6.3.1 Earthquake and Tsunami

Strategy for Tackling Challenges in Earthquake and Tsunami DRR

Before entering into the main discussion, a brief overview of the DRR experiences in Japan is given below as one of the benchmarks for discussing the future strategy for earthquake DRR (including tsunami DRR) in Indonesia. The DRR policy in Japan is based on the "Disaster Countermeasures Basic Act", which stipulates the establishment of the "Central Disaster Management Council" and development of "Basic Disaster Management Plan". Under the principle of the "Disaster Countermeasures Basic Act", there are three substantial laws that play important roles for earthquake DRR. The first one is the "Act on Special Measures Concerning Countermeasures for Large-Scale Earthquakes (1978)" that designates priority areas for implementing countermeasures against the targeted earthquake scenario. The second is the "Act on Special Measures for Earthquake Disaster Countermeasures (1995)" that was enacted after the 1995 Kobe Earthquake, stipulating the establishment of the "Headquarters for Earthquake Research Promotion". The third is the "Act on Promotion of the Earthquake-proof Retrofit of Buildings (1995, amended in 2011)" that was also enacted based on the lessons learned in the 1995 Kobe Earthquakes and amended after the 2011 Great East Japan Earthquake.

The third one to promote the seismic strengthening of existing buildings has been playing a key role for enhancing the seismic performance and resilience especially of the public buildings (i.e. schools and hospitals), and therefore similar legislation should ideally be developed in Indonesia. Having said that, Indonesia is still in the stage of development, constructing and improving basic infrastructures all over the country. Realistically, it may require a long-term view for implementing such a policy and framework.

In this survey, we particularly focus on the other two legal frameworks. The "Act on Special Measures Concerning Countermeasures for Large-Scale Earthquakes (1978)" aimed to strengthen countermeasures especially against the potential Tokai Earthquake (in the seismic gap offshore Tokai Region), which was judged imminent based on the study report issued by the Seismological Society of Japan. It is well known that this legislation has stimulated R&D budgets for earthquake studies and significantly contributed to the progress of earthquake science and engineering in Japan.

The "Headquarters for Earthquake Research Promotion" was established according to the "Act on Special Measures for Earthquake Disaster Countermeasures (1995)", based on the lesson learned in the 1995 Kobe Earthquake that there was no mechanism to transfer the knowledge from the results and findings of earthquake research to the citizens and the government agencies responsible for DRR, so that they could utilize and benefit from the most recent knowledge on earthquake. The Act aims to clarify the roles and responsibilities for research and studies on the earthquake that should be linked to the DRR measures and policies and to promote earthquake research in a coordinated manner by the government. The "Headquarters for Earthquake Research Promotion" has been notably contributing to the progress of earthquake science and engineering and of earthquake DRR, through the improvement of seismic observation networks and probabilistic assessments of seismic hazards.

The two laws or acts discussed here came from a common awareness of the issues on earthquake DRR, i.e. how to minimize damage and loss of earthquake disasters, by reflecting the most recent findings and knowledge on earthquake science and engineering into DRR measures and policies, since the mechanism of earthquake phenomena has not been well understood yet. Promoting basic studies and establishing a mechanism to reflect the outcome of the studies into DRR policies are key to tackle the issues.

With the above understanding, the proposed strategies for earthquake and tsunami DRR are summarized as follows. The proposed priority actions in short-, mid- and long-term are also shown in a roadmap (see Figure below).

Table 6-6 Directionality of Problem Solution about Earthquake, Tsunami DRR Field, the Directionality of Future Support

Priority activity 1(Pillar 1): Mainstreaming DRR
«Strategy 1» Promote Basic Research as National Strategy
【Priority Action 1-1】 Establish PuSGeN as National Agency for Promoting Earthquake & Tsunami Research 【Priority Action 1-2】 PuSGeN implements research projects and updates hazