temperature varies somewhat depending on the area, but the annual average temperature is 27 °C, the average annual maximum temperature is 30°C to 34 °C, the average annual lowest temperature is 22°C to 24 °C, and there is almost no seasonal variation. In addition, the annual average humidity is more than 80%, which is very high compared with Japan. The land is located within latitude ± 10 ° and is not affected by tropical cyclones, though it is divided into the rainy season (May to September) and dry season (October to April) due to the seasonal winds. In Sumatra Island and the western part of Java Island, there is not much difference in rainfall between the seasons, but in Denpasar, Makassar, and Surabaya there is a clear dry period from July to September. Average annual rainfall in the lowland is 1,800 mm to 3,200 mm, and in mountainous areas, there are places that can reach up to 6,000 mm or more. Monthly temperatures and monthly rainfall in Indonesia are shown below respectively[117].

Weather forecasting is important from the standpoint of disasterr management; however, in Indonesia, weather forecasting from weather charts is difficult because there is no typhoon as a feature of the climate in the vicinity of the equator. In response to this, in the scheme of Science and Technology Research Partnership for Sustainable Development (SATREPS), installation of Doppler weather radar and offshore meteorological observation buoys etc. was executed from 2010 to 2013 through "Climate Variability Study and Societal Application through Indonesia - Japan "Maritime Continent COE" - Radar-Buoy Network Optimization for Rainfall Prediction" with BPPT (Agency for the Assessment and Application of Technology) as a counterpart. As a result of the research, the mechanism of heavy rainfall occurrence in Jakarta was clarified and improvement of accuracy of short-term/long-term weather prediction progressed.

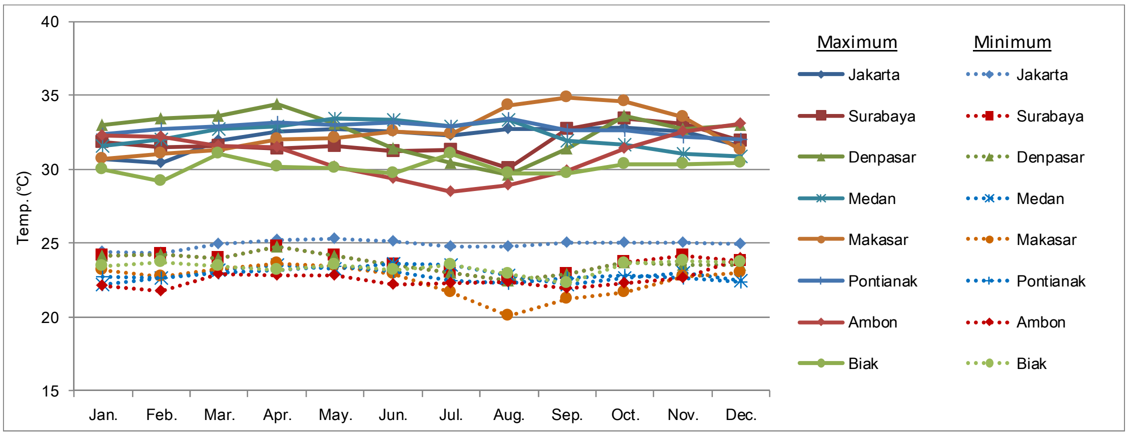


Figure 4-29 Monthly Average Temperature in Indonesia

116 "INDONESIA'S ROADMAP FOR THE IMPLEMENTATION OF THE SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION FOR SUSTAINABLE DEVELOPMENT (2015-2030)"
117 Temperature of Indonesia (http://www2m.biglobe.ne.jp/~ZenTech/world/infomation/kion/indonesia.htm)

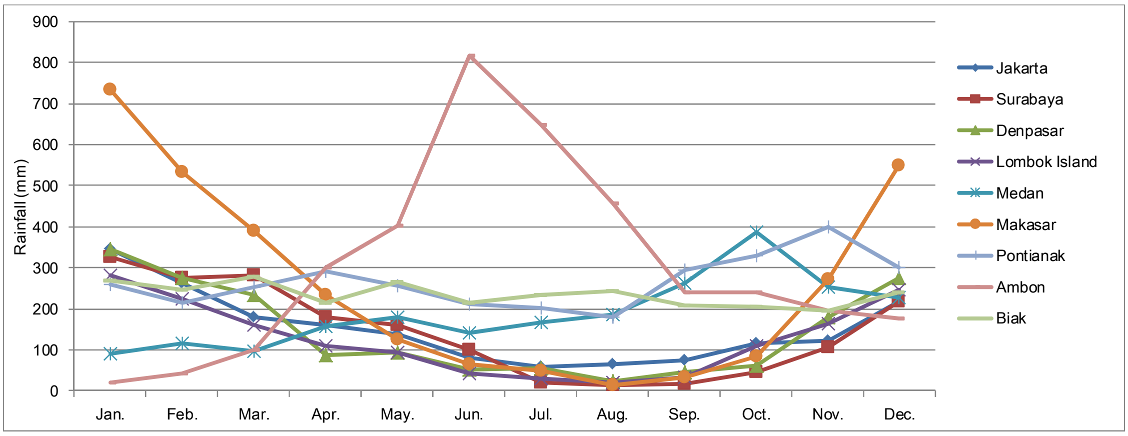


Figure 4-30 Monthly Average Precipitation in Indonesia

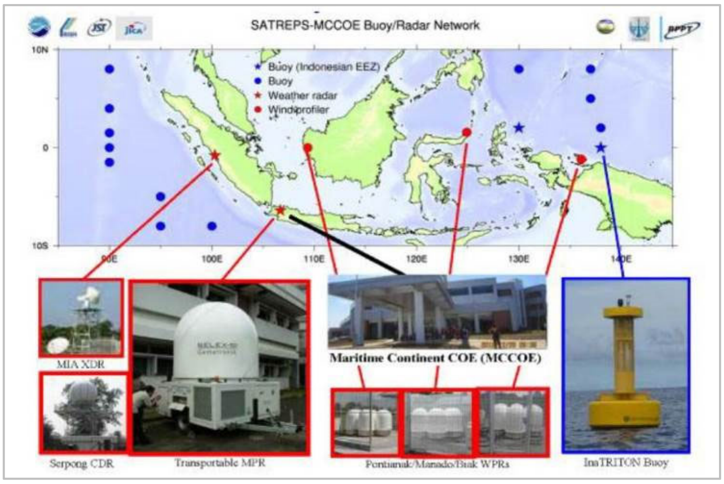


Figure 4-31 MCCOE Radar Buoy Network in SATREPS[118]

4.2.1.2 Impact of Climate Change in Indonesia

Climate change induces the frequent occurrence of floods and sediment-related disasters due to an increase of precipitation. In addition, Indonesia, which has a huge number of islands and vast coastline, has a very high coastal population. For example, 65% of the population of Java lives in the coastal region. Therefore, sea-level rise is of particular concern due to its serious impact on Indonesia. According to the global climate change prediction model, temperatures of the ground, air, and seawater in Indonesia are on an upward trend. For example, over the next 100 years, the temperature in Jakarta is predicted to rise 1.04 degrees in January and 1.42 degrees in July, respectively. There is also a prediction that if the current level of greenhouse gas emissions continues, the sea level will rise by 60 cm by 2070. The climate variability and seasonal variation have significant effects on rainfall trend. In many regions of the country, it is observed that on average the beginning of the rainy season will retreat and the intensity of rainfall during the rainy season will increase, while during the dry season the rainfall will decrease. Such trends are expected to continue in the future, and it is feared that floods, storm surges, and the like, which have occupied more than 50 % of the total number of disasters in the past 50 years, will become more severe due to climate change119. In response to these concerns, the National Action Plan Addressing Climate Change (2007) contains mitigation measures which include the reduction of CO_2 emission in the energy sector and land use regulations which include the promotion of greening. The plan also includes adaptations to the increasing disasters (such as floods caused by climate change), understanding and dissemination of risks of disasters, improvement of climate change

118 "Climate Variability Study and Societal Application through Indonesia - Japan "Maritime Continent COE" - Radar-Buoy Network Optimization for Rainfall Prediction" Final Report, 2014
119 National Action Plan Addressing Climate Change 2007, State Ministry of Environment

prediction technology, revision of planning and design standards for infrastructure improvement including flood control facilities etc.

BMKG conducts long-term weather analysis in order to grasp the influence of climate change on hydrology, agriculture and forests. Figure 4-32 compares the average maximum air temperature of 1971-2000 with the predicted results for the mid-term (2010-2039) and the long-term (2040-2069). This analysis was conducted in two scenarios: RCP 4.5 (medium stabilization scenario) and RCP 8.5 (high-level reference scenario). According to the analysis, in the RCP 4.5, the average high temperature in the mid-term (2010-2039) is expected to rise from 0.4 °C to 1.0 °C, and in the long-term (2040-2069), it is estimated to rise from 0.8 °C to 1.4 °C. In the case of RCP 8.5, the temperature rise in the long-term (2040-2069) is 1.4 °C to 2.2 °C.

For Bali, in order to facilitate the adaptation of agricultural sector to climate change, vulnerability analysis ability in the field of agriculture was developed under the support of JICA, and concrete countermeasures were considered to reduce economic loss due to climate change.

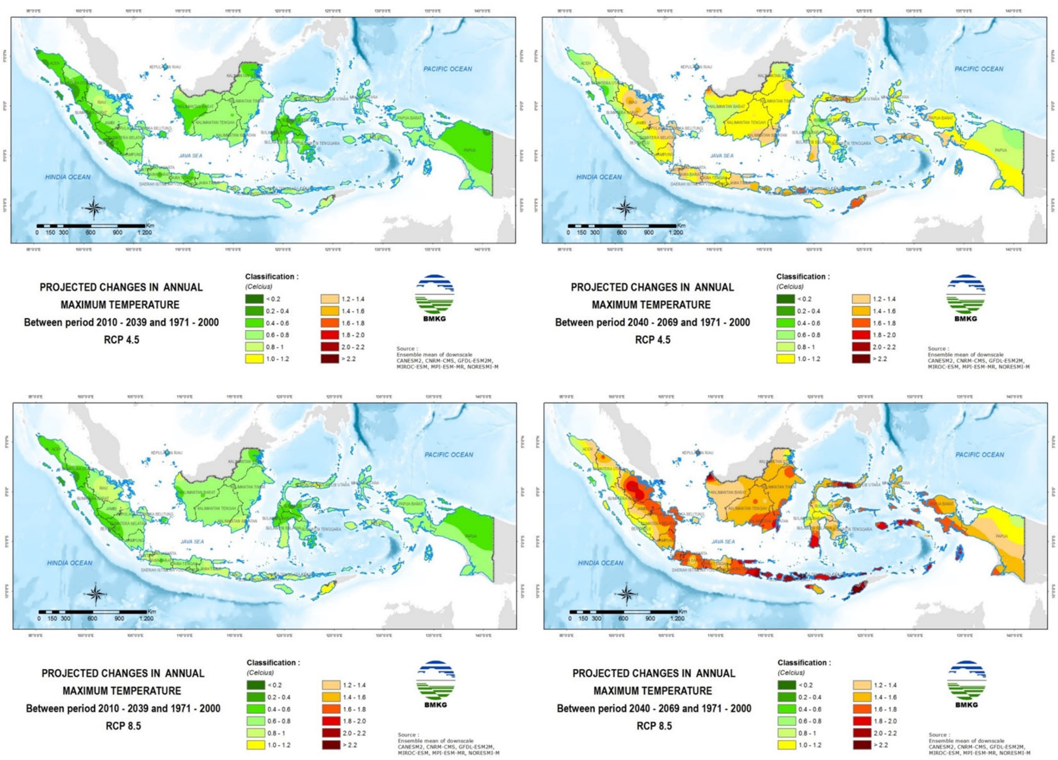


Figure 4-32 Variation of Average Maximum Temperatures in Mid-term and Long-term (top: RCP 4.5, bottom: RCP 8.5)

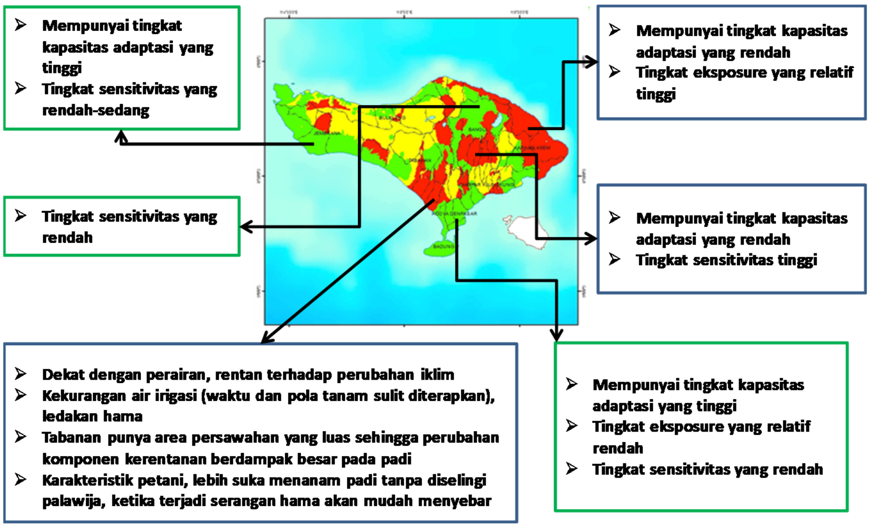


Figure 4-33 Agricultural Vulnerability Map on Climate Change

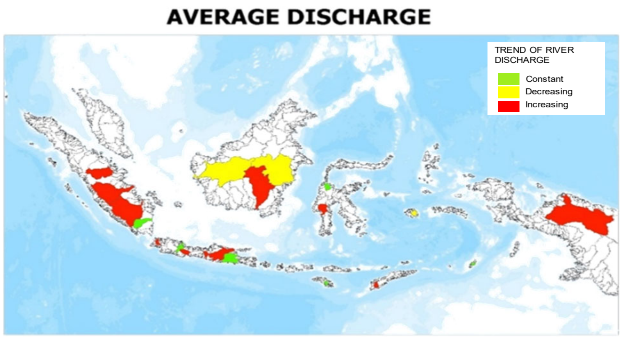


Figure 4-34 Average River Basin Discharge Trend Map on Climate Change

4.2.1.3 Recent Human Damage Caused by Natural Disaster

In order to consider the effect of EWS, the damage trends, especially death toll, owing to natural disasters after 2000 is organized based on Indonesian Disaster Data and Information Database (DIBI) managed by BMKG.

When targeting all disaster types, the mortality due to only the Indian Ocean Tsunami of 2004 (which caused a huge amount of damage to Aceh) occupies 90% of the total number due to all disaster types. Since the damage caused by Indian Ocean Tsunami is a large-scale disaster occurring at low frequency, if it is excluded as a singular value, the damage caused by earthquakes reaches nearly 50 % and floods and sediment-related disasters reach about 40%. This means that these earthquakes, tsunami, floods, and landslides account for about 95% of mortalities caused by natural disasters. In these results about 75% of the mortalities caused by earthquakes were due to the Java Island Central Earthquake of 2006. Based on these results, it can be seen that mortalities due to floods, landslides, earthquakes, and tsunami has remained almost flat, although the number of occurrences of floods and landslides has increased. Such an increase in the number of occurrences of disasters has several causes. It can be assumed that climate change has some influence, but the main reason is the number of cases recognized as disasters increased following economic growth and the expansion of urban area or agricultural area. Once a big earthquake or tsunami occurs, the damages are enormous. The number of earthquake/tsunami has remained flat, but the death toll in 2004 and 2006 in orders of magnitude are larger than other years. This shows that there is no significant relationship between numbers of disaster and mortality.

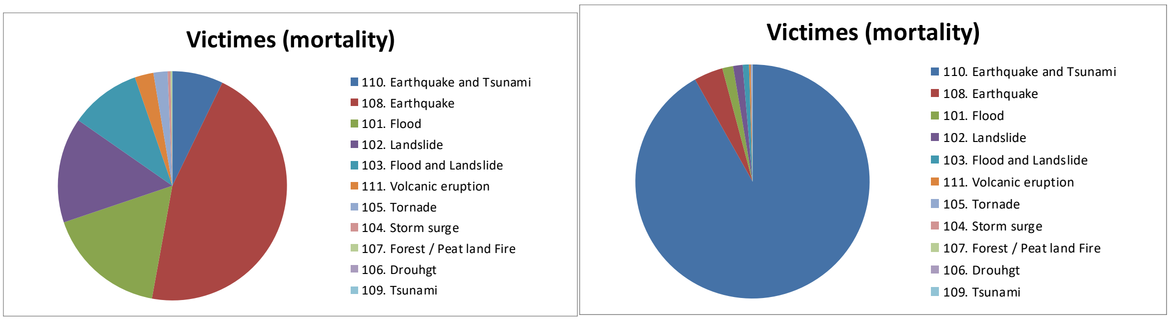
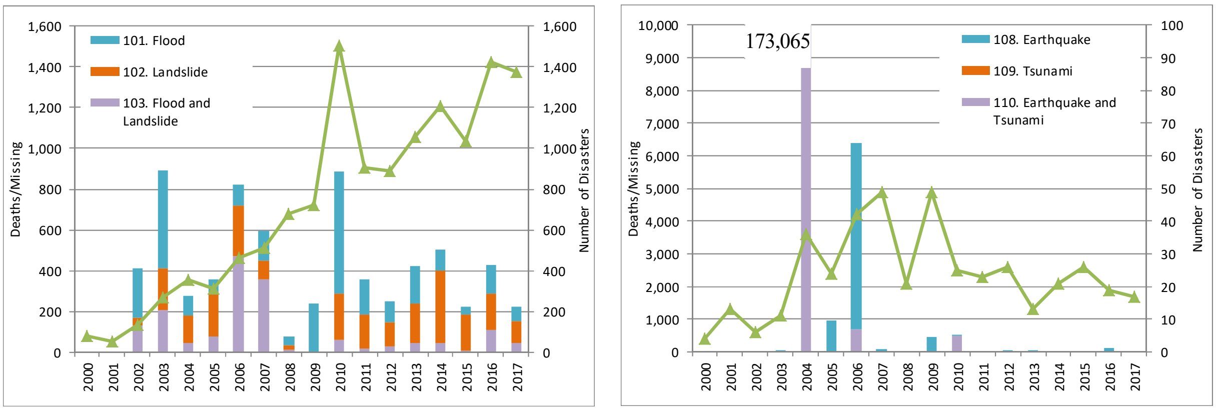


Figure 4-35 Mortality by Disaster Types



(left : Flood/Sediment-related, right : Earthquake/Tsunami)

Figure 4-36 Annual Disaster Occurrence and Mortality[120]

4.2.2 Efforts of the Government of Indonesia

4.2.2.1 Legal Framework / Standards and Guidelines

Indonesia has previously experienced large-scale disasters that have caused unprecedented damages, such as the Indian Ocean Tsunami of 2004 and the Java Island Central Earthquake of 2006. In order to facilitate disaster risk reduction, the government established the Disaster Management Law (Law No. 24-2007) in April 2007, which is the basis of disaster countermeasures in Indonesia. Under this law, early warning activities are defined as one of the pre-disaster actions, aiming to "take quick and appropriate disaster risk reduction activities and prepare emergency response actions". Specific behaviors of early warning are required, including "observation of disaster signs", "analysis of results from disaster signs observation", "decision-making by authorities", "dissemination of disaster warning information", and "community actions". In addition, Government Regulation No. 21-2008 enforced in 2008 to complement the Disaster Management Law stipulates that "early warning action is a process in which the authorities (Authorized Agencies) inform the citizens of disaster information latent in specific areas (Article 1(5)) " and that "disaster information obtained from prescribed organizations is transmitted to citizens as early warning information by government agencies, private broadcasters and mass media based on the judgment of BNPB and BPBD (Article 19(4) and (5)) ".

In 2011, BNPB promulgated a director-general "BNPB Regulation No. 8 (Standard Data Information)" the guidelines on disaster information collection. This Secretary Regulation targets for BNPB and BPBD staff in the provincial, prefectural, and municipal cities, and specifies the operation of disaster information during disaster management and normal times. This regulation also has a disaster information collection format attached. However, this regulation is limited only to an outline description, and it is not sufficient to describe

120 JCIA Study Team prepared based on the data from DIBI

in detail how to collect, transmit and accumulate concrete disaster information especially for the regency/municipality BPBD officials' response. Through "The Project for the Disaster Management Capacity of BNPB and BPBD (2011-2015)", the technical guidelines were formulated to be user-friendly in order to strengthen the system whereby local governments can collect damage information accurately and promptly. The guidelines indicate specific and detailed disaster information collection procedures and methods mainly for regency/municipality BPBD staff. In addition, BNPB has constructed and released the Indonesia Disaster Information Portal Site (DIBI), a unified management system for disaster information under the support of UNDP.

Regarding information dissemination, in the Telecommunications Law (Law No. 36-1999) issued in 1999, the telecommunications business was divided into three fields: development (communication infrastructure development, etc.), service, and special communication service. Dissemination of disaster information is included in the field of special communication service, and it is mandatory for telecommunications carriers to disseminate disaster information in an emergency. Subsequently, following the Great Sumatra Island Earthquake and the Indian Ocean Tsunami that occurred on December 2004, it was prescribed that mass media such as all television, radio, etc. and internet providers launch disaster information with the highest priority in accordance with the Government Regulation No. 50-2005 on broadcasting issued in 2005 and KOMINFO Regulation in 2013 (No. 21-2013). In 2008, in the related ministries and agencies law (Law No. 39-2008), it was stipulated that each ministry shall have supervision and regulatory authority to the businesses which themselves take charge of. As a result, KOMINFO has the authority to supervise and regulate the mass media, telecommunications carriers, and internet providers.

Table 4-16 Laws and Regulations Related with DRR and DRR Information

Law/Regulation		Contents
Disaster management	Law No. 24/2007 (Disaster Management)	Regulation of principle of national disaster management, implementation organization/structure Regulation of BNPB as the organization of disaster management
	Law No. 8/2008	Regulation of the organization and structure of BNPB based on disaster management law
	Governmental Regulation No. 21/2008	Regulation of disaster managements (Regulate that BNPB / BPBD compile the national/local disaster management plan every 5 years)
Early warning	Law No. 24/2007 (Disaster Management)	Regulation of early warning action as one of the pre-disaster action
	Governmental Regulation No. 21/2008	Regulates that BNPB and BPBD determine early warning actions with receiving disaster information from BMKG, and government agencies including BNPB and BPBD, private broadcasters, mass media inform the determined staff to residents
	Law No. 31/2009	Law on weather climate geophysics (Regulates that BMKG executes observing, managing and analyzing earthquake/tsunami information, refining and issuing early warning information, and broadcasters, media, central/local governments provide early warning information to residents)
Dissemination of disaster information	Law No. 31/1999	Law on communication (Regulation that specifies which telecommunications businesses and business operators preferentially transfer disaster information)
	Governmental Regulation No. 50/2005	Regulation of Broadcasting (Regulate that specifies public/private broadcasting, which preferentially transfers disaster information)
	KOMINFO Regulation No. 20/2006	Regulates that TV/radio broadcasting media disseminate early warning information of earthquake/tsunami with the latest information

Law/Regulation		Contents
	Law No. 39/2008	Law on ministries (Regulates that each ministry is authorized to supervise and regulate businesses under the jurisdiction)
	KOMIINFO Regulation No. 21/2013	Regulation that specifies which internet provider preferentially transfer disaster information

4.2.2.2 Organization/Inter-organization Collaboration (including Capacity Building)

Meteorology & early warning involves a wide range of related fields, so many institutions/organizations are involved, and it is necessary to make an appropriate adjustment between related organizations in order to avoid duplication at the time of preparatory measures and confusion in an emergency. Against this backdrop, it is important that a responsible organization is established in both the national and local governments to lead and coordinate the various fields and related organizations across the board. In Indonesia, until the establishment of the Disaster Management Law in 2007 and a disaster management organization after that, the agencies which mainly played a role of coordination had been at the national and local levels respectively. In local administration, that agency only organized in the case of a disaster. However, in order to strengthen it and establish it as a permanent organization, the establishment of disaster management organization/department in the national and regional levels has been progressed based on the Disaster Management Law. Figure 4-37 shows the administrative levels and corresponding disaster prevention organizations.

Decision making on-site during a disaster is the responsibility of local governments. At this time, BPBD, which has been established in each municipality, plays a major role. The emergency system consists of the district/municipal BPBD which is the closest to the residents, and the provincial BPBD, that adjusts them, carries out disaster response as the main player, and when the disaster scale becomes bigger and difficult for the district/municipal BPBD to handle, the provincial BPBD assists BPBD. When the scale becomes even larger, BNPB assists or, depending on the situation, plays the main role instead of BPBD.

Under the legislation mentioned above, improvement of the weather observation system and development of EWS have been underway in Indonesia.The table below shows the institutions responsible for non-structural countermeasures mainly related to early warnings. In order to minimize the damage, BNPB and BPBD are required to share disaster information with the related organizations shown in Table 4-17 before the occurrence of the disaster. The efforts of EWS on BNPB, BMKG, PUPR, and PVMBG is described below.

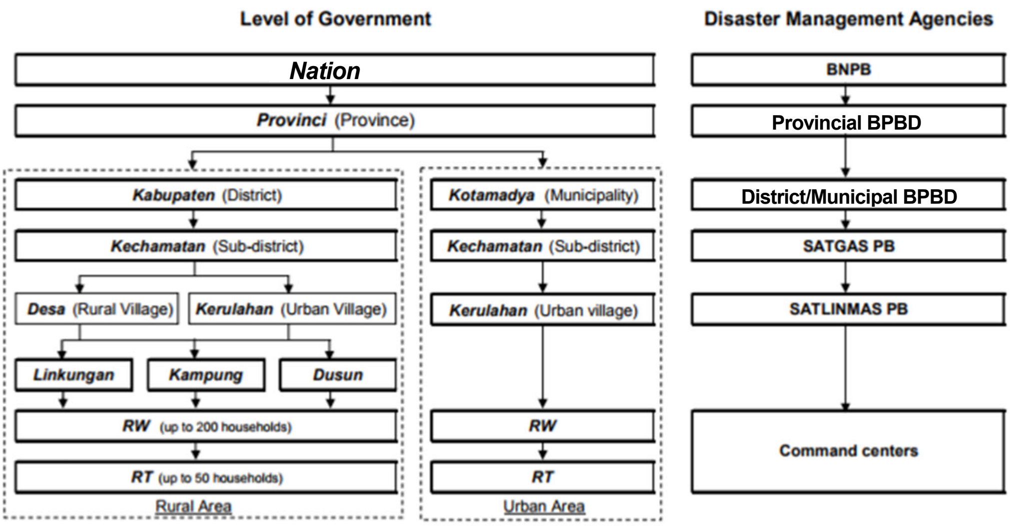


Figure 4-37 Disaster management organization structure by administrative level

Table 4-17 Institutions taking charge on Non-structural Countermeasures

Disaster type	Institution in charge	Outline of activity
Earthquake	GA	Earthquake risk prediction (fault survey, risk assessment, etc.)
	BMKG	Information gathering at the time of earthquake occurrence (epicenter, seismic intensity, etc.) and transmission it to related organization/society
	PUPR	Establishment of seismic design standard
Tsunami	BPPT RISTEKDIKTI ITB LIPI	Tsunami simulation for a constitution of tsunami prediction database Evacuation route plan for local governments and promotion of evacuation drills (RISTEKDIKTI, LIPI)
	BMKG	Collection/analysis of earthquake information (epicenter, magnitude, seismic intensity), search from tsunami prediction database and tsunami prediction
	BIG	Collecting seabed topography data for tsunami simulation
Volcano	GA PVMBG	Production and maintenance of volcanic explosion warning system, creation of lava flow hazard map, related social education
Flood	PUPR	Flood early warning system construction/ maintenance, flood hazard map creation, related social education
	KEMLHK	Watershed conservation such as restoration of degraded land by afforestation etc. and soil conservation
	KEMENTAN, BMKG	Weather observation
Debris-flow	PUPR	Debris-flow early warning system construction/ maintenance, related social education
Landslide	GA	Landslide risk evaluation, landslide early warning system construction/maintenance, landslide hazard map creation, related social education
Draught	KEMENTAN, BMKG	Draught early warning system construction
Forest fire	LAPAN	Forest fire monitoring

(1) BNPB

Until the establishment of the Disaster Management Law in April 2007, the responsible institution of the central government for disaster management was BAKORNAS PB. BAKORNAS PB had implemented inter-organizational coordination but the authority for emergency response was limited at the time of the disaster. Furthermore, BAKORNAS was not able to respond promptly when a disaster occurred due to less public recognition and ability as a coordination institute. In order to surmount this situation, BNPB was established in May 2008 as a new agency comprehensively responsible not limited to inter-organizational coordination but also for a series of activity from prevention (damage prevention/alleviation) measures to emergency response, restoration, and reconstruction.

The responsibilities of BNPB are as follows. BNPB's role in disaster regarding early warning corresponds to a). This requires what is sharing disaster information with forecast/prediction launching organizations (such as BMKG and PUPR) cooperating with BPBD to mitigate disaster damage.

a) Provision of guidelines and directions on disaster countermeasures contributing to fair and equitable prevention (damage mitigation/reduction), emergency response, restoration/reconstruction
b) Regulation of standardization and the necessity of disaster management organization based on the regulation of law

c) Exhibition of activities
d) Reporting on the progress of disaster management activities to the president on a monthly basis or on continuously for the time in a disaster
e) Utilization and accounting of domestic and international donation/support
f) Accounting for Supply Fund from State Budget
g) Implementation of other business based on the regulation of law
h) Preparation of guidelines for the establishment of local disaster management bureaus

(2) BMKG

The agency responsible for meteorological observation is BMKG, and it is stipulated to provide information on weather, climate, and geophysical events to citizens based on Article 29 of the Law No. 31/2009. Headquarters of BMKG Jakarta has four executive organizations: meteorology, climatology, geophysical, and instrumental/measurement/ public transmission department. In addition to the headquarters in Jakarta, there are regional offices throughout the country. There are also 120 weather stations, 5 climate observation stations, 31 geophysical stations, 164 seismographs, and about 250 strong-motion seismographs are installed. The publishing of disaster information is mainly handled by the Earthquake & Tsunami Center and (public) weather center.

BMKG is not only dissemination weather observation information, including earthquakes and tsunami, but also predicting flood occurrence (although it is only in the capital city Jakarta) by analyzing observation rainfall data, and publishing it every day on the website. Furthermore, for other areas, BMKG announces flood warning information based on rainfall data. As for the information transmission method, their smartphone application (info BMKG) also provides push-based information on hydrology, weather, air quality (atmospheric pollution concentration), earthquakes and tsunami.

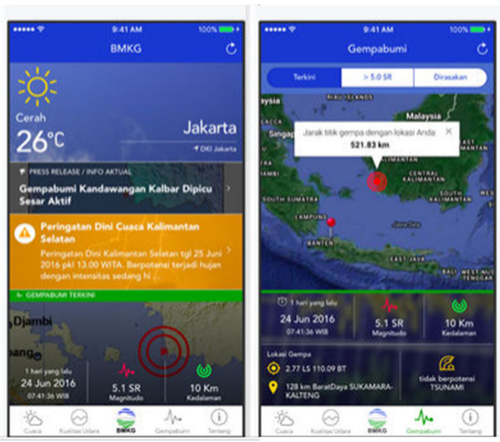


Figure 4-38 infoBMKG interface

The weather department operates the Meteorological Early Warning System (MEWS), which performs numerical weather forecasting based on observed information obtained from tropical cyclones monitoring and constant weather observations by BMKG. These weather forecasts are correlated with local extreme weather phenomena (such as flash floods), maritime phenomena such as severe waves caused by strong winds, weather phenomena, and other natural disasters, and then MEWS figures out the potential risk of disaster damage in a few days or weeks and launches an alarm. In addition, the weather department acquires information on international meteorological institutions such as the French Meteorological Agency and the Australian Meteorological Agency and integrates with the weather observation results of BMKG. The weather department conducts longer-term and extensive weather forecasts with these data and information. MEWS predicts torrential rainfall, flood risk, forest fire rating, smoke trajectory prediction, strong winds, waves, tropical cyclones, etc. and provides disaster information to local governments, BNPB, BPBD, the mass media and others. MEWS also provides safety information on routes to air safety organizations and navigation safety agencies.

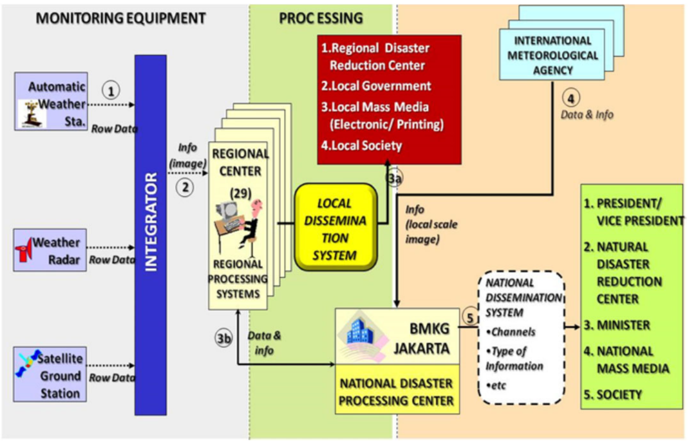


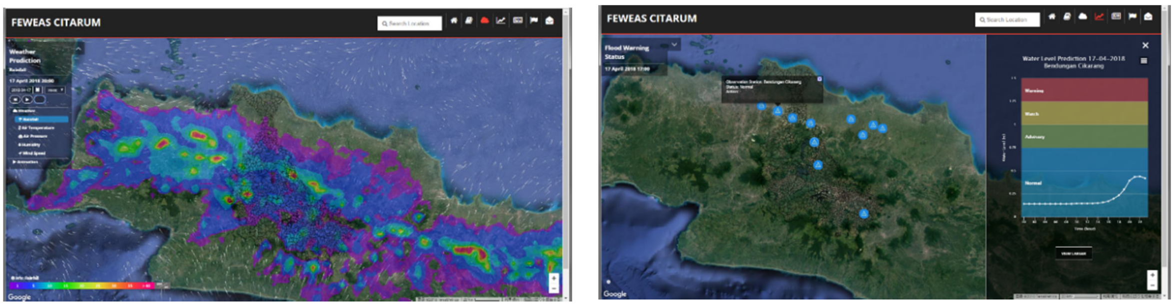
Figure 4-39 Framework of MEWS[121]

(3) PUPR

The agency responsible for flood management in Water Resources Management (DGWR) in PUPR. In 2006 the river basin management office called BBWS or BWS was established in accordance with the PUPR Regulation No. 12/2006 for the purpose of strategic water resource management in the target basin. Currently, 12 BBWS offices and 21 BWS offices manage a total of 65 river basins. Each BBWS office creates flood warning guidelines every year before the rainy season. In the guidelines, institutional design, monitoring network, the flow of reporting, cooperation and alarm transmission, etc. are defined, and three stages of danger level are set for all major rivers. In several river basins, a telemetry type flood early warning system has been established, and these systems are managed by the BBWS office.

In PUPR, PUSAIR which is located in Bandung is responsible for grasping and predicting the occurrence of floods and droughts. PUSAIR advances research and development in the hydrological field and water resource management field and supports the hydrological management in accordance with the PUPR Regulation No. 20/2016 (Article 195). In addition, PUSAIR supports the monitoring of the hydrological situation in river basins and technical evaluation, and also processes and publishes hydrological data and hydrological information (Article 196).

Regarding the flood EWS, Bandung Institute of Technology (ITB) is collaborating with BBWS/BWS, ZURICH and others to develop the system which designates each river basin as an individual unit. The EWS receives weather information from NOAA and other information (topography, land-use plan, etc.) is provided by each agency through BNPB. The Flood Early Warning and Early Action System (FEWEAS) that is currently in operation are available for two river basins, Bengawan Solo River and Citarum River. FEWEAS makes it easy to access hydrological and hydraulic information of the river basin on the web or by smartphone applications for free.



(Top: short-time rainfall prediction; bottom: warning water level information)[122]

Figure 4-40 Interface of FEWEAS Citarum River

121 Document from BMKG
122 FEWEAS (http://smartclim.info/citarum/en)

(4) KOMINFO

KOMINFO has authority to make Internet service providers (KOMINFO Minister Regulation No. 21/2013), Public / Private Broadcasters (Law No. 50/2005), and Telecommunications carriers (Law No. 36/1999) to transfer disaster information respectively. KOMINFO and BNPB agreed to join the Memorandum of Understanding (MoU) in 2012 and cooperate in disaster information dissemination with each other and the disaster management sector to utilize the infrastructure of KOMINFO for transmission.

Also, KOMINFO has a responsibility to provide the center (basic infrastructure) that relays disaster information including earthquake tsunamis to disaster information providers (ministries and agencies conducting disaster observation and forecasting) in accordance with the KOMINFO Minister Regulation No.2 / 2016, which obliges cellular phone operators to distribute disaster information to users. Moreover, KOMINFO confirms distribution functions and exchanges opinions through information communication training in collaboration with mobile phone operators once a year. Through this activity, it is trying to maintain and improve the disaster information transfer function.

(5) PVMBG

The role of PVMBG related to disaster information is to present a legal basis for compartment regulations under Article 61 (4) of the Governmental Regulation No. 26/2008 Spatial Plan. PVMBG is also responsible for creating hazard maps for earthquakes and tsunami in Presidential Regulation No. 9/2016. In the current situation, PVMBG deals with four disaster countermeasures against three types of disaster, earthquake/tsunami, volcano, and sediment-related disasters. The countermeasures are as follows.

a) Preliminary investigation on geology, topography and past disaster
b) Creating hazard maps based on the above investigation
c) At the time of a disaster, investigate at the site and advise a response to the local governor
d) Report on advising local governments on spatial planning and large projects (such as railway construction, high standard road construction, etc.) and constructions to be constructed, related to consultation from related organizations

Since volcanic eruptions and sediment-related disasters often have time from detecting signs to the actual emergencies, PVMBG carries out a continuous observation, and alarms based on these observed data. PVMBG also report to the heads of local governments and BNPB according to the level of disaster risk. Regarding earthquakes and tsunami, PVMBG responds after the occurrence of earthquakes only when the magnitude is 5 or more.

(6) LAPAN

LAPAN is committed to providing technical answers to national problems such as disasters through satellite image collection and application of remote sensing technology. In Law No. 21/2013, the activities of space use and remote sensing of LAPAN are stipulated. Under Presidential Regulation No. 6/2012, activities that utilize satellite images such as SOPT are also stipulated. Although BIG also plays a role in handling satellite imagery, LAPAN has the results that do not require interpretation by analysts, and the results of interpreting and correcting are regarded as BIG's responsibility. For activities such as disaster monitoring, the Center for Data Collection acquires satellite images, and the Remote Sensing Application division receives the images and applies (monitors) remote sensing technology to the following tasks. Monitoring results using satellite images are shared by BNPB and BPBD Disaster Emergency Response Center through a WhatsApp Group. LAPAN also provides image information directly to BNPB.

a) Forest fire monitoring
b) Hotspot (areas where fires frequently occur) monitoring
c) Mist and haze monitoring
d) Torrential rain prone areas monitoring

LAPAN, which plays a role in collecting information at the disaster response stage, also prepared a Standard Operation Procedure (SOP) for disaster response. Within 24 hours after the disaster, satellite images obtained from information sources such as SPOT 6, SENTINEL Asia, ALOS 2, International Charter etc. are provided to relevant organizations such as BNPB. In addition, LAPAN also creates the following application results.

a) Risk assessment of forest fire at Fire Danger Rating System (Canada)
b) Flood, Sediment Disaster Alert (Japan): Identify torrential rain areas from HIMAWARI images
c) Estimation of agricultural damage from the flooded area (Ministry of Agriculture)
d) Monitoring of volcanic activity (Ministry of Energy and Mineral Resources): Fixed point observation of ground surface temperature (22 places)
e) Evaluate land use and use it to evaluate flood risk (30 state governments)

4.2.2.3 Plan and Policy for Disaster Risk Reduction

(1) Position in National Disaster Management Plan (2015-2019)

The "National Disaster Management Plan (2015-2019)" is positioned as the next plan to the "National Disaster Management Plan (2010-2014)", and it defines the medium-term policies, targets and priority actions of disaster prevention for national disaster management. The national medium-term development plan will be formulated consistent with the President of Indonesia’s term in office. The "National Medium-Term Development Plan (2015-2019)" contains policy direction in the field of disaster management and served as the basis for the formulation of the "National Disaster Management Plan (2015- 2019)". It has been recognized that policy direction is positioned at the top of the medium-term policy of BNPB. Among the policies and strategies indicated in "National Disaster Management Plan (2015-2019)", the matters related to the early warning are as follows.

Table 4-18 Policy and Strategy on Early Warning in National Disaster Management Plan

Policy	Strategy
Reduction of disaster vulnerability	• Educate and improve disaster prevention culture through disaster prevention enlightenment, and improve knowledge on disasters. • Diffuse and promote disaster risk reduction to society through newspapers/magazines, radio, and TV. • Provide and disseminate disaster-related information to the public.
Improvement of disaster management ability	• Provide disaster EWS and ensure the appropriate function of EWS in the disaster-prone areas. • For disaster preparation and disaster management, develop and promote science and technology and education. • Implement simulation and disaster drill regularly and continuously in disaster-prone areas.

(2) Attitudes in international trends

In the National Progress Report on the Implementation of the Hyogo Framework for Action (2015), items related to early warning systems (Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning) are highly evaluated in each indicator. However, regarding "early warning (improvement of the early warning system based on the inhabitants)", EWS for various types of disaster are being developed, but there is the problem in the EWS that information does not reach the grassroots communities, and there is a need for capacity strengthening to build communities’ capacities to respond to warnings.

Furthermore, the Indonesian government formulated a roadmap (INDONESIA'S ROADMAP FOR THE IMPLEMENTATION OF THE SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION FOR SUSTAINABLE DEVELOPMENT (2015-2030)) in 2017 to ensure the achievement of SFDRR. In the roadmap, by 2022, improvement of EWS by strengthening observation/forecasting system, risk analysis, and access to disaster information, etc. are regarded as milestones for achieving SFDRR.

4.2.3 Cooperation by JICA

In this section, the support by JICA from the viewpoint of disaster risk reduction through weather forecasting and early warning is described. Natural disasters such as earthquakes, tsunami, and floods occur frequently in Indonesia and cause huge amounts of damage every year. JICA recognizes that strengthening the capacity of BNPB and BPBD (which are responsible for disaster management), flood countermeasures through integrated water management, and building an institution for earthquake resistance of houses are necessary to enhance disaster management capacity. JICA, therefore, has implemented support through the disaster management capacity improvement programs[123]. Of the JICA projects, many of the forecast/warning projects have selected the Jakarta metropolitan area as a pilot area. These projects are broadly divided into the following three items by their cooperation contents.

- Improvement of the observation system (installation of observation equipment, improvement of communication infrastructure)
- Construction of governmental structure for early warning systems in DRR and capacity building at the national/local level
- Disaster response capacity improvement, disaster prevention education, and evacuation drills

The disaster prevention capacity of BNPB, other DRR related organizations, and disaster-prone area residents have been strengthened due to the JICA support thus far; however, strengthening cooperation among relevant ministries and enhancing guidance and support system for local governments, strengthening disaster observation and monitoring system, etc. are recognized as future tasks.

Table 4-19 Projects Related to Early Warning Supported by JICA

Corporate Scheme	Project Name	Period	Target Area
Technical cooperation	Forest fire Prevention Management Project	96.7～03.6	Kalbar
Technical cooperation	Forest fire Prevention Management Project Phase Two	01.4～06.4	
Technical cooperation	Integrated Sediment Disaster Management Project for Volcanic Area	01.4～06.3	Yogyakarta
Technical cooperation	Forest Fire Prevention Project by Initiative of people in Buffer Zone	06.12～ 09.11	National parks (Riau, Jambi, Kalbar)
Technical cooperation	The Institutional Revitalization Project for Flood Management in JABODETABEK	07.3～10.2	Jakarta metropolitan area
Technical cooperation	Project on Capacity Development for National Center of Indonesian Tsunami Early Warning System	07.8～09.5	Jakarta metropolitan area
Grant Aid	The Project for Improvement of Equipment for Disaster Risk Management	～18.3	
Technical cooperation	A project of Capacity Development for Climate Change Strategies	10.10～ 15.10	
Technical cooperation	The Project for Enhancement of the Disaster Management Capacity of BNPB and BPBD	11.11～ 15.11	Jakarta Sulut, NTB
Preparatory Survey	The Project for Strengthening Disaster Management Information System	14.10～16.2	
Technical cooperation	Project on Capacity Building for Information Security	14.7～17.1	

4.2.4 Cooperation by Other Organizations

Indonesia has actively introduced disaster-related technologies and disaster-related systems from abroad and has applied them to the on-site disaster countermeasures. Therefore, Indonesia is technologically and ideologically ahead of the other countries in the Southeast Asia region with similar problems due to disasters. Meanwhile, the introduction of high-speed advanced technology has caused a divergence from the reality of

[123] Country Assistance Policy for the Republic of Indonesia, Ministry of Foreign Affairs of Japan

disaster sites, and it has been noted that several projects have not been able to realize the expected results. Thus the necessity of reexamination of the operation and implementation systems has been recognized.

In regard to recent technical trends, USAID and other organizations have supported the efforts of Humanitarian Open Street Map Team (HOT) to utilize the crowd sourced flooding information from smartphone applications like PetaBencana.id and Open Street Map Project, which are popular in Indonesia, in the implementation of countermeasures. In addition, the application of InaSAFE (software for investigating the assumed damage scenario, which was developed by the Australian Agency for International Development (AusAID) have been expanded to various types of disasters. It has also been developed for Southeast Asian countries through funding by World Bank.

On the other hand, although advanced disaster management information systems have been introduced to support decision-making and other functions, there are many systems that still have not achieved the expected results due to delays in their integration with related systems and lack of support at the disaster sites. Since misalignment of the information system can cause a gap between the disaster site and the central government agency, the necessity of restructuring the flow of the system operation and information transmission came to be recognized.

In addition, the Indonesian version of "COASTAL INUNDATION FORECASTING DEMONSTRATION PROJECT INDONESIA (CIFDP-I)", which is promoted by the World Meteorological Organization (WMO) as part of climate change and storm surge countermeasures, was conducted in Jakarta and Semarang, the selected pilot area.

(1) Government of USA (USAID)

The history of support in the disaster management field by USAID is relatively short, having started in 2012. USAID carries out development and operation support of the Indonesia All-hazards Warning and Risk Evaluation (InAWARE) on BNPB, which is an integrated warning, analysis, and risk assessment system of all disaster type, through Pacific Disaster Center. In addition to this, USAID (with the cooperation of MIT Urban Risk Lab) supports the development and operation of PetaBencana.id, emergency response and disaster management support platform that uses information collected by residents.

1) InAWARE

InAWARE monitors a wide range of events, not only natural disasters such as earthquakes, tsunami, floods, etc. but also incidents which cause crises to the public society, such as terrorism. InAWARE collects disaster information, such as observation information, predictions from observation -institutions, and damage information on disaster sites from the BPBD and others, and then it provides this information using the web. It also has a notification function using popups. Disaster information provided by related organizations is displayed as a disaster information layer superimposed on a map. Phase 1 of the InAWARE project was implemented from 2012 to 2016, and now Phase 2 (2016-2018) is underway and further extension is planned. InAWARE has already been operated by BNPB, in Phase 2, and it is trying to further strengthen the operational capacity by implementing training for about 1,000 BNPB and BPBD staff. The operation and maintenance cost of the system is still borne by USAID.

Since InAWARE is a monitoring system, it does not transfer disaster information by SMS, etc., but it is planned to integrate with existing EWS and aim to install a function of transmission of disaster information. Also, in the current situation, only a few BPBD are registered in InAWARE, so information can be limited. InAWARE has also not integrated with PUPR's flood EWS. However, it should be noted that the system is still under development.

2) PetaBencana.id

PetaBencana.id is an information collecting system which started operation in 2013, and its information is based on real-time information about disasters from social media (Twitter) and information from callres (crowdsourcing), including such information as inundation area and flooding depth, with an information validity period of 2 hours. As for now, it is limited to flood information in big cities such as Jakarta, Bandung, and Surabaya, but expansion into other areas and other disaster types is also being considered. The system is currently operating with six members, four in Jakarta, one in US MIT (adviser), and one in Australia (IT architect).

Regarding the reliability of information (flood water level etc.) from residents, the system requires that it is verified by individuals or BPBD. (The disaster records confirmed by BPBD remain until BPBD judges that it is unnecessary and deletes it.) In the Jakarta flood that occurred in 2014, there were 150,000 tweets. These tweets covered almost all areas, and it was used for grasping the condition of inundation area and depth by BPBD of Jakarta Capital Special State.

Prior to the development of PetaBencana.id, flood information relied solely on information from local governments, but now the information from both local governments and residents is being integrated by PetaBencana.id. In addition, PetaBencana.id is incorporated as a layer in InAWARE.

(2) UNDP

UNDP conducted the project of "Safer Community through Disaster Risk Reduction" with multilateral cooperation as support for Indonesia 's disaster management (damage prevention/mitigation) measures. This project was funded by UNDP, AusAID, and the UK Ministry of International Development. The main outcomes of the project are as follows.

- Support to the establishment of national policy, the legal system, and regulatory framework for disaster risk reduction
- Support to strengthening of organizational structure for disaster risk reduction and building a partnership
- Support for disaster prevention education for disaster risk reduction and raising public awareness
- Promotion of disaster risk mitigation advocacy for safe and secure community formation
- In order to achieve the above outcomes, the following activities were carried out.
- Support to improvement of disaster management law structure
- Dispatch of experts to BNPB
- Construction of disaster database system (DIBI)
- Support to establishment of national/state disaster management plan
- Support for creating disaster risk map (for states)
- Community support (activities through NGOs such as the Indonesian Red Cross)

The disaster database system (DIBI) has been transferred to BNPB and is currently maintained by BNPB's Data and Information Center. UNDP developed an online GIS analysis tool, InaRISK (contributing to development and maintenance costs by BNPB) which provides disaster risk map creation support (used for disaster prevention planning, the scenario at the time of crisis management plan formulation, evacuation plan, etc.), and UNDP also dispatches experts to support the utilization of InaRISK.

(3) Government of Australia (AusAID)

Government of Australia has provided assistance with an emphasis on preventive measures (damage prevention/damage mitigation). By the end of the project in 2015, in the disaster relief program (Australia Indonesia Facility for Disaster Reduction: AIFDR) earthquake/tsunami risk assessment guidelines and earthquake hazard maps had been created, a QGIS plug-in (InaSAFE) that enables verification of natural disasters scenario was developed, and a tsunami inundation model was formulated. The counterpart of AIFDR is BNPB, but an independent organizational structure was established by AusAID, and two new offices and one training institution (established in the same building as these two offices) was built for the dispatch of many Australian experts. Also, in the same building as BNPB, funds are issued to construct a donor cooperation support room and facilities are being developed to encourage dialogue among donors. However, experts dispatched from these donors are also employed by their donors, so it does not necessarily contribute to the improvement of BNPB staff capacity.

In addition, in June 2009, the Government of Australia announced the policy "Disaster Risk Reduction Policy for Safer Future" as a Disaster Management Support Program to Indonesia. The purpose of this program is to reduce the vulnerability to disasters and enhance the resilience of the nation and communities to disasters. The following four outcomes are the pillars of this policy.

1) Risk and vulnerability (creation of hazard risk map (state))
2) Training and drills (preparation of training materials, training of staff in central and local disaster management, etc.)
3) Research and innovation (research on community strengthening, redevelopment method for disaster risk reduction, emergency response method, etc.)
4) Partnership (support for building partnerships among related organizations such as international organizations, donors, and NGOs)

(4) Government of Germany (GIZ)

The Government of Germany implemented a project to BMKG to develop a tsunami/earthquake early warning system (GITEWS), the predecessor of the present InaTEWS. This project began in 2005 and was handed over to BMKG as InaTEWS in March 2011. At present, assistance from Germany to BMKG is not being implemented.

1) InaTEWS

Indonesia Tsunami Early Warning System (InaTEWS) is a tsunami early warning system that collects, analyzes and consolidates earthquake and tsunami information, and provides information to related government agencies and mass media. InaTEWS is under the control of BMKG and is installed in BMKG Jakarta. BMKG Bali also has a backup system and personnel with the same function as Jakarta.

Information from InaTEWS is provided mainly by SMS and web. Related government organizations such as BPBD monitor the information by receiving terminals (computers) via the internet, and each agency uses this information to guide disaster prevention activities within their jurisdiction. As examples of utilization is used to carry out evacuation instructions via sirens and request for local broadcasting stations and radio stations to broadcast evacuation information.

Certain equipment such as sirens have an operation check only about once a year, and it has been reported that there have been cases where the sirens do not actually function. Meanwhile, the InaTEWS receiving terminal set up in the provinces are installed in a condition that it can be constantly checked by many BPBD, and it is presumed that the operating condition is good.

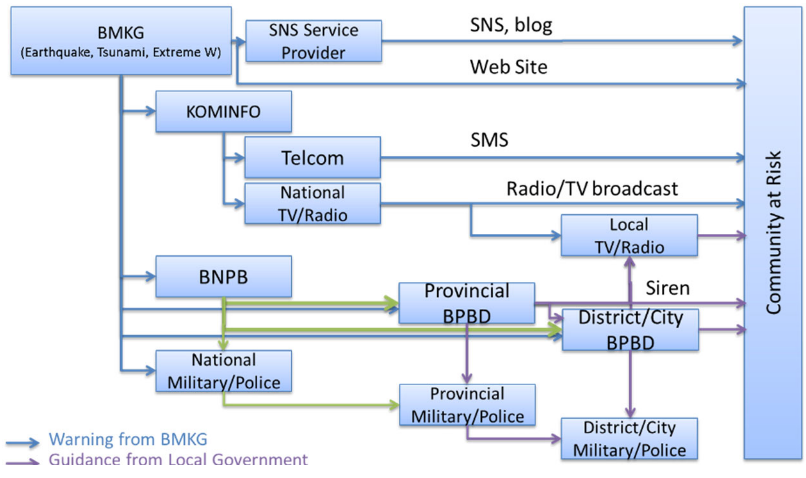


Figure 4-41 Information Transmission Flow of InaTEWS

The early warning information provided by InaTEWS to the communities is mainly what is transmitted by SMS using the public communication line. During the Sumatra Offshore Earthquake that occurred in 2012, a transmission delay due to the congestion of the communication lines occurred, and the system still has problems in making a prompt and appropriate response.

(5) World Bank (WB)

Currently, the World Bank assistance in Indonesia has been focused on the following three fields.

- Human resource development for organizations related to mainstreaming disaster risk management (BNPB, PUPR)
- Earthquake resistance for school buildings through the Safer School Initiative (Ministry of Education, PUPR)
- Support for Community Based Disaster Risk Management (grass-roots activity)

The World Bank recognizes that climate change is the biggest threat to Indonesia. The rising sea level and the weather pattern changes cause depletion and destabilization of available water resources; declining food production; and stagnation of transportation, economic activities, and urbanization development, etc.

There is particular concern about the circumstance causing harm to low-income people. Therefore, WB has been assisting the implementation of mainstreaming disaster risk management, and that disaster risk management concept is integrated into the framework of regional development. Countermeasures against climate change are also to be incorporated into policies.

As part of the above activities, the WB has promoted the development of earthquake resistance technical guidelines and implementing them in the rebuilding of damaged schools to make them earthquake resistant. WB also invested in InaSAFE, which was developed with the aim of utilizing Indonesia's disaster countermeasures at the site, and has expanded case studies in Southeast Asia and Oceania countries. WB also supports the formation of communities that are highly resistant to disasters in rapidly expanding urban areas with the grass-roots community disaster prevention efforts.

In Indonesia, WB is planning activities in the future in the following fields.

- Formation of a disaster-resistant community in a rapidly expanding urban area
- Continued efforts to incorporate disaster risk reduction into policies in new educational investment and renovation of existing educational facilities that are at disaster risk
- Research on protection measures using financial methods

4.2.5 Evaluations of Disaster Risks and Identified Challenges

4.2.5.1 Identified Challenges on Meteorology and Early Warning System

Based on the present situation of disaster management in the weather and early warning field which is described in Chapter 4 to 4.2.4, the following nine problems/gaps have been extracted in the four fields of "Disaster Information", "Governance", "Disaster Risk Reduction", "Environment, and Climate Change".

Table 4-20 Problems/Gaps in Weather and Early Warning Disaster Management

Fields	Problems/Gaps in Weather and Early Warning Disaster Management
Disaster information (Understanding Disaster Risknajd Share Information)	(i) Weather observation network has problems providing stable data (ii) The risk and expected effect of EWS of each disaster type is not understood well (iii) Insufficient operational record and analysis for improvement of EWS
Governance (Strengthen Governance for Disaster Risk Management)	(iv) Effective EWS in collaboration with management plans and policies by disaster type is not constructed (v) Collaboration among ministries and agencies on disaster management policy is weak, and the effectiveness of EWS is not sufficient (vi) EWS is sporadic and its sustainability/continuity is weak
Disaster Risk Reduction (DRR Investment for Resilience)	(vii) There are no concrete plans for improvement of the observation system aimed at the improvement of forecasting and alarming technology (viii) The capacity of participants at each stage of disaster management in weather and early warning is not sufficient
Environment, Climate Change (Adaptation to the intensification of disasters)	(ix) Countermeasures against new disasters due to climate change are not sufficient

(1) Disaster information (Understand Disaster Risk and Share Information

«Challenge1» Weather observation network has problems to provide stable data

Weather observation in Indonesia is carried out by BMKG, and the meteorological division receives observation information from meteorological satellite "HIMAWARI-8" in addition to the observation system consisting of 120 weather stations and 41 radar observation stations and provides meteorological information, the climatology division collects and publishes water level information (by 104 Agricultural Auto Water Stations) for water use, rainfall information (by 467 Auto Rain Stations), and weather information (by 339 Auto Weather Stations). However, observation data quality is not well developed due to a delay in the introduction of automatic observation instruments, and even in the case of automatic observation stations, lack of observed data due to malfunctions of observation instruments and data communication equipment are often seen. According to a study of the observation condition of AWS published on the web in May 2018, observed data was not updated for more than two days at about 30% of observatories[124]. PUPR also conducts hydrological observation separately from BMKG and developed a hydrological monitoring system targeting the whole country in 2018. However, 6 observation stations out of the 63 observation stations with water levels that would trigger alerts were not operating normally[125]. For disaster management with early warning, a stable collection of weather observation data is indispensable, and urgent improvement is required.

«Challenge2» The risk and expected effect of EWS of each disaster type is not understood well

Disaster management by early warning aims to precisely ascertain signs of disasters and to minimize human damage caused by disasters by improving evacuation behaviors. An invaluable element for achieving the purpose is precisely ascertaining the timing of disaster occurrence and the extent of evacuation required in advance. Earthquakes, tsunami, and sediment-related disasters are directly linked to human damages in cases where disaster evacuation is delayed. But on the other hand, in floods where the level of flooding gradually rises in the areas without embankments and it is possible for residents to use their own judgment regarding evacuation, it is thought that early warning is more effective for the economic damage reduction than for human damage reduction. Besides that, even if the scale of a disaster (earthquake magnitude, amount of precipitation, etc.) is the same, the risk varies depending on topographical factors, the distance to the evacuation center, and the condition of the evacuation route, etc. Therefore, it is not necessarily appropriate to set warning criteria corresponding to disaster scales.

The current EWS launches disaster information on the occurrence of floods and tsunami, but the disaster management organization in the affected site is ultimately the one to make a decision to evacuate. That may cause evacuation behavior not taken earlier than the empirical knowledge based on simulation analysis in present condition. In the case of ordering evacuation based on simulation analysis, especially in the case of a flash flood or sediment disaster, there is a tendency to have to base the decision on prediction results with low reliability in order to ensure enough time for evacuation. However, even if evacuation ends up being unnecessary, it is a reasonable judgment for the purpose of reducing human damage through early warning. Although it is necessary to continually improve the accuracy of simulation analysis, it is expected that both the disaster management organization and residents under its jurisdiction deepen their understanding of the system and foster the environment in which the early warning technologies reduce damage.

«Challenge3» Insufficient operational record and analysis for improvement of EWS

EWS predicts disasters which require evacuation and plan the content, method, and timing of transmission of disaster and evacuation information taking into consideration the required time for transmission and evacuation. However, in actual operation, it is often the case that there is difficulty transmitting the information and evacuation takes more time than planned. In Indonesia, despite the progress to EWS for the earthquake/tsunami because of the experience of receiving tremendous damage due to the 2004 Indian Ocean

124 AWS Center BMKG (http://202.90.198.212/awscenter/index.php)
125 HYDROLOGY INFORMATION SYSTEM AND WATER RESOURCES ENVIRONMENT (SIHSDA(http://112.78.146.44/))

Tsunami and the introduction of InaTEWS in 2011, in the Sumatra Offshore Earthquake in 2012, the transmission was delayed due to congestion of the communication line. This highlighted the problem of EWS information transmission. Although such problems become clear during EWS operation in an actual disaster, it is difficult to discover all of the possible issues that may occur with EWS and implement countermeasures against them during the planning stage. Therefore, it is most realistic to strengthen the ability of EWS by finding solutions to challenges that arise during operation. For this reason, regular evacuation drills play an important role in order to enhance the disaster reduction potential of EWS.

On the other hand, many of the EWS that have been introduced so far do not accumulate detailed operational records, therefore, even if the problems are revealed, effective task analysis cannot be carried out and SOP has not been revised because of the insufficient weather and hydrological observation records necessary for the examination. As a result, EWS improvement has not been made for residents of affected areas to take prompt and appropriate evacuation behavior.

(2) Governance (Strengthen Governance for Disaster Risk Management)

«Challenge4» Effective EWS in collaboration with management plans and policies by disaster type is not constructed

As written in 4.2.2, further improvement of the development of the EWS is stated in the "National Disaster Management Plan (2015-2019)". Since the EWS has a complementary role in cooperating with the disaster type structural measures, it is necessary to consider in disaster type planning and policy. (The multi-hazard EWS is an integration of EWS constructed for each disaster type, and there is a fear that making an organization and process standardization regardless of disaster type could not demonstrate the disaster-reduction effect of EWS.) Meanwhile, the roadmap for SFDRR shows the recognition that "development of EWS for such as tsunamis, floods, landslides, etc. are inadequate" as a problem related to disaster management with early warning. Disaster types such as tsunami, floods and landslides listed in the roadmap are considered to be disaster types requiring countermeasures to achieve "(a) Substantially reduce global disaster mortality" in SFDRR.

EWS has been able to construct a system covering whole Indonesia regardless of the development progress of structural countermeasures for each disaster type due to progress of observation networks and communication technologies developed so far, however, the disaster information which such EWS can disseminate is standardized or generalized, and it is difficult to provide effective disaster information for disaster risk reduction, especially against the disasters that cause human damage mentioned above, which based on highly accurate weather forecasting around the affected area, hydrological analysis based on these weather forecast, topography, geology, land use, evacuation shelter, and evacuation routes.

Long-term and comprehensive plans and policies for each disaster types have not been formulated in Indonesia. When the formulation of disaster pre-measures and risk reduction measures is being carried out, it is essentially needed to formulate policies and plans for each disaster type individually because the policies and countermeasures are significantly different depending on the characteristics of disaster types. At the stage of formulating the risk reduction plan to each disaster type, consideration of the required role of EWS is a useful measure for promoting specific countermeasure against disaster type and accelerates disaster risk reduction.

«Challenge5» Collaboration among ministries and agencies on disaster management policy is weak, and the effectiveness of EWS is not sufficient

In Indonesia, in accordance with the law of disaster management, BNPB was established as an organization responsible for a series of conduct/management related to disaster response from pre-disaster management to recovery/reconstruction, but weather observation and disaster monitoring which is necessary for EWS are handled in charge of each ministry and agencies are implementing them. BMKG is responsible for the meteorological observation, providing weather and climate information from the normal condition, PUPR observes a river water level and flow rate, PVMBG monitors a volcanic eruption, LAPAN monitors forest fires by satellite images, etc. In addition, these ministries and agencies are also conducting disaster monitoring and disaster information dissemination in accordance with their respective duties. As a pre-disaster countermeasure, BNPB collects disaster information in collaboration with ministries and agencies, and, in order to reduce disaster risk, BNPB transmits the necessary information at an appropriate timing to the related organizations such as BPBD in affected areas. However, since the cooperation system of ministries and agencies are not clear and there are duplications of some roles, confusion often occurs among disaster management agencies and residents. Moreover, BPBD does not have sufficient ability regarding obtaining and utilizing disaster information from IT system, disseminating information to residents, issuing instructions such as evacuation for residents. For disaster risk reduction in the field of early warning, it is desirable to clarify the roles of ministries and agencies, to consolidate and organize disaster information, and to improve the transmission capacity, in parallel with improving the accuracy of EWS.

«Challenge6» EWS is sporadic and its sustainability/continuity is weak

In Indonesia, the improvement of EWS is located as a part of the national plan in accordance with the law of disaster management in 2007. EWS has developed starting with tsunamis and earthquakes, then for each type of disaster such as floods, sediment-related disasters, storm surges and so on. In the early years of EWS improvement, EWS was introduced in the area where a large-scale disaster occurred as a pilot area, however, during these periods EWS had not been extended nationwide, the introduction of another EWS which was also targeting nationwide was conducted. That resulted in an overlap of EWS in the pilot area and often makes the situations in which proper evacuation behaviors are hindered. Also, in recent years, EWS has gotten various improvements owing to improving IT communication speed and information processing performance, spreading free map applications, GIS engines, smart-phones, and the like. However, with regard to floods, for example, the most important disaster information in early warning is information as to whether house buildings of residents are flooded individually, whether evacuation is necessary, when and where to evacuate, but the limited EWS, which was conducted in the river basins where an outflow analysis model has been constructed by river improvement project or so in the past, is able to launch such information. If proper and timely disaster information transmission is not possible, the EWS will not be operated, there will be no improvement in accuracy and will eventually be superseded by another EWS. In addition, since ministries and agencies are developing EWS and these systems provide overlapping functions and information, making it an undesirable environment for early warning disaster management. EWS is not able to achieve the disaster risk reduction effect with the only installation, but through experiencing the disaster and operating it, the system itself and the system user will improve disaster response capability and become an effective system. Therefore, it is necessary to implement a sustainable policy program by formulating long-term vision and roadmap of early warning disaster management toward a resilient country and preparing the concrete action plan for short/medium- term.

(3) Disaster Risk Reduction (DRR Investment for Resilience)

«Challenge7» There are no concrete plans for improvement of the observation system aimed at improvement of forecasting and alarming technology

Although the condition of observation work is improving by international support and self-help efforts, these are also important parts in early warning disaster management what progress of prediction/warning capability using observation data and improvement of information transmission.

According to BMKG, it is considered that building an observatory in the vicinity of the planned development site and the automation of the observation equipment, and denseness of the observation network for future observation system development, but this purposes to obtain the efficiency of the observation work and the enhancement of weather grasping ability. Strengthening the meteorological observation system is also effective for improving early warning disaster management, but in order to accurately grasp the signs of disaster occurrences and to reduce disaster risk by appropriate evacuation, it is necessary to understand the disaster area characteristics based on topography, geology and land-use, and then to rationally arrange observation locations and items. In order to increase the disaster investment for being resilient, it is essential that establishing the goal of disaster risk mitigation by early warning disaster management, and then indicating the necessary observation system for achieving the goal through formulating EWS improvement plan. It is hoped that BNPB leads the formulation of the plan and collaborate with related ministries and agencies such as BMKG, PUPR, and KOMINFO.

«Challenge8» Capacity of participants at each stage of disaster management in weather and early warning is not sufficient

The series of actions of early warning disaster management is understood as a grasp of disaster signs by observation, an assumption of disaster risk by analysis of observed information, dissemination of disaster information, and appropriate evacuation based on disseminated disaster information. Regarding the observation network and disaster risk analysis, a more effective system and analytical techniques should be progressed with a planned introduction, as described above. On the other hand, there is concern of lack of ability of players who take action for managing or reducing disaster damages at each stage. In the roadmap toward SFDRR, as a task in the ability of players in early warning disaster management, "Limited technical capacity to conduct risk analysis and mapping both for the national and local stakeholders", "Limited outreach of Early Warning System (EWS) to the grassroots communities and low capacity of communities to respond to warnings" are listed.

In this study, the interview survey to the operation of EWS in rural areas to Manado and Aceh's BPBD (it's called BPBA in Aceh). According to the survey, only InaTEWS was recognized by both organizations, in Manado, BPBD knows only the existence of InaTEWS but has never operated it. It means even though technical guidance has been made from BNPB to BPBD in each region, the capacity difference between central and local organizations is great. Given that BPBD is the main implementing body for disaster management education and evacuation drill for local residents, it is easy to understand that even if local residents obtain disaster information, they have only personnel with poor response capacity utilizing the information. Firstly, strengthening the capacity of BNPB and BPBD is a challenge, but in order to improve the effectiveness of early warning disaster management, in addition to collaboration and mutual understanding between the related agencies in the central, the regional organizations of the related agencies, strengthening early warning disaster management capabilities, including understanding the characteristics of each region should be done.

(4) Environment, Climate Change (Adaptation to Intensification of Disasters)

«Challenge9» Countermeasures against new disasters due to climate change are not sufficient

As described in Chapter 4, it is expected to increase the seasonal deviation of rainfall and rise in sea level by climate change. These phenomena will result in an increase in the frequency of disasters and its intensification not only in disaster prone-areas but also in the areas where disaster experiences seldom have been experienced before. In particular, in areas with few experienced disasters, disaster response capacity is assumed to be lower than disaster prone-areas, therefore, it is a concern that enormous damage will occur. In order to reduce such disaster risks, it is required to estimate and prepare against the disasters in advance, which are expected to occur as a result of climate change. Currently, BMKG's climate change prediction is based on a model (spatial resolution 20 km) covering the whole of Indonesia, and a higher definition model (spatial resolution 4 km) is used in Java, Sulawesi, and Sumatra. In these areas, in addition to variations in temperature and rainfall, flow variation trends for major rivers are announced to the public. However, the development of hazard maps and evacuation plans, disaster information dissemination through disaster drills based on them, enhancement of information transmission/reception, and evacuation action enhancement have not been sufficient.

4.2.5.2 Identified Challenges on Localities

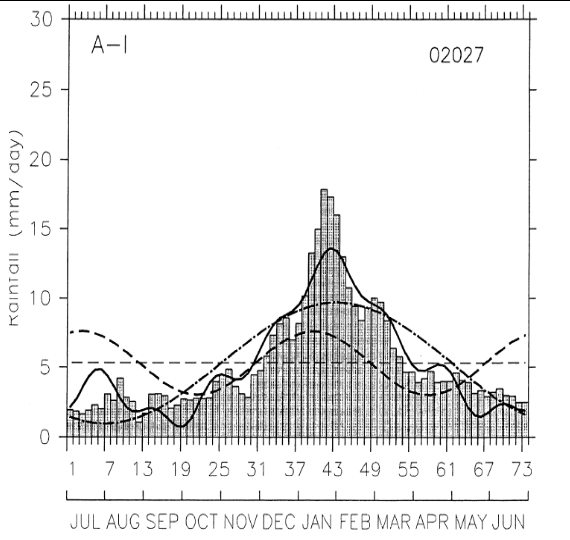
Disaster characteristics and risks vary by region. The lead time required for evacuation also varies by region. Therefore, it is necessary to issue the best forecasting and warning taking into topographical factors, land use, and capital concentration. This system has to be improved in operation. In this regard, organizations that have received technical assistance from donors must keep understanding the nature of early warning systems even after the end of the project.

4.3 Water Induced Disasters

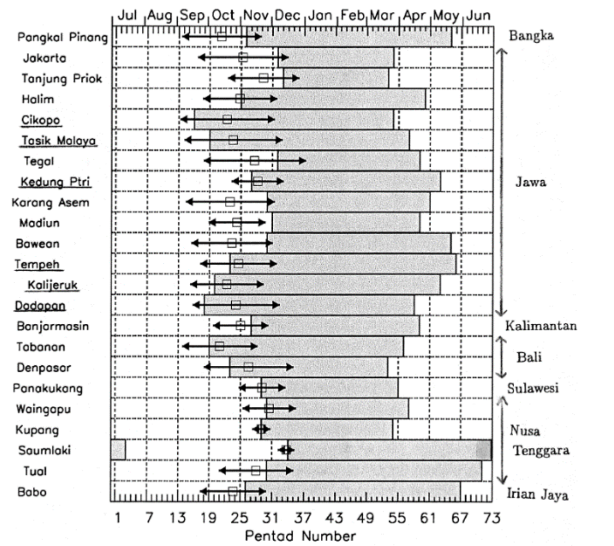
4.3.1 Characteristics of Recent Water Induced Disasters

4.3.1.1 Overview of Rainfall Patterns and Rivers in Indonesia

Rainfall pattern in Indonesia can be clearly divided into dry a season and a rainy season as shown in the figure. The rainy season is from December to March, and large floods are concentrated during the season. However, in recent years, floods have occurred outside of this season due to the effects of climate change.



Jakarta's Mean Daily Rainfall / 10 days



Period of Rainy Season at Major Cities in Indonesia

Source: Spatial and Temporal Variations of the Rainy Season over Indonesia and their Link to ENSO (2002)

Figure 4-42 Overview of Rainy Season and Dry Season in Indonesia

In the table, Indonesia's top ten rivers in length are listed. These rivers exist in one of the three large islands of Kalimantan, Sumatra or Papua. However, the rivers that actually cause floods flow through urban areas such as in Java Island where population and assets are concentrated. The scale of these rivers is relatively small, but their floods give serious impact on the socio-economics of the capital or major local cities. Cities that have been affected by floods include Jakarta, Semarang, Surabaya in Java Island, Manado, Gorontalo, Makassar in Sulawesi Island and Medan in Sumatra Island. In basins of volcanoes, eruptive products flow down the rivers during rainy seasons, causing sediment disasters such as debris flow. As a typical example, the Merapi volcano has caused sediment and water disasters in Yogyakarta. In Indonesia, dams are used for water resources of agriculture, urban domestics, industry and power generation rather than for flood control.

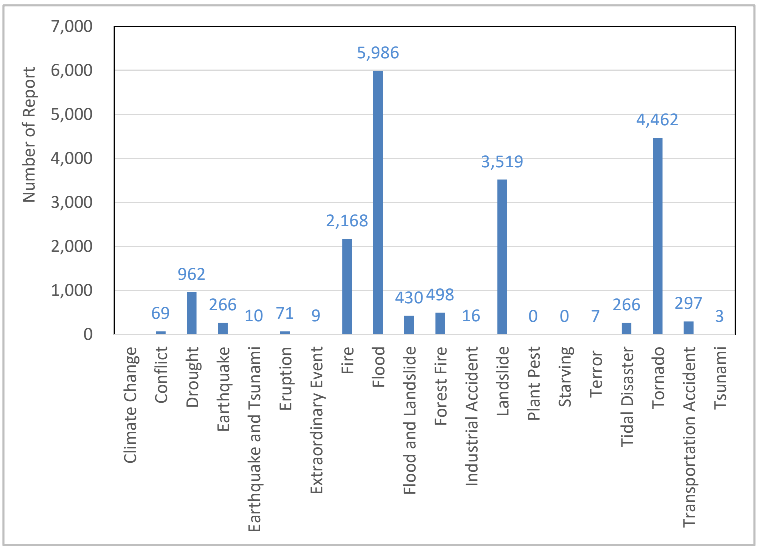
Table 4-21 Indonesia's Top Ten Rivers in Length

	River Name	Length(km)	Island		River Name	Length(km)	Island
1	Kapus	441	Kalimantan	6	Batang Hari	308	Sumatra
2	Sepik	434	Papua	7	Musi	289	Sumatra
3	Fly	405	Papua	8	Pulau	260	Papua
4	Mahakam	378	Kalimantan	9	Mamberamo	258	Papua
5	Brito	351	Kalimantan	10	Kahayan	231	Kalimantan

Note: The longest river in Japan is River Shinano with a length of 367 km *Source: World Atlas*

4.3.1.2 Characteristics of Recent Water Induced Disasters

Based on the disaster database (DIBI) over 10 years from 2007 to 2016 in BNPB, the Figure (Figure 4-43) shows the number of occurrences for each type of disaster. Floods are the most frequent occurrences with 5,986 events, followed by Tornados and landslides. The total number of disasters by flood, floods accompanied by landslide and landslide reached 9,935 events occupying about half of the total occurrences of 19,039 events. The annual average occurrence number of these three water induced damages reaches 994 events/year.

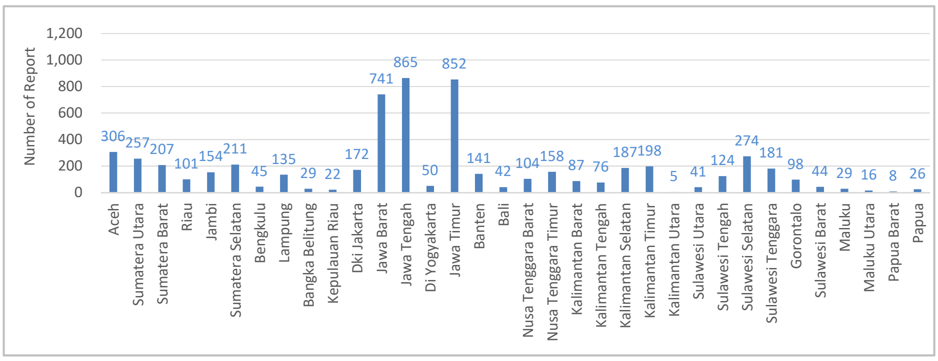


Source: BNPB, DIBI

Figure 4-43 Disaster Occurrences by Type over 10 Year (DIBI, BNPB)

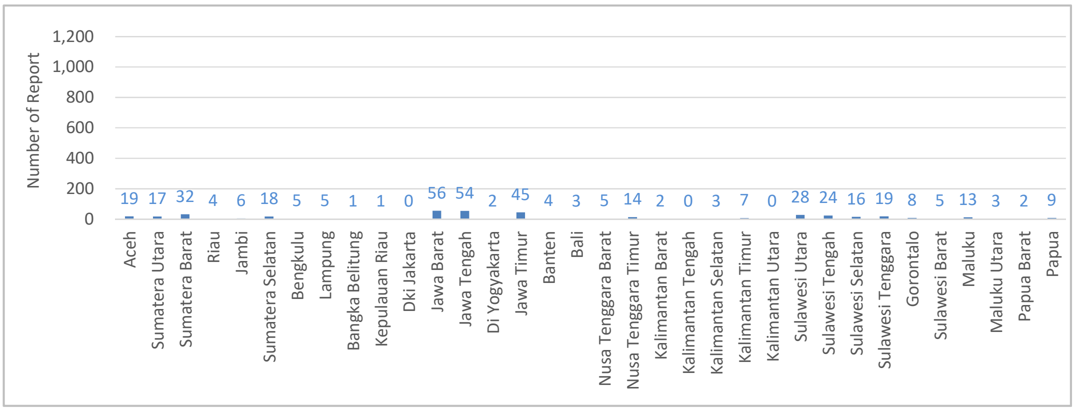
Among the occurrences of floods, floods with landslides and landslide, the following figure shows the occurrence by Province. Most of the floods occurred in Java Island (West, East and Central Java), followed by Sumatra Island including Aceh Province, North Sumatra Province and South Sumatra Province.Regarding floods with landslides, the trend is similar to that of floods and concentrates in Java Island and Sumatra Island.According to the statistics from 1980 to 2017 in EM-DAT's disaster list, the total death toll reached about 190,000 people, the total affected population showed 24.45 million people, and total economic damage amounted to about 29.4 billion US dollars.

Economic losses, affected population and death toll due to different disaster types are shown in Figure 4-46. Flood damages cost the US $ 6.7 billion less in economic losses only to disasters by earthquake and forest fire. Regarding the affected population by disaster type, the flood damages showed the second most impactful after the earthquakes. Regarding the number of the death toll, the flood is the most severe.



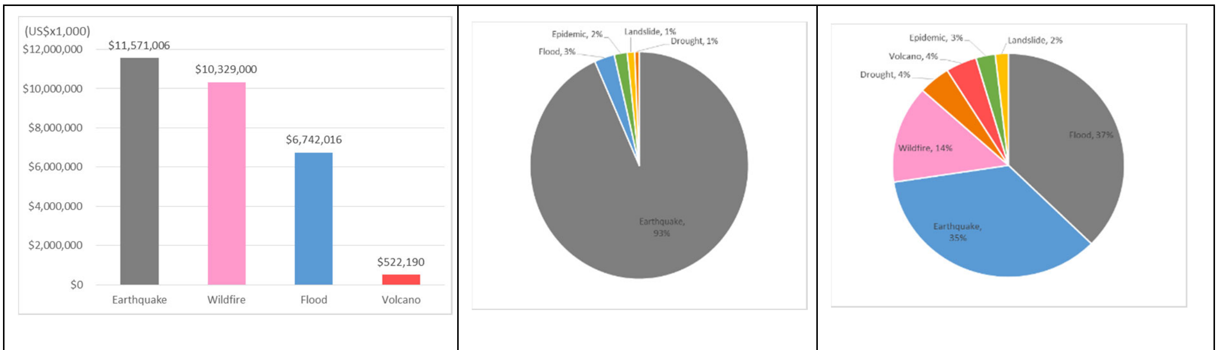
Source: BNPB, DIBI

Figure 4-44 Flood Disaster Occurrences by Province over 10 Year (DIBI, BNPB)



Source: BNPB, DIBI

Figure 4-45 Flood with Landslide Disaster Occurrences by Province over 10 Years (DIBI, BNPB)



Economic Losses by Major Disasters	Affected Population by Type	Death Toll by Type

Source: EM-DAT (1980-2017)

Figure 4-46 Profiles by Major Statistics on Floods (1980-2017, EM-DAT)

Based on the death toll and the size of the affected population, the major flood disasters after the year 2013 are summarized from the web-site of “Flood List” and shown in Table 4-22. From 2013, the major floods with death toll more than ten people occurred in September 2016 (Garut in West Java), June 2016 (Purworejo in Central Java), March 2015 (Sekabumi in West Java), December 2014 (Banjarnegara in Central Java) and January 2014 (Kudus in Central Java and Manado in North Sulawesi).

Table 4-22 Major Disasters on Floods, Flood with Landslides, Landslides (2013-2017)

SN	Year	Date of Event Occurred	Province	Disaster Events	Dead	Missing	Injured	Affected people	People evacuated	Affected Houses
1	**2017**	2 June 2017	Gorontaro	Flood				2,747	2,000	484
2		11 May 2017	South Sulawesi	Landslide	7		Several			14
3		15 May 2017	East Kalimantan	Flood					35,000	
4		11 April 2017	Aceh	Flash Flood	2	1				298
5		12 April 2017	Aceh	Flash Flood				1,784		
6		1 April 2017	East Java	Landslide	3	25	20	130		30
7		20-21 February 2017	West Java	Floods	2			1,314	400	
8		February 2017	Bali	Landslide	7		4			
9		6-11 February 2017	WNT	Floods				40,291		
10		26-29 January 2017	North Sulawesi	Floods & Landslide				5,000	1,000	
11	**2016**	21-24 December 2016	SE Tenggara	Floods					104,378	
12		12 November 2016	West Java	Flood				19,669	6,373	5,776
13		25-27 October 2016	Gorontaro	Floods					4,000	
14		21 September 2016	West Java	Flash flood Landslide	33	20	35		6,361	283 destroyed /685 damaged
15		30 June 2016	East Java	Flood				50,000		14,000
16		17-22 June 2016	North Sulawesi	Floods & Landslide	4	1				
17		17-22 June 2016	Central Java	Landslide	47	15				
18		8-13 March 2016	West Java	Floods	2	3		24,000	10,000	
19		26 February 2016	East Java	Flood	1			34,225		
20		5 February 2016	Central Java	Landslide	5	2				
21		5 February 2016	West Sumatra	Flood & Landslide	4	2				
22		19-23 January 2016	Jambi	Floods & Landslide	3					
23		17 January 2016	Aceh	Flood					1,505	
24	**2015**	11 December 2015	Aceh	Flood	1			51,000		
25		2 December 2015	Bengkulu	Flood & Landslide	4	15				
26		1 December 2015	North Sumatra	Flood & Landslide	2		9			235
27		14 July 2015	Aceh	Floods	0			25,765	2,000	7,904
28		30 March 2015	West Java	Landslide	12			30	300	
29		17 March 2015	West Java	Flood				15,000	4,000	100
30		8-9 February 2015	West Java	Floods				15,517	5,986	
31		31 January 2015	Bali	Landslide	2	2				
32	**2014**	12-16 December 2014	Central Java	Landslides	93	23			400	100
33		10-11 August 2014	Central Sulawesi	Floods		1		15,000		
34		25 February 2014	West Java	Flood		1			2,300	240
35		5 February 2014	West Java	Flood					18,500	
36		31 January 2014	East Java	Flood		1		1,100		
37		28-29 January 2014	West Java	Flood				43,452	9,985	
38		Jan-14	Banten	Flood				1,270		
39		17 January 2014	Central Java	Flood & Flash flood	12				10,000	7
40		23-24 January 2014	Bali	Flood	5		Several		60	
41		8-18 January 2014	West Java	Flood	5				63,958	
42		14 January 2014	North Sulawesi	Flood & Landslide	13	2			40,000	
43	2013	14 December 2013	West Java	Landslide	2					
44		18 December 2013	East Java	Flood	4				20,000	
45		30 November 2013	North Sumatra	Landslide	9					
46		29 July 2013	Maluku	Landslide	8	10				30
47		24-26 July 2013	ulawesi, Gorontaro	Floods	4	3			28,000	
48		15-23 January 2013	West Java, Banten	Floods	47				20,000	

Source: "FloodList" Web-site

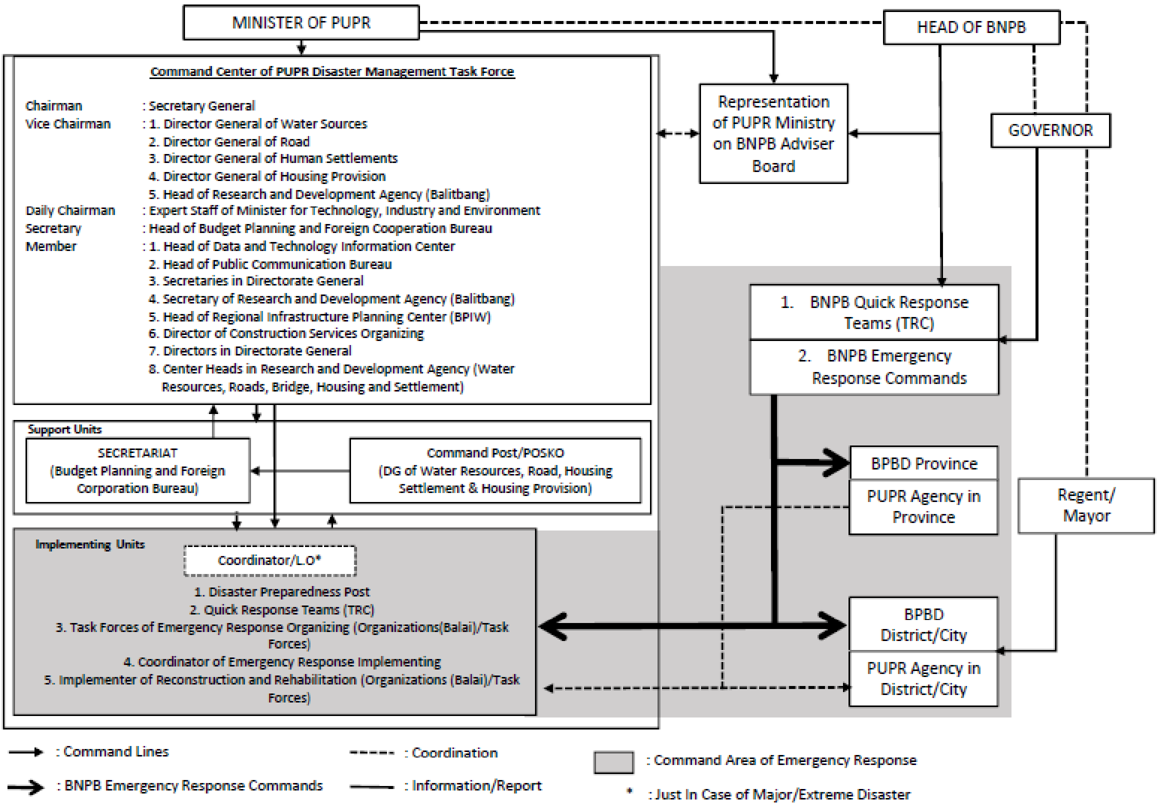
4.3.2 Efforts by the Government of Indonesia

Regarding disaster risk reduction (DRR) activities, BNPB (BPBD) comprise of various agencies at the national or central level (BNPB), provincial level (BPBD Province), and district level (BPBD District / Municipality). As the scale of the disaster increases, the corresponding level changes. BNPB corresponds and acts at the national level disaster. In the case of the flood event in Manado that occurred on January 2014, BNPB at the central level corresponded, and collecting data, rescue activities and rehabilitation activities were carried out.

Structural measures (disaster prevention and rehabilitation activities) for floods, sediment disasters, and landslides are governed by the Ministry of Public Works and Housing (PUPR) and the provincial government.

With regards to nonstructural measures such as forecasting and warning systems, hazard map preparation, watershed conservation, etc., PUPR, the Ministry of Forestry, the Ministry of Agriculture, Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) are responsible depending on disaster types.

The flow of information communication at the time of the disaster in PUPR is shown as follows. In emergency response, BNPB and PUPR work together at the administrative level, respectively.

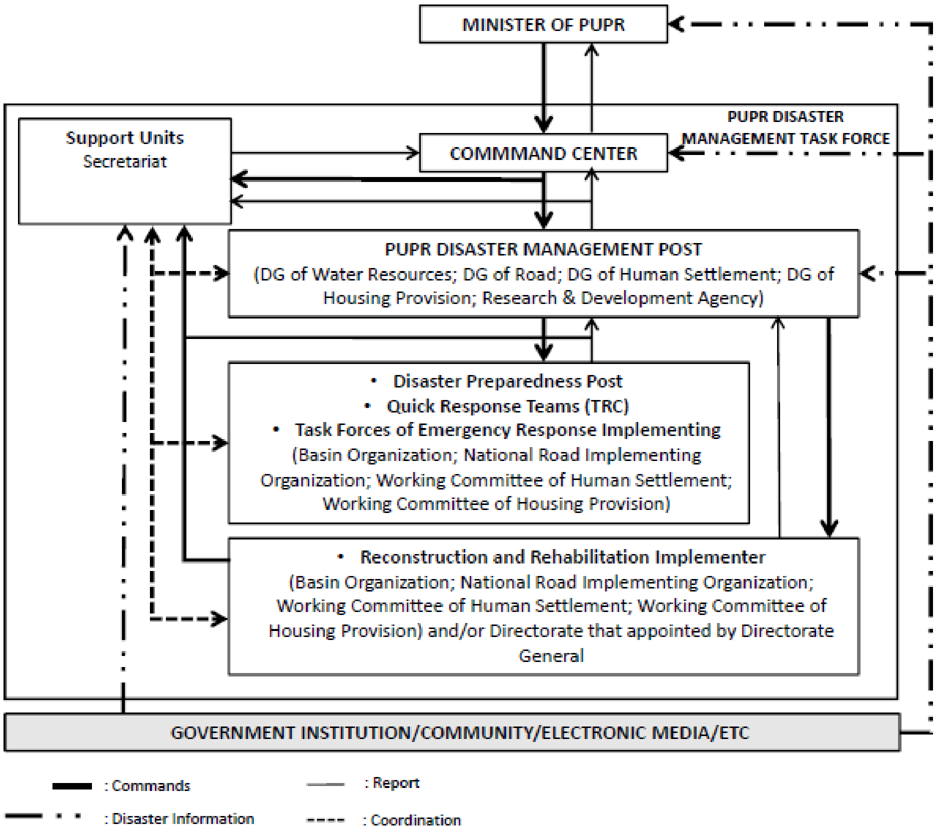


Source: PUPR

Figure 4-47 Information Communication Flow on Disasters between PUPR and BNPB

The command system of DRR in PUPR and the reporting system are shown as follows. In the event of a disaster, a task force is prepared and along with the BNPB Quick Response Team respond to the disaster. In post-disaster recovery and rehabilitation activities, the PUPR Team conducts initiative activities with BPBD and provincial/district governments.

Regarding water-related legislation, the Law No. 7 Water Resources, 2007 enacted in 2004 is the basic law concerning water resources management. In order to promote integrated water resource management through the participation of stakeholders in each watershed, clarity of water resources management (WRM) responsibilities between central and local government, institutional arrangement on WRM, WR planning, strengthening of water resources management planning and implementation, development of information networks, fiscal strengthening system for sustainable management are stipulated in this law.



Source: PUPR

Figure 4-48 Command System for DRR in PUPR

Relevant laws/regulations such as Government Regulation on Water Resources Management (No.42, 2008) and Government Regulation on Rivers (No.38.2011) have been enacted under this law. These basic skeletons are summarized as follows.

a. The river basin managed at the national level is either a river basin crossing the border, a river basin that extends multiple provinces, or a national strategically important river basin.
b. Water resource management is done in the river basin unit.
c. The central government establishes a river basin management office (organization) and manages water resources.
d. Water resources management is conducted on the basis of "conservation of water resources", "usage of water resources", and "management of water-induced damages".
e. In formulating the basic plan of the catchment basin, the government collects the opinions and requests from stakeholders through TKPSDA （Watershed Adjustment Committee) and makes adjustments.

Depending on Presidential Decree 12 enacted in 2012, water resources management on flood control and sediment control was conducted in the river basin (SDA, Sumber Daya Air) unit. River Basin Organization (RBO), Balai (Besar) Wilayah Sungai, BBWS) for management in the designated basin (SDA) was established by PUPR, and BBWS (Large RBO) was established in 13 basins in important large basins such as Citarum, Brantas and Ciliwung-Cisadane River basins. In other basins, 22 BWSs (RBOs) with smaller basin sizes than BBWS were established, and basin management such as river management, flood management, and sediment control are implemented.
The major legal systems (Laws, Decrees, and Regulations) on water resources (including floods, sediment-related disasters, etc.) are as follows.

Table 4-23 Legal Systems (Laws, Decrees and Regulations) on Water Resources

Classification	Laws/Decrees/Regulations (Year)	Name/Title
Law	Law No. 7 in 2004	Water Resources
	Law No. 10/2004	Formulation of Laws and Regulations
	Law No. 24/2007	Disaster Management
	Law No. 26/2007	Spatial Planning
Presidential Decree	Presidential Decree No.123/2001	Water Resources Management Coordination Team
	Presidential Decree No. 83/2002	Amendment of Presidential Decree No. 123 in 2001
	Presidential Decree No. 12/2008	Water Resources Council
	Presidential Decree No. 8/2008	National Disaster Management Agency (BNPB)
	Presidential Decree No.12/2012	Determination of River Region
Government Regulation	Government Regulation No. 42/2008	Water Resources Management
	Government Regulation No. 21/2008	Implementation of Disaster Management
	Government Regulation No. 22/2008	Finance and Management of Aid for Disaster
	Government Regulation No. 23/2008	Participation of International Institutions and Foreign Non-Governmental Institutions in the Mitigation of Disaster
	Government Regulation No. 38/2011	River
	Government Regulation No. 23/2017	National Spatial Plan
Ministry Regulation	Ministry of PW Regulation No.63/PRT/199\3	Right of River Boundary, Effective River Width, Right of River Area and Old River
	Ministry of PW Regulation No.4/PRT/M/2008	Guideline for Establishment of Water Resources Council in Province, Regency/City and River Basin Levels
	Ministry of PW Regulation No. 11A/PRT/M/2006	Criteria and Determination of Clustered River Basin
	Ministry of PW Regulation No. 12/PRT/M/2006	Organization and Work Arrangement of River Basin Main Office (BBWS)
	Ministry of PW Regulation No. 13/PRT/M/2006	Organization and Work Arrangement of River Basin Office (BWS)
	Ministry of Pw Regulation No. 26/PRT/M/2006	Amendment of No. 12/PRT/M/2006 and No. 13/PRT/M/2006
	Ministry of PW Regulations No.27/2007	Guidelines of Landslides Prone Areas on Spatial Planning
	Ministry of PW Regulation No.22/PRT/M/2009	Technical Guidelines and Procedures for Preparation of POLA of Water Resources Management
	Ministry of Internal Affairs Decree No. 46/2008	Disaster Countermeasures
	Ministry of PWH No.13/2015	Disaster Emergency Management due to Water Induced Damage
	Ministry of PWH No.27/2015	Dam Requirement the Safe Dam Developing and Management od such Dams
	Ministry of PWH No.28/2015	Establishment of River Boarder to Protect River and Lake's Function and Control Water Damage of River and Lake

Source: Web-sites (PUPR, BNPB, BAPPENAS, etc.)

4.3.3 Cooperation by JICA

The Japan International Cooperation Agency (JICA) has been listed and supported for policies on cooperation to Indonesia under three pillars such as (1) support for further economic growth, (2) support for correcting imbalances and building a safe society, and (3) support for capacity improvement to cope with issues in Asian regions and the international communities. The followings are the list of JICA cooperation projects concerning flood disasters including sediment disasters based on JICA database (water resource development (WRD) with partially overlapping disaster management (DRR)). As flood-related projects, many projects have been implemented in Sumatra and Java corresponding with a large number of occurrences of water-induced disasters such as in Kurueng Aceh and Medan Rivers in Sumatra Island as well as Ciliwun-Cisadane, Citarum, Brantas and Solo Rivers in Java Island.

Table 4-24 Cooperation Projects in Water Resources Sector by JICA

SN	Province	No.	Major Projects Implemented by JICA	Implementation Period	Floods	Sabo (Sediment)	WRD	DRR
1	Aceh	1	Krueng Aceh Urgent Flood Control Project	1972-1993	✔			
2	North Sumatra	1	Ular River Flood Control and Improvement of Irrigation Project	1969-1995	✔			
3		2	Lower Asahan River Flood Control Project	1984-1990	✔			
4		3	Medan Flood Control Project	1990-2009	✔			
5	West Sumatra	1	Padan Area Flood Control Project	1982-2011	✔			
6	DKI Jakarta & West Java	1	Jakarta/Jabodetabek Flood Control Project	1985-2008	✔			
7		2	Ciujun Cidurian Integrated Water Resources Development Study	1994-2008			✔	
8		3	Ciliwun-Cisadane Master Plan, Feasibility Study and Detailed Design	1994-2008	✔			
9		4	JABODETABEK Institutional Revitalization Project for Flood Management	2007-2010	✔			
10		5	Capacity Development of Jakarta Comprehensive Flood Management	2010-2013	✔			
11		6	Capacity Development Project for River Basin Organization in Practical Water Resources Management and Technology	2008-2011			✔	
12		7	East Pump Station of Pluit Urgent Reconstruction Project	2011-2014	✔			
13		8	Upper Citarum River Basin Flood Control and Farm/Forest Land Conservation Project	1987-2018	✔			
14		9	Mt. Galunggung Disaster Prevention Project	1987-1988		✔		
15	Central Java (including YGY)	1	Wonogiri Multipurpose Dam Project	2014-2018	✔		✔	
16		2	Capacity Development Project for SABO, VSTC, STV,ISDM	1982-2006		✔		
17		3	Semarang Integrated Water Resources and Flood Management Project	1992-2014	✔		✔	
18		4	Mt. Merapi and Mt. Semeru Volcanic Disaster Countermeasures Project	1987-2001		✔		
19		5	Mt. Merapi, Progo River Basin Urgent Disaster Reduction Project	2005-2014		✔		
20		6	Mt. Merapi Urgent Disaster Reduction Project	2014-2018		✔		
21		7	Wonogiri Multipurpose Dam Project	1972-2004	✔		✔	
22		8	Mt. Merapi and Mt. Semeru Volcanic Disaster Countermeasures Project	1995-2001				
23	East Java	1	Wlingi Multipurpose Dam Project	1971-1978	✔		✔	
24		2	Brantas Middle Reaches River Improvement	1971-1990	✔			
25		3	Surabaya River Improvement & Surabaya Urban Development Project	1971-2002	✔			
26		4	Madiun (Solo) River Urgent Flood Control Project	1972-1995	✔			
27		5	Mt. Kelud Urgent Volcanic Disaster Mitigation Project(1992)	1992-1996		✔		
28		6	Mt. Merapi and Mt. Semeru Volcanic Disaster Countermeasures Project(1995)	1986-2001		✔		
29		7	Water Resources Existing Facilities Rehabilitation and Capacity Development Improvement Project	2003-2011			✔	
30		9	Natural Disasters Reduction Project	2007-2009		✔		✔
31		8	"Banjir Bandang" Integrated Disaster Mitigation Management Project	2008-2011		✔		✔
32		9	Lower Solo River Improvement Project (Phase I, Phase II)	1970-2013	✔			
33	Bali	1	Bali Beach Conservation Project	1988-2008				✔
34	South Kalimantan	1	Barito River Basin Development and River Mouth Dredging Project	1969-1979	✔			
35	South Sulawesi	1	Bili Bili Dam Multipurpose Dam	1990-1999	✔		✔	
36	South Sulawesi	2	Jeneberang River Basin Development Project	1979-2006	✔		✔	
37		3	Mt. Bawakaraeng Urgent Disaster Reduction Project	2005-2014		✔		
	Notes: WRD:Water Resources Development, DRR:Disaster Risk Reduction							

4.3.4 Cooperation by Other Donors

4.3.4.1 Cooperation by the World Bank (WB)

According to the data released on the website of the World Bank, the World Bank Group has implemented a total of 188 projects since 2005 in Indonesia, of which water resources and disaster prevention related to irrigation, drainage, water supply, and flood prevention are a total of 50 cases (26.6%).The World Bank Group on DRR includes components deeply involved in facility operations management and urban flood control related to the PURR. DRR projects also include the Dam Operational Improvement and Safety Project (DOISP) (No.3 and 32) and Jakarta Urgent Flood Protection (No.15 and 35).

Table 4-25 Cooperation Projects by the World Bank

No.	Project Title	Sector	Commitment Amount (US Million$)	Status As of 2018	Approval Date
1	Integrated Infrastructure Development for National Tourism Strategic Areas (Indonesia Tourism Development Project)	Sanitation	300.00	Active	2018/05/30
2	Regional Infrastructure Development Fund	Sanitation Waste Management Water Supply	100.00	Active	2017/03/10
3	Dam Operational Improvement and Safety Project Phase 2	Public Administration - Water, Sanitation and Waste Management Other Water Supply, Sanitation and Waste Management	125.00	Active	2017/02/27
4	Indonesia National Slum Upgrading Project	Sanitation Waste Management Water Supply	216.50	Active	2016/07/12
5	REPLICATION AND MAINSTREAMING OF REKOMPAK (COMMUNITY-BASED SETTLEMENT REHABILITATION AND RECONSTRUCTION)	Sanitation Waste Management Water Supply	1.62	Closed	2016/05/10
6	Indonesia's Infrastructure Finance Development (IIFD) - RE	Other Water Supply, Sanitation and Waste Management	8.28	Active	2016/04/22
7	The National Rural Water Supply and Sanitation Project (PAMSIMAS AF)	Sanitation Water Supply Public Administration - Water, Sanitation and Waste Management	300.00	Active	2016/01/08
8	Additional Financing PAMSIMAS Support Trust Fund	Sanitation Water Supply Public Administration - Water, Sanitation and Waste Management	44.00	Active	2014/04/23
9	Add. Fin. - Third Water Supply and Sanitation for Low Income Communities (Community Based Water Supply/PAMSIMAS II)	Sanitation Water Supply	99.90	Active	2013/05/02
10	VILLAGE INNOVATION PROGRAM (VIP)	Other Water Supply, Sanitation and Waste Management	650.00	Active	2012/12/11
11	First Connectivity Development Policy Loan	Other Water Supply, Sanitation and Waste Management	100.00	Closed	2012/11/20
12	National Community Empowerment Program In Urban Areas For 2012-2015	Other Water Supply, Sanitation and Waste Management	266.00	Active	2012/11/20
13	National Community Empowerment Program In Urban Areas For 2012-2014	Sanitation	23.50	Active	2012/11/20
14	Indonesia Infrastructure Guarantee Fund Project	Other Water Supply, Sanitation and Waste Management	29.60	Active	2012/09/11
15	Jakarta Urgent Flood Mitigation Project	Other Water Supply, Sanitation and Waste Management	139.64	Active	2012/01/17
16	FOURTH NATIONAL PROGRAM FOR COMMUNITY EMPOWERMENT IN RURAL AREA (PNPM IV)	Irrigation and Drainage Other Water Supply, Sanitation and Waste Management	531.19	Closed	2011/07/14
17	Indonesia - Third National Program for Community Empowerment in Rural Areas - Additional Financing	Irrigation and Drainage Water Supply	32.70	Closed	2011/06/02
18	Third National Program for Community Empowerment in Rural Areas - Disaster Management Support	Irrigation and Drainage Water Supply	14.10	Closed	2011/03/23
19	Water Resources and Irrigation Sector Management Program 2	Irrigation and Drainage Public Administration - Water, Sanitation and Waste Management Other Water Supply, Sanitation and Waste Management	150.00	Closed	2011/03/22
20	Fourth Infrastructure Development Policy Loan	Other Water Supply, Sanitation and Waste Management	200.00	Closed	2010/11/18
21	Indonesia Climate Change Development Policy Project	Other Water Supply, Sanitation and Waste Management	200.00	Closed	2010/05/25
22	Third National Program for Community Empowerment in Rural Areas (PNPM-Rural	Irrigation and Drainage Water Supply	785.00	Closed	2010/03/30
23	Third National Program for Community Empowerment in Urban Areas III	Sanitation	149.98	Closed	2010/03/30
24	TF Water and Sanitation Sector Monitoring (WASAP E)	Other Water Supply, Sanitation and Waste Management	1.37	Active	2009/10/30
25	WASPOLA Facility	Sanitation Water Supply Public Administration - Water, Sanitation and Waste Management Public Administration - Water, Sanitation and Waste Management	2.33	Closed	2009/10/20

Source: WB Web-sites

Table 4-26 Cooperation Projects by the World Bank

No.	Project Title	Sector	Commitment Amount (US Million$)	Status As of 2018	Approval Date
26	Third Infrastructure Development Policy Loan	Other Water Supply, Sanitation and Waste Management	250.00	Closed	2009/09/24
27	ID-Urban Water Supply and Sanitation	Water Supply	23.56	Closed	2009/07/28
28	WASAP D - Community and Municipal Sanitation Pilots	Sanitation	2.24	Closed	2009/06/01
29	PAMSIMAS Support Trust Fund	Sanitation Water Supply Public Administration - Water, Sanitation and Waste Management	6.54	Closed	2009/05/26
30	Second National Program for Community Empowerment in Rural Areas Addit	Irrigation and Drainage Water Supply	300.00	Closed	2009/04/14
31	National Program for Community Empowerment in Urban Areas (PNPM II UPP	Other Water Supply, Sanitation and Waste Management	115.00	Closed	2009/04/14
32	Dam Operational Improvement and Safety	Public Administration - Water, Sanitation and Waste Management Other Water Supply, Sanitation and Waste Management	50.00	Active	2009/03/19
33	GPOBA W3 - Expanding Piped Water Supply to Surabaya's Urban Poor	Water Supply	2.57	Closed	2009/02/11
34	Second Infrastructure Development Policy Loan	Other Water Supply, Sanitation and Waste Management	200.00	Closed	2008/12/09
35	TA for Jakarta Flood Mitigation	Waste Management Other Water Supply, Sanitation and Waste Management	5.02	Closed	2008/10/20
36	Makassar - TPA Tamangapa Landfill Methane Collection and Flaring	Waste Management	7.70	Closed	2008/09/30
37	ID National Program for Community Empowerment in Rural Areas	Irrigation and Drainage Water Supply	231.19	Closed	2008/05/20
38	Bekasi Landfill Gas Flaring	Waste Management	0.00	Closed	2008/02/15
39	ID-Infrastructure DPL (IDPL)	Water Supply	200.00	Closed	2007/12/04
40	Jakarta Water	Water Supply	5.00	Closed	2007/11/01
41	Pontianak - LFG Recovery Project	Waste Management	0.00	Closed	2007/06/15
42	ID - KDP3 Second Phase - Add'l Financing	Irrigation and Drainage Other Water Supply, Sanitation and Waste Management	123.00	Closed	2007/04/26
43	Aceh Infrastructure Reconstruction Financing Facility (IRFF)	Other Water Supply, Sanitation and Waste Management	100.00	Closed	2006/12/11
44	ID-Aceh-Infra. Reconstr Enabling Program (IREP)	Water Supply Other Water Supply, Sanitation and Waste Management	42.00	Closed	2006/06/30
45	Third Water Supply and Sanitation for Low Income Communities Project	Sanitation Water Supply	137.50	Active	2006/06/27
46	EMERGENCY REHABILITATION OF THE DRAINAGE AND FLOOD PROTECTION SYSTEM OF BANDA ACEH	Other Water Supply, Sanitation and Waste Management	4.50	Closed	2006/04/06
47	Integrating Environment and Forest Protection into the Recovery and Future Development of Aceh	Irrigation and Drainage	20.57	Closed	2006/02/10
48	EC GRANT - ID NTB-River Basin Water Resources Based Poverty Alleviation Project	Other Water Supply, Sanitation and Waste Management	10.19	Closed	2005/12/20
49	Community-based Settlement Reconstruction and Rehabilitation Project for NAD and NIAS	Other Water Supply, Sanitation and Waste Management	85.00	Closed	2005/09/14
50	Community Recovery in Earthquake Affected Areas through UPP	Other Water Supply, Sanitation and Waste Management	17.96	Closed	2005/08/24
51	Third Urban Poverty Project	Other Water Supply, Sanitation and Waste Management	138.70	Closed	2005/05/17
52	Dutch TF Grant - ID Water and Sanitation Program	Sanitation Water Supply	6.00	Closed	2005/02/10

Source: WB Web-sites

4.3.4.2 Cooperation by the Asian Development Bank (ADB)

The Asian Development Bank (ADB) has provided support in line with the priority of the national medium-term development plan (RPJMN) in Indonesia focusing on infrastructure development, human resource development and economic policy. According to the data published on the website of the Asian Development Bank, 25 projects/programs on water and other urban infrastructure and services are implemented in the sector related to water resources and DRR. By sector, there are 10 projects in urban policy and 8 projects in the urban water supply. There are few projects related to disaster prevention such as flood protection (1 project of No. 3).

Table 4-27 Cooperation Projects by the Asian Development Bank (ADB)

No.	Project Name	Subsector	Type	Status (Jun.2018)	Approval Date
1	Sewerage System Development Project	Urban sanitation	Loan	Proposed	2018/07/22
2	Accelerating Infrastructure Delivery through Better Engineering Services Project	Urban policy, institutional and capacity development	Loan	Approved	2016/11/10
3	Flood Management in Selected River Basins Sector Project	Agriculture Natural resources an rural development	Loan	Approved	2016/09/30
4	Sustainable Infrastructure Assistance Program - Capacity Development for the Metropolitan Sanitation Management Investment Project (Subproject 6)	Urban policy, institutional and capacity development Urban sanitation Urban solid waste management	Technical	Active	2014/06/13
5	Sustainable Infrastructure Assistance Program - Capacity Development for the Metropolitan Sanitation Management Investment Project (Subproject 6)	Urban policy, institutional and capacity development Urban sanitation Urban solid waste management	Technical	Active	2014/06/13
6	Metropolitan Sanitation Management Investment Project	Urban sewerage	Loan	Active	2014/03/31
7	Neighborhood Upgrading and Shelter Project (Phase 2)	Urban housing Urban policy, institutional and capacity development Urban slum development	Loan	Active	2014/03/31
8	Green Cities: A Sustainable Urban Future in Indonesia	Urban policy, institutional and capacity development	Technical Assistance	Active	2013/11/26
9	IKK Water Supply Sector Project	Urban water supply	Technical Assistance	Closed	2013/11/06
10	Sustainable Infrastructure Assistance Program - Technical Assistance Cluster Management Facility (Subproject 1)	Urban policy, institutional and capacity development Urban solid waste management Urban water supply	Technical	Active	2013/10/10
11	Sustainable Infrastructure Assistance Program	Urban policy, institutional and capacity development Urban solid waste management Urban water supply	Technical	Approved	2013/06/17
12	EAST JAKARTA WATER SUPPLY DEVELOPMENT PROJECT	Urban water supply	Loan	Approved	2013/02/15
13	Metropolitan Sanitation Management and Health Project II	Urban sanitation	Technical Assistance	Closed	2011/12/13
14	Water Supply and Sanitation Sector Development	Urban water supply	Technical Assistance	Closed	2011/11/25
15	Urban Sanitation and Rural Infrastructure Support to PNPM Mandiri Project	Urban sanitation	Loan / Technical Assistance	Active	2011/08/05
16	Supporting Water Operators' Partnerships	Urban water supply	Technical Assistance	Closed	2010/12/14
17	Mount Merapi Disaster Response Project	Urban housing	Grant	Dropped / Terminated	2010/12/07
18	Infrastructure Reform Sector Development Program - Subprogram 3	Urban policy, institutional and capacity development	Loan	Closed	2010/12/01
19	Metropolitan Sanitation Management and Health Project	Urban policy, institutional and capacity development Urban sanitation Urban sewerage	Loan	Active	2010/07/19
20	Capacity Development for Metropolitan Sanitation Management and Health Project	Urban sanitation	Technical Assistance	Closed	2010/07/19
21	Infrastructure Reform Sector Development Program (Subprogram 2)	Urban policy, institutional and capacity development	Loan	Closed	2008/11/27
22	WEST JAKARTA WATER SUPPLY DEVELOPMENT PROJECT	Urban water supply	Loan	Approved	2007/08/31
23	Infrastructure Project Development Facility	Urban policy, institutional and capacity development	Grant / Loan / Technical Assistance	Closed	2006/11/21
24	Metropolitan Sanitation Management and Health	Urban sanitation Urban sewerage Urban solid waste management	Technical	Closed	2006/01/16
25	Support for Infrastructure Development	Urban water supply	Technical Assistance	Closed	2005/12/12

Source: Web-site ADB

4.3.4.3 Cooperation by Other International Organizations / Bilaterals

Cooperation projects by countries and donors in Indonesia are shown below. BNPB-related projects are listed regardless of sectors, but regarding PUPR-related projects, areas listed only water induced disasters sector and water resources development sector.

Table 4-28 Cooperation Projects for BNPB from International Donors (All Projects/Programs)

SN	Donors	Activities,Programs,Plans	Budget	Objectives & Activities	Status	Remarks
1	MFAT - New Zealand Aid	STIRRRD (Strengthened Indonesia Resilience: Reducing Risk from Disaster)	NZ$ 7.6 million	GNS Science (NZ) partnering with Gadjah Mada University (UGM, Jogjakarta), supports the increasing the DRR capability of local government and local universities.	Ongoing	
2		Implementing a better warehousing and logistic management	-	No further Information	-	Same with WFP activity (No. 5)
3		National Disaster Response Framework	NZ$ 1.5 million	Formulation of Indonesia Disaster Response Framework (NDRF - who do what during emergency response)	Finished	Final product submitted to BNPB during National Coordination
4	USAID	InaWARE	FY 2014: US$ 837,000	Development of Disaster Monitoring System for Decision Support System. Project was conducted by PDC (Pacific Disaster Center). InAWARE is based on the PDC's DisasterAWARE platform and will enhance BNPB's disaster management capabilities.	Ongoing	Phase 1 (2013-2016) Phase 2 (2016-2019)
5	WFP (World Food Program)	Formulation of Humanitarian Logistics Master Plan (HLMP)	-	Kick Off meeting was conducted on March 15, 2018	Ongoing	
6		Activities registered in BNPB, 32 was funded by USAID	Based on activity, no total budget	1) For Mt. Sinabung, USAID provide USD$ 200,000 for emergency response 2) In 2014, USAID provide USD$ 494,000 to strengthen capacity of BNPB to manage humanitarian logistics operation.	Finished	
7	IOM	Activities funded by USAID was registered in BNPB	Based on activity, no total budget	Sample of activities: 1) For Mt. Sinabung (2013-2014), USAID provide USD$ 100,000 for procurement & distribution of emergency relief commodities. 2) in FY 2014, USAID provide USD$ 1.3 million to strengthen the DM capacity in 8 Districts in Aceh Province 3) USAID provide USD$ 700,000 for IOM to build the capacity of BNPB to develop appropriate training on humanitarian camp coordination and camp management.	Finished	
8	Mercy Corps	Activities funded by USAID was registered in BNPB	Based on activity, no total budget	1) During Jakarta Flood 2013, USAID provide USD$ 150,000 to distribute cleaning supplies, hygiene items and other commodities 2) During Ambon Flood 2012, USAID provide USD$ 100,000 to distribute relief commodities; 3). Institutionalizing Disaster Management Capacity: Embed teams of trainers to province BPBD to provide technical support. 4) READI (Resilient Environment through Active DRR Initiatives) (FY 2014 - USD$ 215,000)	Finished	
9	China - University of TsingHua	MHEWS (Multi Hazard Early Warning System)	No information	Design stage - under preparation	Ongoing	Information from social media
10	DFAT - Australia AUSAID	AIFDR (Australia-Indonesia Facility for Disaster Reduction) (MOU signed 2011) http://dfat.gov.au/geo/indonesia/development-assistance/Pages/indonesia-development-cooperation-completed-programs.aspx	Total AIFDR 2008-2015 (AUS$ 67 millions)	Three program areas: 1)training & outreach; 2)partnerships; and 3)risk & vulnerability. Total 67 activities of AIFDR are officially handed over to BNPB. Sample of activities: 1). Development of EOC (Pusdalops) in Makasar (South Sulawesi), Kupang (east Nusa Tenggara) and Padang (West Sumatera). 2) For No 3). Risk & Vulnerability: one of the result is InaSAFE.	Finished	Originally, AIFDR was Finished on Dec 2015, but extended until Oct 2016 for completing the administration works
11		Australia-Indonesia Partnership on Disaster Risk Management (MOU signed April 2016) http://dfat.gov.au/geo/indonesia/development-assistance/Pages/human-development-in-indonesia.aspx	2015-2018 (AUS$ 19 millions)	1) Keep supporting the InaSAFE program through DMInnovation 2) Conduct Technical Cooperation Project with BNPB in South Sulawesi and East Nusa Tenggara, with following activities: a) facilitation & advocation on disaster related regulations (DM Plan, Contingency Plan.etc), b) Strengthening the role of Pusdalops (EOC) and c)Institutional Capacity enhancement of BPBD South Sulawesi and East Nusa Tenggara (NTT)	Ongoing	
12	UNDP	Strengthening Schoold Preparedness for Tsunami in Asia Pacific Region (UNDP Regional Project - 18 countries)	No information	Tsunami awareness education and safety drills for schools in Aceh (9 schools) and Bali.	Ongoing	
13		SCDRR Phase 1 (2007 – 2013) Safer Communities through Disaster Risk Reduction	US$ 18 million	Four key outputs: 1) Policy, Legal and Regulatory Frameworks 2) Institutional Strengthening 3) Public Awareness and Education 4) Community Level DRR Initiatives	Finished	
14		SCDRR Phase 2 (2013 – 2016)	No information	Scalling up the phase 1 activities. Two main outputs: 1) Policy guidance developed to support the integration of DRR in development planning and specific sectors 2) Strengthen the technical capacities of DM actors to plan, implement and monitor DRR.	Finished	
15		IMDFF-DR Merapi Mountain, Mentawai islands, Sinabung Mountains, etc.	Various, depend on disaster's location	1)Indonesian Multi Donor Fund for Disaster Recovery managed by UNDP 2) Other UN based organization to support the funding of recovery activities in varous disasters. 3)Suporting the recovery activity of Tsunami in Mentawai Island (2010) 4) Eruption of Mt. Sinabung (2014); Eruption of Mt. Kelud (2015), etc.	Finished	
16	World Bank	Replication and Mainstreaming of Rekompak (Community Based Settlement Rehabilitation and Reconstruction) (May 2016 – March 2018)	US$ 1.62 million	1)To support in meeting the needs for disaster-resilient settlements 2)To mainstream community-based processes into the national framework for DRR. "Rekompak" was introduced during Tsunami Aceh (2004), then Jogja Earthquake (2006), Padang Earthquake (2009) and Merapi eruption (2010).	Ongoing	Most activities are to support the Mount Sinabung (North Sumatera Province) resettlements. Implementer is PUPR, & BNPB
17		Scaling Up Safe School Facilities in Indonesia (Des 2015 – Sept 2017)	US$ 300,000	1)Building capacity to support the implementation of a safer schools program. 2)Collaboration with the Ministry of Education and BNPB on the development of a safe school risk map. 3) A school vulnerability assessment	Finished	
18		Disaster Risk Management for the Third National Program for Community Empowerment in Urban Areas (Des 2012 – Sept 2017)	US$ 514,690		Finished	

Source: Web-sites, BNPB, BAPPENA

Table 4-29 Cooperation Projects for PUPR from International Donors (DRR, WRD)

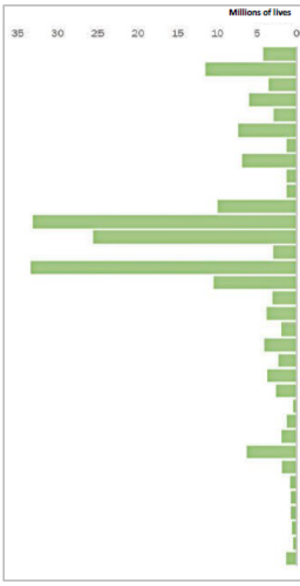
SN	Donors	Projects, Loans	Budget	Objectives & Activities	Status	Remarks
1	World Bank	Jakarta Urgent Flood Mitigation Project	USD Million 139.64	To contribute to the improvement of the operation and maintenance of priority sections of Jakarta's flood management system. 1) Dredging and rehabilitation of selected key floodways, canals and retention basins. 2) Technical assistance for project management, social safeguards and capacity building.	Ongoing	Project Location: Jakarta
2		Dam Operational Improvement and Safety Project (DOISP)	USD Million 50.0	1) To increase the safety and the functionality with respect to bulk water supply; 2) To strengthen the safety and operational management policies, regulations and administrative capacity of PW The project was composed of five components: 1) Dam Operational Improvement and Safety Works and Studies 2) Operations & Maintenance Improvement and Capacity Building 3) Reservoir Sedimentation Mitigation 4) Dam Safety Institutional Improvement 5) Project Management	Finished	Project Location: 1) East Java Province 2) East Kalimantan Province 3) South Sulawesi Province 4) Lampung Province 5) West Java Province 6) Special Region of Yogyakarta Province 7) West Nusa Tenggara Province 8) East Nusa Tenggara Province
3	ADB	Flood Management in Selected River Basin	USD Million 108.7	1) Planning for flood risk management enhanced. 2) Improved Land Management and Upgraded Flood Infrastructure 3) Capacity for community-based flood risk management enhanced 4) Policy, coordination, and capacity at national level improved	Ongoing	Project Location: 1) Cidanau – Ciujung – Cidurian River Basin 2) Ambon – Seram River Basin
4		Integrated Citarum Water Resources Management and Investment Program (ICWRMIP)	Amount of the Loan: - ADB (Ordinary Capital Resources): USD 20,000,000 - ADB (Special Fund Resources) : SDR 20,162,000 (USD 30,900,000) Amount of the Grant: - ADB: USD 3,750,000	The desired impact of the Investment Program: By the year 2023, poverty, health and living standards in the Citarum River Basin will be significantly improved. The outcomes : 1) Improved integrated water resources management; 2) Achieved through improved infrastructure facilities, 3) Putting in place effective institutional arrangements for IWRM in the basin, 4) Creating the conditions for improved and IWRDM, with government and the community working in partnership to achieve a shared vision formulated as part of the Roadmap development process.	Finished	Project Location: Citarum River, West Java Province
5	Korea	Construction of Karian Multipurpose Dam Project	USD Million 97.2	The activities of this project consist of 3 (three) packages, namely: • Construction Supervision Package of Karian Dam, Lebak Regency • Civil Works Package – Karian Dam Constuction, Lebak Regency • Hydromechanical Works Package – Karian Dam Construction, Lebak Regenc The project will have two output : 1) Infrastructure Development For Off-Site Wastewater Systems Completed 2) Project Implementation Support Institutionalized	ongoing	Project Location: Lebak Regency, Banten Province
6		Engineering Service for Coastal and River Development Project	USD 10,094,000	To ensure the high priority projects are implemented efficiency by advancing preparatory activities in a systematic manner through engineering services. Scope of Project: 1. Compose the documents regarding project preparations, consist of; (i) master plan (ii) feasibility study (iii) detail design (iv) environmental and social impact assessment (AMDAL) (v) land acquisition and resettlement action plan (LARAP) 2. Strengthen the capabilities of human resources of river and coastal's stakeholder.	Planned (Based on List of Planned Priority External Loans 2017 – Bappenas)	Project Location: Nationwide
7		Engineering Service for Multipurpose Dam Development Project	USD Million 21.61	To ensure that high priority projects are implemented efficiently by advancing preparatory activities in a systematic manner through engineering services.Scope of Project: 1. Compose the documents regarding project preparations, consist of; (i) master plan, (ii) feasibility study, (iii) detail design, (iv) environmental and social impact assessment (AMDAL), and (v) land acquisition and resettlement action plan (LARAP). 2. Strengthen the capabilities of human resources of river and dam's stakeholder.	Planned (Based on List of Planned Priority External Loans 2017 – Bappenas)	Project Location: Nationwide
8	China	Additional Loan for Jatigede DAM	USD Million 117.0	1) Civil works : preparatory general works, grouting gallery, main dam, road works 2) Hydro-mechanical : power gates, primary electrical works, secondary electrical work	Finished	Project Location: Sumedang Regency, West Java Province

Source: Web-sites, PUPR, BAPPENAS

4.3.5 Evaluations of Disaster Risks

4.3.5.1 Disaster Risk of Water Induced Disasters

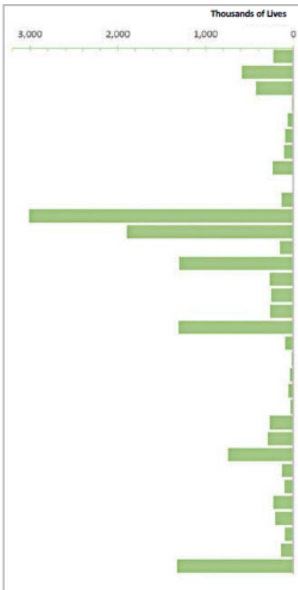
The assessment results on disaster risks by Province on floods and landslides by BNPB (Risko Bencana Indonesia) are shown below. Regarding the floods, there are many social lives in the West Java, Central Java, Central Java and North Sumatera. Regarding landslides, West Java, Central Java, Eastern Java and East Nusa Tenggara (NTT) show many social lives.



Province	Social (Lives)	Physical (IDR Millions)	Economy (IDR Millions)	Environment (Ha)
Aceh	4.215.518	4.309.182	4.585.055	101.340
Sumatera Utara	11.492.466	16.045.057	23.012.605	70.404
Sumatera Barat	3.527.323	574.667	4.606.822	21.965
Riau	6.009.366	10.757.456	32.858.382	726.422
Jambi	2.944.070	6.811.219	7.591.720	181.832
Sumatera Selatan	7.349.177	6.874.374	16.237.598	1.027.262
Bengkulu	1.306.053	2.678.268	1.375.846	11.266
Lampung	6.857.749	1.313.182	18.303.353	97.217
Kep. Bangka Belitung	1.305.260	3.055.175	579.169	86.127
Kepulauan Riau	1.302.395	418.862	79.778	38.402
DKI Jakarta	10.017.900	2.987.433	12.732	-
Jawa Barat	33.103.921	13.244.668	31.795.731	23.806
Jawa Tengah	25.463.472	20.770.536	21.922.021	9.189
DI Yogyakarta	2.964.112	97.064	1.192.058	2
Jawa Timur	33.327.643	23.622.748	31.891.405	12.148
Banten	10.476.016	3.811.288	3.611.576	1.705
Bali	3.041.479	357.530	241.135	627
NTB	3.821.342	6.095.056	1.818.401	7.201
NTT	1.936.246	240.250	2.011.917	23.188
Kalimantan Barat	4.013.577	13.936.066	6.520.029	811.980
Kalimantan Tengah	2.275.787	13.500.414	3.656.477	2.458.907
Kalimantan Selatan	3.747.950	9.323.452	5.640.801	184.186
Kalimantan Timur	2.564.167	3.548.254	5.639.760	759.589
Kalimantan Utara	440.369	444.950	370.519	200.589
Sulawesi Utara	1.258.486	278.010	1.686.724	3.455
Sulawesi Tengah	1.928.027	733.786	4.588.622	28.573
Sulawesi Selatan	6.301.018	3.254.830	8.769.288	27.577
Sulawesi Tenggara	1.854.488	514.789	2.691.272	45.742
Gorontalo	822.007	293.126	2.089.365	9.118
Sulawesi Barat	736.704	283.071	3.080.876	5.427
Maluku	754.536	1.012.596	1.411.974	145.456
Maluku Utara	603.016	127.890	245.963	21.877
Papua Barat	447.892	707.978	176.780	705.743
Papua	1.354.616	4.306.576	2.643.940	4.286.849
TOTAL	199.564.148	176.329.804	252.939.692	12.135.165

Source: Risko Bencana Indonesia (BNPB)

Figure 4-49 Provincial Region Flood Disaster Risk Exposure Amount Matrix

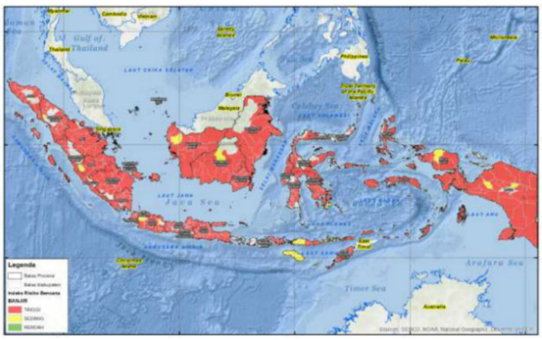


PROVINCE	Social (Lives)	Physical (IDR Millions)	Economy (IDR Millions)	Environment (IDR Millions)
Aceh	224,124	1,944,931	3,363,662	2,657,117
Sumatera Utara	588,335	4,054,112	4,041,656	1,395,110
Sumatera Barat	426,349	2,183,995	3,965,252	1,351,230
Riau	17,654	122,310	207,280	259,479
Jambi	66,624	424,976	501,207	552,693
Sumatera Selatan	92,618	465,904	279,095	493,590
Bengkulu	106,578	611,292	729,746	434,633
Lampung	237,215	1,030,370	1,375,070	260,273
Kep. Bangka Belitung	1,526	13,351	11,543	22,300
Kepulauan Riau	133,560	736,344	52,501	69,420
Jawa Barat	3,012,251	11,553,090	16,296,811	228,940
Jawa Tengah	1,895,989	7,730,803	16,948,195	78,222
DI Yogyakarta	155,691	816,806	715,890	743
Jawa Timur	1,301,217	5,666,123	11,299,978	340,934
Banten	266,564	1,055,690	2,456,167	17,595
Bali	254,515	1,239,777	1,544,458	107,703
NTB	264,917	1,255,535	722,727	709,376
NTT	1,309,660	8,473,283	959,513	1,163,236
Kalimantan Barat	95,819	541,587	248,880	2,236,553
Kalimantan Tengah	24,445	274,208	143,205	1,542,649
Kalimantan Selatan	36,525	251,279	74,420	470,420
Kalimantan Timur	55,378	377,632	333,421	2,543,106
Kalimantan Utara	33,592	1,013,432	330,226	3,543,544
Sulawesi Utara	266,364	1,354,183	1,030,880	431,317
Sulawesi Tengah	291,353	1,810,517	2,412,831	2,944,384
Sulawesi Selatan	741,643	5,018,034	3,020,287	1,371,574
Sulawesi Tenggara	129,468	715,506	694,889	1,052,585
Gorontalo	102,158	596,273	382,200	511,927
Sulawesi Barat	224,283	1,443,413	489,120	790,649
Maluku	207,737	1,068,602	85,914	1,289,983
Maluku Utara	98,228	478,969	107,418	952,297
Papua Barat	144,013	2,176,081	57,696	3,229,221
Papua	1,325,149	11,781,417	933,748	8,284,904
TOTAL	14,131,542	78,279,825	75,815,886	41,337,707

Source: Risko Bencana Indonesia (BNPB)

Figure 4-50 Provincial Region Landslide Disaster Risk Exposure Amount Matrix

According to Rencana Nasional Penanggulangan Bencana (National Disaster Management Plan, 2015-2019), damage risks due to flooding by Province are shown as follows.



Source: Rencana Nasional Penanggulangan Bencana (BNPB)

Figure 4-51 Damage Risks due to Floods by Province (IRBI: Index Rawan Bencana Indonesia)

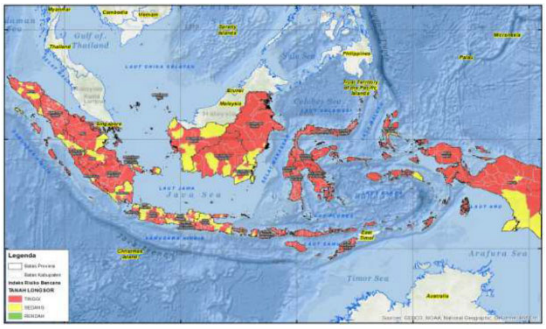
As a result, shown above, during the period from 2015 to 2019, the following river basins in ten (10) Provinces have been selected as priority provinces for implementation of flood disaster mitigation measures.

Table 4-30 Selected Ten (10) Provinces for Implementation of Flood Mitigation Projects

SN	Province	River Basin (DAS:Daerah Aliran Sungai)
1	East Java	DAS Bungawan Solo
2	Banteng	DAS Ciunjung, DAS Cisadane, DAS Ciliman
3	Central Java	DAS Bengawan Solo
4	DKI Jakarta	DAS Ciliwung
5	West Java	DAS Citarum, DAS Cimanuk
6	East Nusa Tenggara	DAS Benain
7	South Kalimantan	DAS Sepapah
8	North Sumatra	DAS Wampu
9	South Sumatra	DAS Batanghari
10	Aceh	DAS Krueng Aceh Tamiang

Source: Rencana Nasional Penanggulangan Bencana (BNPB)

A similar assessment was also conducted on landslides. The results of the assessment are shown in the Figure below. The ten selected states are: 1)Western Java 2)Central Java 3)East Java 4)East Nusa Tenggara 5)Western Sumatra 6)North Sumatra 7)South Sulawesi 8)Papua 9)Central Sulawesi and 10) Bali.



Source: Rencana Nasional Penanggulangan Bencana (BNPB)

Figure 4-52 Damage Risks due to Landslides by Province (IRBI, 2013)

4.3.5.2 Identified Challenges on Localities

(1) Aceh Province (Flood, Flash Flood)

Recent disaster events in Aceh Province (covering 2013 - 2017) are shown below and their causes are due to floods and flash floods (FF). Regarding floods, it is characterized with large inundation areas, and concerning sediment damage (FF), there were death toll in April 2017 event.

Table 4-31 Disasters y Floods in Aceh Province

Date of Event Occurred	Regency	District/Village	Disaster Events	Dead	Missing	Injured	Affected people	People evacuated	Affected Houses
11 April 2017	Southeast	Semadam,Lawa Sigale-Gala	Flash Flood	2	1				298
12 April 2017	West Aceh	Woylav Barat, Arongan Lambalek	Flash Flood				1,784		
17 January 2016	Aceh	Mantangkuli,Tanah Luas, Samudera, 12 Districts	Floods					1,505	
11 December 2015	West Aceh, Aceh Jaya, Nagan Raya, Aceh Selatan	Labuhan Haji	Floods	1			51,000		
14 July 2015	Aceh Jaya & Aceh Barat		Floods	0			25,765	2,000	7,904

Source: "FloodList" Web-site

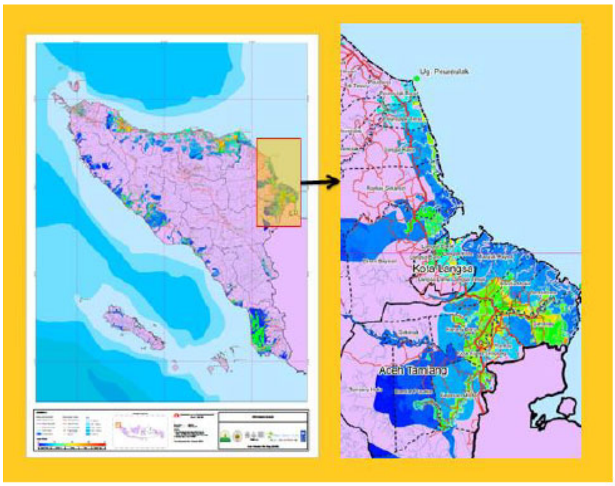
Based on the national disaster management plan, the disaster management plan in Aceh Province consist of the following five basic strategies. The basic strategies and key measures (foci) are shown below.

Table 4-32 Five (5) Strategies and Key Measures (Foci) in DMP in Aceh

SN	Strategies	Foci(Key Measures)
1	Enhancement of Regulatory Framework and Institutional Capacity	1)Strengthening the Cooperation Framework for the Implementation of DM.
		2) Enhancement of institutional capacity and support system for DM
2	Integrated Disaster Management Planning	1) Establishment of Aceh DM priority zone
		2) Formulation of Contingency Plans in the DM Priority Zone
		3) Establishment of a Logistics Distribution System
3	Research, Education and Training	1)Disaster Education in Formal Education Institutions to enhance the resilience of the communities and governments
		2)Partnership between Government, Aceh DRR Forum and Academician
4	Enhancing The Capacity and The Participation of The Community and Other Stakeholders in Disaster Risk Reduction	1)Utilization of research results and technology for the implementation of disaster management
		2)Synchronization and Enhancement of Government Sectoral Poverty Reduction Program in Aceh DM Priority Zone
5	Community Protection from Disaster	Disaster Prevention and Mitigation
		Disaster Preparedness
		Disaster Response

Source: Disaster Management Plan (Aceh)

Among the above, it is worth noting the designation of the disaster management priority zone (ZPPBA in Indonesian). As for the flood, as regencies (Kabpaten) to preferentially deal with flood mitigation response, three regencies such as Aceh Timur, Langsa and Aceh Tamiang were selected.



Source: Rencana Kontinjensi Bencana Banjir (Zona Prioritas Penanggulangan Bencana Aceh)

Figure 4-53 Regencies for Disaster Management Priority Zone (ZPPBA) in Aceh Province

The envisioned scenarios in the flood disaster management plan (ZPPBA) are shown as follows.

1) Flooding occurs at night and is started from upstream areas. This means that flood events occur suddenly without preceded by rain in basin.
2) At the time flood occurred, the rising tides from the sea also occurred in ZPPBA.
3) New water puddles receded after 2 weeks, and only completely dried after 1 month, due to existing some areas in the form of basins in ZPPBA.
4) Puddles are predicted as high as 1.5-3 meters from the country road.
5) ZPPBA for flood disaster is crossed by a kerosene transmission line that causes people to not cook and use fire during a flood disaster to avoid a possible fire disaster as a follow-up disaster.
6) In addition to fire, the potential for flash flood (FF) disasters is also likely to occur in ZPPBA. This

FF disaster can occur when the Kemuning Hulu Dam located in Langsa City leaked until broken.

7) In the event of a flood, all power supplies are cut off. Power supplies were cut off across districts /cities in ZPPBA floods during the peak of submergence. After the peak phase of the immersion, electricity supplies in some areas that are not immersed in water. Within 1 week after the peak of the flood event, electricity is operating normally again.
8) Due to high water velocity and high water immersion during flooding, all alternative land transportation infrastructure facilities to ZPPBA cannot be used.

Source: Rencana Kontinjensi Bencana Banjir (Zona Prioritas Penanggulangan Bencana Aceh)

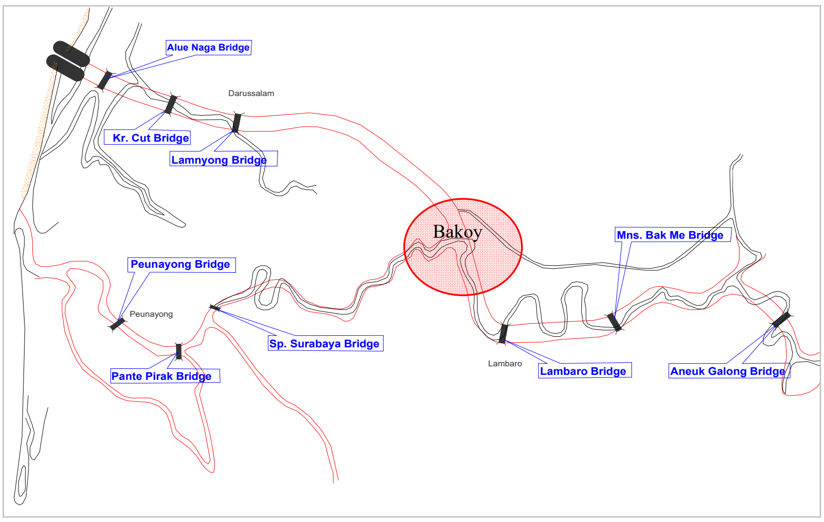
Table 4-33 Implementation Plans on Rivers in BWS Sumatra I (RPJMN)

SN	Project/Plan	Location
1	Normalization of floodway in Krueng Aceh	Kota Banda Aceh
2	Construction for Water Damage Control infrastructures in Krueng Singkil (River)	Kab. Aceh Singkil & Kota Subulussalam
3	Flood Control for Lawe Bulan River	Kab. Aceh Singkil
4	Coastal Protection in Meulaboh Town Beach	Kab. Aceh Barat
5	Coastal Protection near Rivermouth of Krueng Peudada (River)	Kab. Bireum
6	Coastal protection in Krueng Raya Beach	Kec. Mesjid Raya & Aceh Besar
7	River restoration in Krueng Lawe Alas and Lawe Bulan (Rivers)	Kab. Aceh Tenggara & Aceh Singkil
8	River restoration in Krueng Baro, Tiro and Aceh (Rivers)	Kab. Aceh Besar, Pidie & Pidie Jaya

Source: RPJMN (Book III) (2015-2019), BWS Sumatera I Banda Aceh

Among the above, improvement plan for the Aceh Floodway which was being designed by BWS Sumatra I is outlined below. The floodway with distance of 13 km was constructed to protect the city area of Aceh by diverting river water at Bakoy located in the upstream part of the city and draining to the Malacca Sea. Construction of the floodway was carried out by JICA loans and completed in 1992. The total loan amount was 4.7 billion yen. Although the design discharge of floodway was secured as 900 m3/sec with 5-year probability, after 25 years since the operation started, the sedimentation in the riverbed has increased, and flow capacity of the floodway has reduced to about 770 m3/sec. The BWS Sumatra I is planning dredging works to improve the flow capacity in the floodway. The outline of the floodway and the current situations in the field survey are shown below.

According to the design result prepared by BWS Sumatra I, the amount of dredging volume is 1.88 million m3, and the construction cost is estimated at 281.5 billion rupiah.

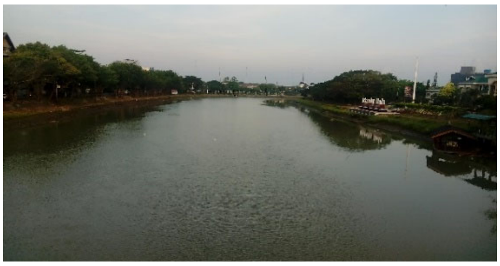


Source: Pengerukan Floodway (BWS Sumatera I)

Figure 4-54 Location of the Floodway and Diversion Point in the Krueng Aceh

Diversion Site at Bakoy

Floodway at Bakoy



Krueng Aceh Downstream at Lamnyoung Bridge

Downstream at Lower Floodway

Source: Pengerukan Floodway (BWS Sumatera I) & The Survey Team

Figure 4-55 Current Situations at Diversion, Floodway and Krueng Aceh (February 2017)

Current monitoring system for rainfall and water level as well as climate elements in BWS Sumatra I is shown below. Monitoring stations are classified into three categories namely; automatic rainfall recorder (ARR), automatic water level recorder (AWLR) and climatological station. For AWLR, the monitoring is available at 13 out of 28 sites, at 12 out of 22 site for ARR, and at 3 out of 7 sites for the climatological station.

Table 4-34 Monitoring Situations for Rainfall, Water level and Climate in BWS Sumatra I

River Basin Classifications	Kind on Instruments	Number (Available / Total)
Aceh-Meureudu	Automatic Water Level Recorder (AWLR)	5 of 9 Stations
	Automatic Rainfall Recorder (ARR)	5 8
	Climatological Station	1 3
Woyla-Bateue	AWLR	5 of 10Stations
	ARR	2 5
	Climatological Station	1 2
Jambo-Aye	AWLR	1 of 3 Stations
	ARR	1 3
	Climatological Station	1 1
Alas-Snigkil	AWLR	0 of 3 Stations
	ARR	2 4
	Climatological Station	0 1
Tamian-Langsa	AWLR	1 of 1 Stations
	ARR	1 1
	Climatological Station	0 0
Pasee-Peusangan	AWLR	1 of 2 Stations
	ARR	1 1
	Climatological Station	0 0
RBO Total	**AWLR**	**13 of 28 Stations**
	ARR	**12 22**
	Climatological Station	**3 7**

Source: Hydrology Section (BWS Sumatera I)

The status of formulation for POLA (Development Plan) and RENCANA (Program & Action Plan) is shown as follows.

Table 4-35 Status of Formulation for POLA and RENCANA in BWS Sumatera I

No	River Basin	POLA PSDA		RENCANA PSDA	
		Draft	Formulation	Draft	Formulation
1	Aceh - Meureudu	Finished 2016	(Not yet)	2015 (Stage I)	(Not yet)
2	Woyla - Bateue	2009-2010	Dec. 2015	2014 (Stage I) & 2015 (Stage II)	(Not yet)
3	Jambo Aye	2008	May 2014	2014 (Stage I) & 2015 (Stage II)	(Not yet)
4	Alas -Singkil	2010	July 2014	2013 (Stage I) & 2014 (Stage II)	(not yet)

(2) North Sulawesi Province Manado (Food, Land Slide)

The recent flood events in North Sulawesi Province (covering 2013 - 2017) are shown below. The causes of these events are due to floods and landslides. Among them, flooding in January 2014, which occurred mainly in Manado City, experienced the largest damage. In this flood, there were 13 deaths, and the damage amount was estimated at Rp 1,440 Billion.

Table 4-36 Disasters in North Sulawesi (2013-2017)

Date of Event Occurred	Regency	District/Village	Disaster Type	Dead	Missing	Injured	Affected People	People Evacuated	Affected Houses
26-29 January 2017	Billitung		Flood & Landslide				5,000	1,000	
17-22 June 2016	Manado, Tomohon,Minamasa Selatan, Kepulauan Sitaaro, etc.		Flood & Landslide	4	1				
14 January 2014	Manado & Minahasa	Kota Manado	Flood & Landslide	13	2			40,000	
24-26 July 2013	Konawe Selatan		Flood	4	3			28,000	

Source: "FloodList" Web-site

In the flood event in 2014, the flooded area ranged nine (9) Regencies and 59 Districts.

The above-mentioned disaster rehabilitation plan was prepared and works were carried out with JICA loans, and currently the construction of the first phase is in progress. (As of May, 2018) This rehabilitation plan was done with probability scale of 1/5, but after that in 2016, the master plan study and the feasibility study were carried out, which was upgraded to the design discharge of 1/25. The outline of the river improvement plan and current work situations are shown below in Table 4-12.

Source: BPBD North-Sulawesi

Figure 4-56 Inundation Areas and Picture in Manado by Flood Event in January 2014

Table 4 12 River Improvement Plans in Manado City (Probability: 1/25)

Name of the River	Distance for Improvement (m)	Design Discharge (m3/sec)	Current Flow Capacity (Probability)
Tondano River	7,200	1,220 - 650	1/3-1/5
Tikala River	7,200	600	½
Sario River	5,300	155 - 125	½
Malalayan River	2,400	270 -240	1/5
Bailang River	1,000	270 -190	½
Mahawu River	4,600	80 60	½

Source: Urban Flood Control System Improvement in the Selected Cities (Manado, JICA)

Tondano River at Megawati Br.

JICA Loan Works Downstream of Mahakam Br.

Tondano River at WL Monitoring Site

Lower Sario River

Source: The JICA Survey Team

Figure 4-57 Current Situations in Tondano and Sario River (February 2018)

The river water level monitoring system is in operation in Manado City. After flood in 2014, automatic water level recorder was installed in upstream of the Tondano Rive by the assistance of JICA. Also, community-based water level monitoring is done at the Monitoring Post (Dendengan Luar) in downtown area. Flood experiences in 2014 made consciousness among residents, and disaster mitigation awareness has also been spreading.

WL Monitoring Station in Tondano River

River Situation around Monitoring Station

Source: The JICA Survey Team

Figure 4-58 Automatic Water Level Recorder in Tondano River (Assistance by JICA)

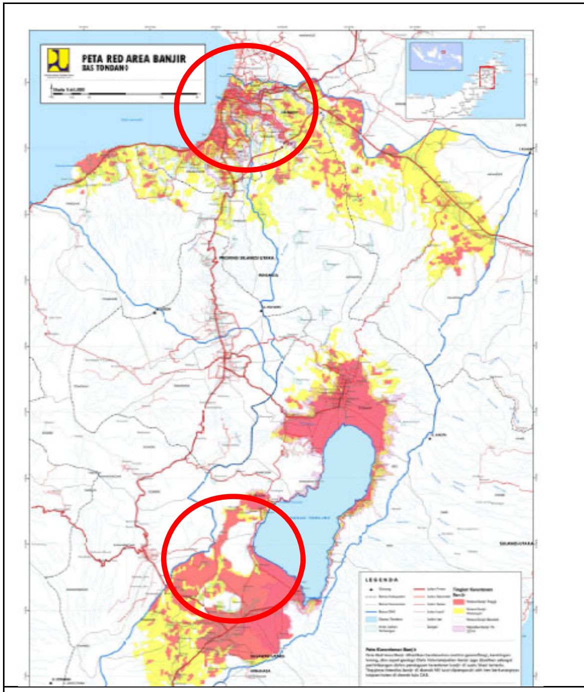
The estimated damaged areas by floods and sediment-related disasters in the vicinity of Manado City obtained by field survey and report are shown below. The flood areas by the flood are concentrated in the vicinity of Manado city center (lowland areas) and near the Lake Tondano. Regarding the landslides, areas are distributed evenly in the downstream, middle and upstream portion in the basin.

Monitoring Post in Tondano River

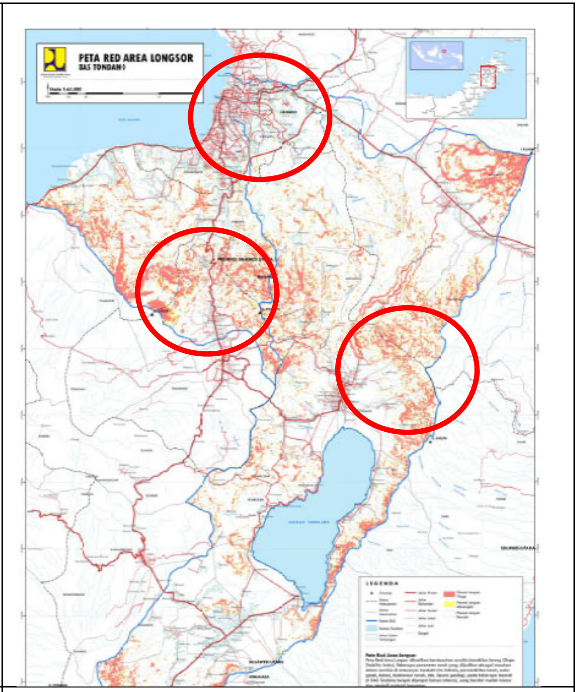
WL Stuff Gauge

Source: The JICA Survey Team

Figure 4-59 Water Level Monitoring Station in Tondano River (Water Front City)



Possible Flooding Areas



Possible Landslide Areas

Source: PUPR BWS Sulawesi I

Figure 4-60 Disaster Risk Areas by Floods and Landslides

The implementation plans on rivers and coasts in BWS Sulawesi I(Manado) are shown as follows. The status of formulation for POLA (Development plan) and RENCANA(Program & Action Plan) is shown as follows.

Table 4-37 Implementation Plans on Rivers and Coastal in BWS Sulawesi I (RPJMN)

SN	Name of the Project	Project Area
1	Reinforcing Tondano River Flooding Embankment (Package 1)	Tondano River, Kota Manado
2	Reinforcing Tondano River Flooding Embankment (Package 2)	Tondano River, Kota Manado
3	Construction of the Sabo Dam in the Milangodaa River	Milangodaa River, Kab. Bolsel
4	Coastal Protection (Continued)	Kab. South Minahasa
5	Coastal Protection in Miangas Island (Continued)	Kab. Island Talaud
6	Construction of Dam Lolak	Kab. Bolaang Mongondow
7	Construction of Dam Kuwil	Kab. North Minahasa
8	Revitalization of Lake Tondano	Kab. Minahasa

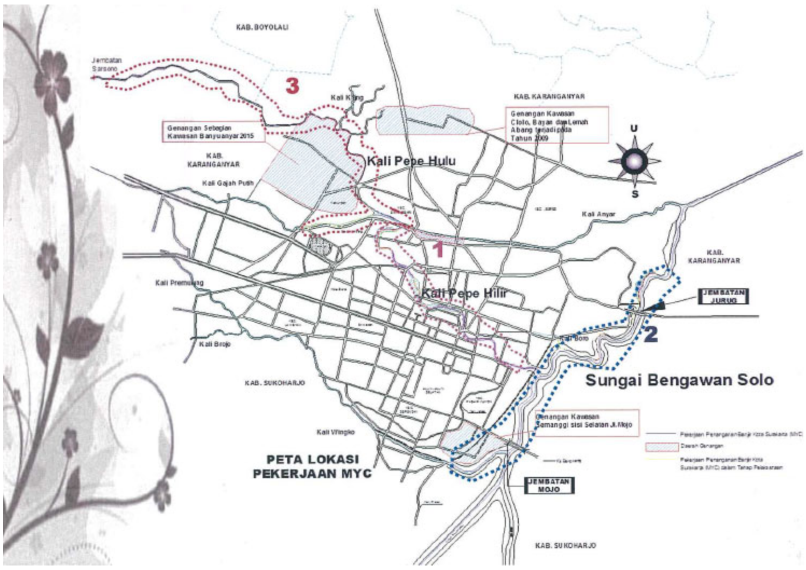
Source: RPJMD North Sulawesi Province (2016-2021), BWS Sulawesi I Manad

Table 4-38 Status of Formulation for POLA and RENCANA in BWS Sulawesi I

No	River Basins	POLA PSDA		RENCANA PSDA	
		Draft	Formulation	Draft	Formulation
1	Tondano-Sangihe-Talaud-Miangas	2012	Feb 2017	2014 (Stage I) & 2015 (Stage II)	(not yet)
2	Dumoga Sangkup	Review 2012	Mar 2017	2014 (Stage I) & 2015 (Stage II)	(not yet)

(3) Central Java Province, Sunakarta (Flood)

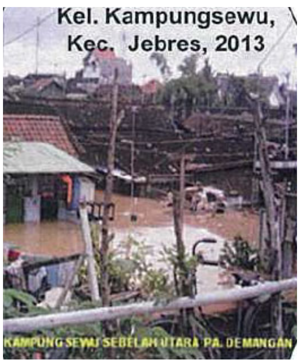
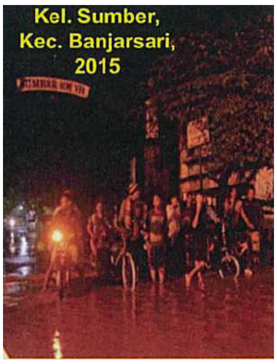
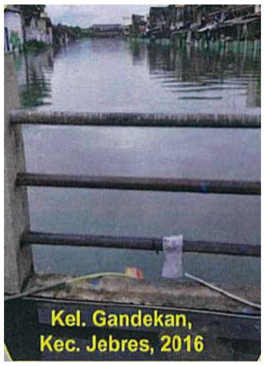
In Surakarta, the major city in the upstream part of the Bengawa Solo flowing from Central Java province to East Java province, was affected by floods every year from 2013 to 2015. The flood inundation areas in Surakarta are the three areas shown in Figure below, and the downstream section (Hilir) of the Kali Pepe (Length L = 5 km, No. 1 in the Figure) and the upstream section (Hulu) (L = 8 km, No. 3) and the left bank area of the Solo River (Sungai Bengawan Solo) (Lenght L = 18 km, No. 2).



Source: Penaganan Banjir Kota Surakarta (Solo 2016-2018, BBWS Bengawan Solo)

Figure 4-61 Affected Ares by Floods in Surakarta

The flooding summaries mentioned above areas are shown below. The causes of flooding are not only flooding of Solo River but also due to inland water flooding caused by higher water level in Bengawan Solo. Therefore, for countermeasure works, improvement was made to increase the flow capacity of the river by widening and raising of levees and improvement of draining channel with pumping facilities. Regarding raising levees in the Bengawan Solo, the parapet structures are planned and adopted considering the land acquisition and the current state of land use (national highway, public use facilities and parking lots).

		
Flooding of Kel. Kampungsew, Kec. Jebres (2013)	Flooding of Kel. Sumber, Kec.Banjarsari (2015)	Flooding of Kel. Gendekan, Kec. Jebres (2016)

Source: Penaganan Banjir Kota Surakarta (Solo 2016-2018, BBWS Bengawan Solo)

Figure 4-62 Inundation Situations during Floods (2013-2016)

Planning and design to mitigate these floods have been carried out, and improvement works are being implemented as of 2018. The outline of these constructions is shown in Table 4-39. It costs 527 billion rupiah (equivalent to 4.13 billion JPY) in total construction.

Table 4-39 Outline of the River Improvement Works in Surakarta

Package	Name	Major Works	Project Cost (Rp. Billion)
1	Works in Kali Pepe Downstream	Normalization of river with bank improvement. Length=5.0 km (Karet Tirtonadi Weir to Demangan Water Gate)	134.16
2	Works in Bengawan Solo	a. Parapet wall construction with 5.6km b. Revetment with 2.3km c. Pumping house with pumping unit at 7 sites	212.20
3	Works in Kali Pepe Upstream	a. Rehabilitation of rubber dam b. Normalization works with 4.6km with revetment works with 3.0 km c. Pumping unit at one (1) site	180.20
Total Cost (Currency: Rp.13=1 JPY)			526.56

Source: Penaganan Banjir Kota Surakarta (Solo 2016-2018, BBWS Bengawan Solo)

Of the works highlighted inTable 4-39, current situations of work packages 2 and 3 at the sites (as of September 2018) are shown below. Beside the river improvement works, in addition to the construction of weir, installation of pump facilities for inland flood drainage and parapet walls which are constructed in the areas where impossibility of land acquisition are carried out.

Rubber Weir Tirtonadi (Width=73m)

Normalization (River Improvement) Kali Pepe

Parapet Wall at Jurug in B. Solo (H=4.5m)

Pumping Unit at Jurug in B. Solo

Source: The Survey Team (13 September, 2018)

Figure 4-63 River Improvement Works in Surakarta

Flood related disaster prevention activities in Surakarta is carried out by BPBD Kota Surakarta. The BPBD here was set up in 2013, and the actual activities started in 2014. As of year 2018, there is a shortage of personnel and response skills. Regarding flood response, preparedness is impossible, and the main actions are the emergency response at the time of flooding. Therefore, SOP has not been formulated and hazard maps have not been created. However, even under such circumstances, BPBD identifies the flooding areas from the past flooding results, and issues flood alerts in the critical areas.

Regarding community disaster mitigation, there is no activity by BPBD. However, in 15 places the Indonesian Red Cross (Palan Merah Indonesia, PNI) and SIBAT (Siaga Buncana Berbasis Masyarakyat, Community based Action Team) conduct regional disaster mitigation activities. Regarding the cleanup activities of rivers, it is undertaken regularly by the city of Surakarta City. Regarding the flood early warning system, BPBD plans to install the system in three places.

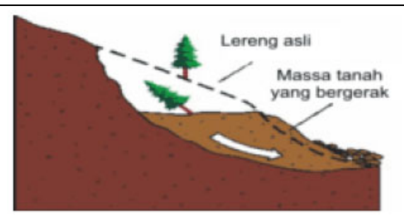
Source: Flood Management in the Brantas and Bengawan Solo river Basins (PJT 1, Malang)

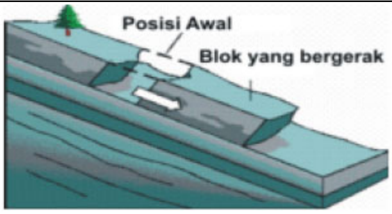
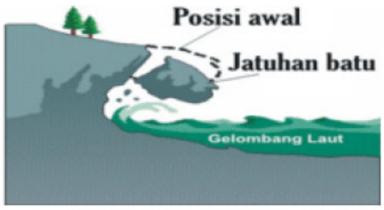
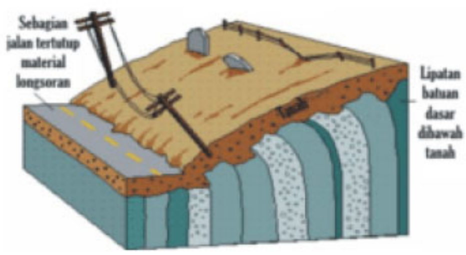
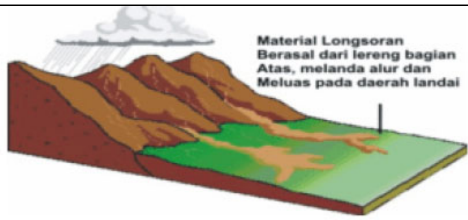
Figure 4-64 Flood Early Warning System in Community Based Flood Mitigation

(4) Central Java Province (Landslide)

Volcanology Survey of Indonesia (VSI) has conducted the following six classifications on landslides in Indonesia. Among them, as landslides in Indonesia, it is said that there are two typical types, one of which is translation landslide with the movement of the soil and rocks, and another one of which is rotation landslide with movement of soil and rocks along the circular arc.

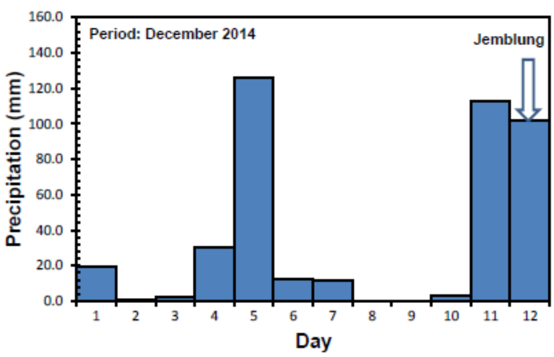
Table 4-40 Classification of Landslides (VSI)

Type of Landslide(Indonesian)	Explanation with Schematic Figure
1. Translation (Longsor Translasi)	
2.Rotation (Longsor Rotasi)	

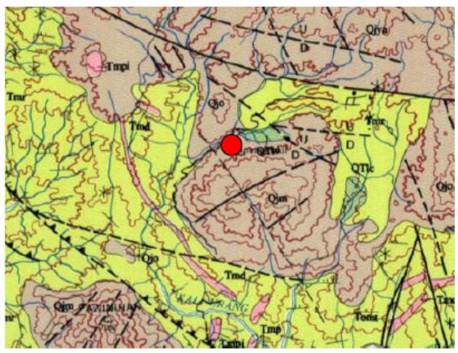
3.Movement of Blocks (Pergerakan Blok)	
4. Debris Stones (Runtuhan Batu)	
5. Soil Floating (Rayapan Tanah)	
6. Flow of Material (Aliran Bahan Rambakan)	

Source: Pengenalan Gerakan Tanah (Introduction of Land Movement) (VSI)

Landslide disasters, as mentioned above, are frequently occurring in Java island such as West Java Province and Central Java Province. Landslide events are categorized into two (2) types. These are caused by high rainfall intensity or earthquake vibrations. Landslide occurring during the rainy season is caused by rain. An example of an event which landslides occurred due to high rainfall intensity is the event that occurred in Jemblung, Banjarnegara District in Central Java Province in December 2014 causing 93 deaths and 23 missing. The details of the event is shown in below.. In this event, as described below, daily rainfall with 100 mm or more consecutively occurred, which is the cause of the disaster's occurrence.



Daily Rainfall at Jemblung Village

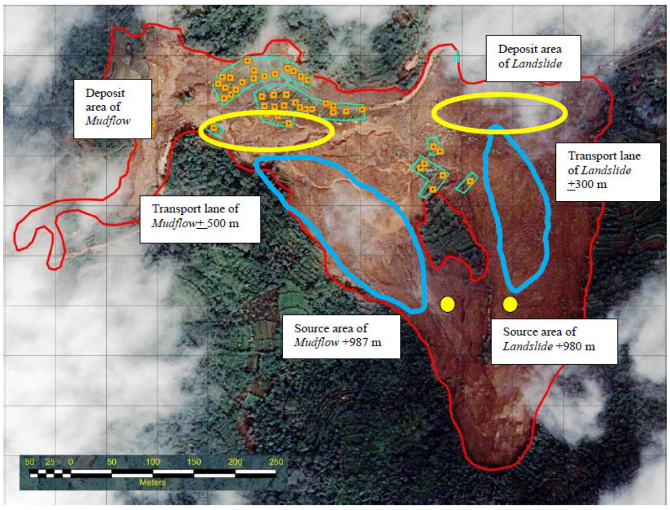


Geology Map of Jemblung Site

Source: Managing and Assessing Landslide Risk including the Consequences (Proceeding of Slope 2015)

Figure 4-65 Daily Rainfall and Geology Map in Jemblung, Central Java

This landslide events occurred after consecutive rainfalls had occurred, and the landslide had two different sediment movements. The first movement was the occurrence of mudflow, occurring in the west side of the Telegalele Mountain. Another movement was the landslide that occurred in the east side of the mountain. Estimated amount of sediment volumes was 56, 100 m 3 (with 5m thickness) by mudflow, 49,800 m 3 (with 7m thickness) by landslide, totaling 105,900 m 3 *(Source: Managing and Assessing Landslide Risk including the Consequences (Proceeding of Slope 2015))*



Source: Managing and Assessing Landslide Risk including the Consequences (Proceeding of Slope 2015)

Figure 4-66 Landslide and Mudflow Occurrences in Banjarnagra (December 2014)

Regarding the occurrence of landslide induced by the earthquake, there is example of Jogjakarta, Bantul District, which occurred in May 2006, and the outline thereof is shown in Figure 4-67. In the vicinity of Jogyakarta, an earthquake with magnitude 6.3 occurred on May 27, causing damage to Bantul District and Gunung Kidul District. The rock masses on the slope fell due to the vibrations of the earthquake.

Earthquake Induced Rock Falls in Bantul Regency, DI Jogjakarta

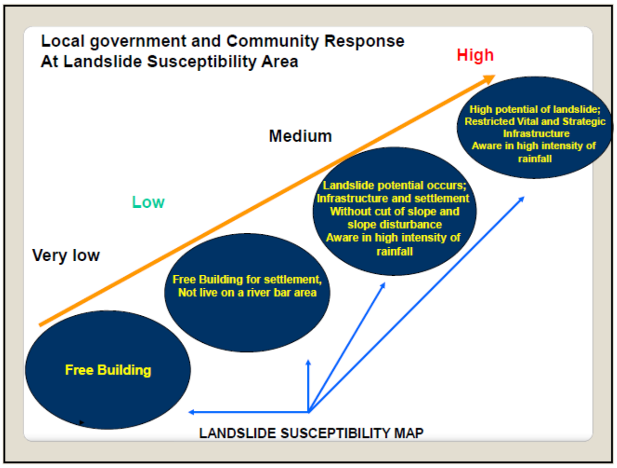
Source: Strategic Program for Landslide Disaster Risk Reduction: A Lesson Learned from Central Java (UGM & UEA)

Figure 4-67 Earthquake Induced Rock Falls in Bantul Regency, DI Jogjakarta (May 2006)

Countermeasures for mitigation of landslide prepared by PVMBG are shown as follows:

a. Preparing landslide susceptibility mapping
b. Evacuation by early warning system
c. Mitigation by landslide monitoring
d. Holding socialization
e. Dispatch of quick respond team

Among the above, the landslide susceptibility map is created by classifying the possibility of landslide occurrence as "high, medium, low and very low". The definitions by PVMBG is shown as follows:



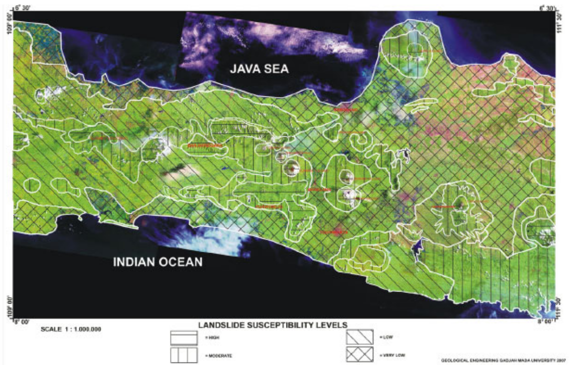
Source: Risk and Situation Update of Recent Landslide in Majalengka District (PVMBG, 2013)

Figure 4-68 Classifications in Landslide Susceptibility Map

According to the American Academy of Sciences, there are four (4) land hazard maps. These are the landslide inventory map showing the place where the landslide occurred, the land susceptibility map showing the stability of the slope created based on the GIS, the land hazard map showing the annual probability of the landslide, and the landslide risk map showing disaster risk (*Source: Committee on the Review of the National Landslide Mitigation Strategy, CRNLHMS, USA 2004*).

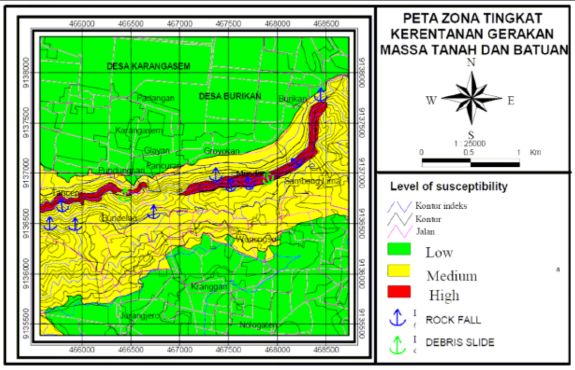
The following Figure 4-69 is an example of creating the landslide susceptibility map for Central Java Province. This figure was analyzed and created from the satellite image with emphasis on geographical and geological conditions.

Examples of the landslide susceptibility map and the risk map created for the Mundon in Gunung Kudul District of Jogjakarta are shown below. The created susceptibility map shows possibility of occurrence of rock falls and debris slides and is mainly created for the purpose of promoting appropriate development of land use (spatial) plan including development regulation. This figure has a role to regulate the construction of infrastructure facilities and houses in areas where the possibilities of landslide are high. On the other hand, the risk map is created to estimate the social impact assumed when landslides occur. The creation of these figures is made by participatory consensus building among the residents. Regarding areas where the occurrence of landslides is anticipated, reduction, prevention or mitigation measures are formulated. As concrete measures, construction method combining appropriate drainage systems with slope stabilization works and traditional construction methods in the area are adopted.

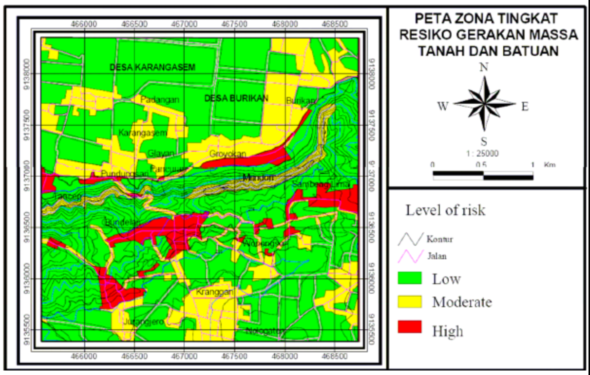


Source: Strategic program for landslide disaster risk reduction: a lesson learned from Central Java (UGM & UEA)

Figure 4-69 Landslide Susceptibility Map in Central Java



Landslide Susceptibility Map

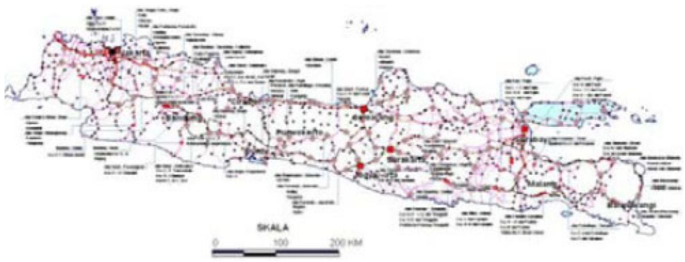


Landslide Risk Map

Source: Strategic Program for Landslide Disaster Risk Reduction: A Lesson Learned from Central Java (UGM & UEA)

Figure 4-70 Landslide Susceptibility Map and Risk Map (Gunung Kidul, Jogjakarta)

As for the early warning system, PVMBG conducts monitoring by using GPS. The monitoring networks in Java Island are shown as follows. The installation devices related to the landslide are extensometer, piezometer and tiltmeter in addition to GPS.



Monitoring Network of GPS for Landslide

Monitor for GPS

Source: Risk and Situation Update of Recent Landslide in Majalengka District (PVMBG, 2013)

Figure 4-71 GPS Networks for Landslide Monitoring in Java Island

The landslide warning system at the village level is monitored by extensometers and rain gauges which can measure the movement of the ground in units of 0.1mm as shown below

Extensometer for Monitoring

Dry Battery for Extensometer

Source: Strategic Program for Landslide Disaster Risk Reduction: A Lesson Learned from Central Java (UGM & UEA)

Figure 4-72 Extensometer for Landslide Monitoring

In the case of Central Java Province, the landslide monitoring system is installed with five (5) extensometers and on (1) rain gauge at two sites in the area of 50-70 ha. Maintenance and monitoring of these devices are being carried out by local community task force staffs. This community task force is composed of village heads, representatives from youth groups and young leaders. Since this task force is basically implemented without compensations or financial supports, sustainability on motivation is an issue for implementing disaster reduction activities.

According to the PVMBG, regarding the landslide, from the recognition that the understanding of geological phenomena and disaster prevention management are important, effective disaster mitigation education programs for residents are held called "Socialization". The purpose of holding the socialization is as follows.

a. To understand landslide hazard early warning system
b. Information of susceptibility to landslide zone
c. To calm down community in the landslide area
d. To improve understanding and awareness on geohazard phenomena as well as the importance of local community, local governments, decision makers and public education.
e. To develop appropriate strategy and program for public education.

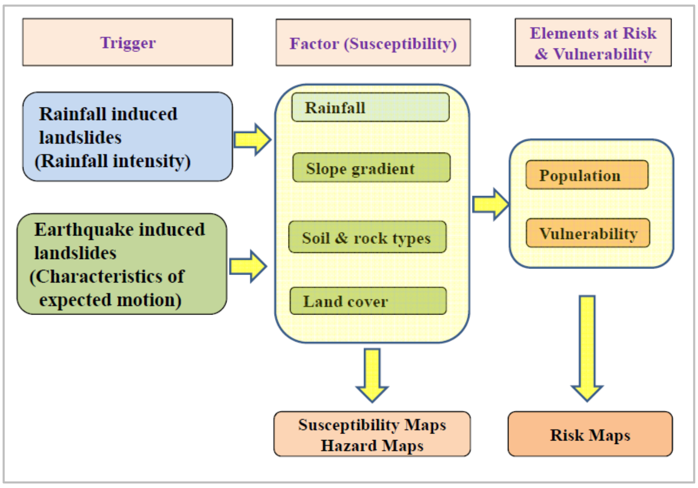
When disasters are anticipated, PVMBG dispatch Quick Response Team (QRT) to deal with technical problems. For disaster response at the community level, to effectively utilize the early warning system in the area where the system is installed, evacuation exercises and disaster mitigation education for residents are effective.

Source: Strategic Program for Landslide Disaster Risk Reduction: A Lesson Learned from Central Java (UGM & UEA)

Figure 4-73 Drills for Landslide in Central Java

As an example of drill on early warning systems preventing damages in advance, there is case in Kalitelaga Village, which occurred on 7th of November 2007, to prevent landslides of 35 families from being damaged. (*Source: Development of community-based landslide early warning system in Indonesia. World Landslide Forum, 2008*)

According to GAR, the following approaches shown in Figure 4-74 gives the factors and elements of landslide hazards and risk evaluation.



Source: Landslide risk in Indonesia (Global Assessment Report on Disaster Risk Reduction, 2011)

Figure 4-74 Factors and Elements of Landslide Hazard and Risk Evaluation (GAR)

In the Figure above, rainfall and earthquake are shown as triggers of landslides. Furthermore, rainfall (intensity), topography (slope gradient), geology (soil and rock type) and land cover conditions are shown as factors causing landslide. The risk assessment of landslide in Indonesia is basically done by combining these four factors and the social conditions such as population and vulnerability. On the premise of these, as preventive measures by PVMBG, they are shown as follows:

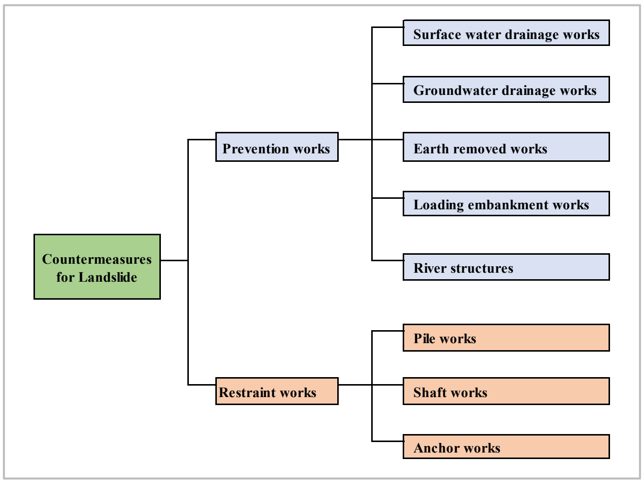
a. Prepare landslide hazard map/susceptibility map
b. Monitoring of dangerous (susceptibility) sites
c. Evacuation by early warning system (EWS)

The following countermeasures are taken for structural measures of landslide disasters in Indonesia. (Introduction of Land Movements, VSI)

a. Improving soil drainage
b. Reduction of slope angles
c. Vegetation
d. Concrete retaining wall

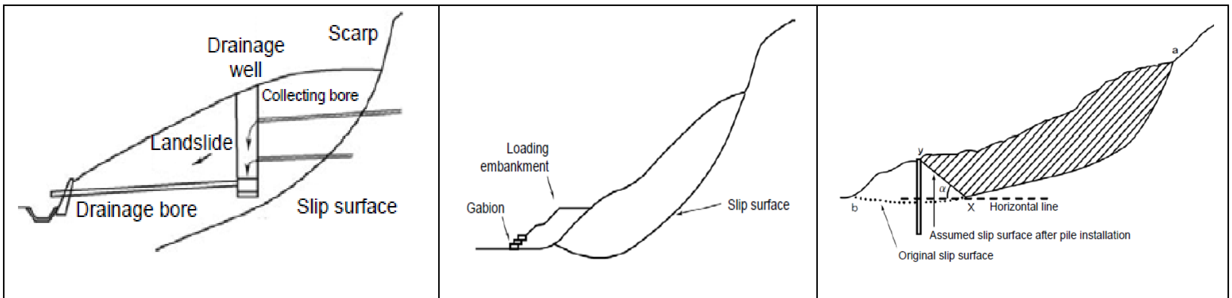
Basically, these methods are; method to reduce the groundwater in the soil mass, method of changing the gradient of the soil mass itself, method of covering the ground surface and method of suppressing the movement of the soil mass.

As countermeasures widely adopted in Japan, there are the following methods, and in particular, regarding various restraint works such as pile works and anchor works, it is judged that it can be also adopted in Indonesia.



Source: Guidelines for Landslide Prevention Technologies (Draft) September 2007(Public Works Research Institute (Japan)

Figure 4-75 Classification of Works for Landslide by Public Works Research Institute (PWRI), Japan



Groundwater Drainage Works	Embankment Loading	Pile Works

Source: Guidelines for Landslide Prevention Technologies (Draft) September 2007(Public Works Research Institute, Japan)

Figure 4-76 GW Drainage Works, Embankment Loading and Pile Works (PWRI, Japan)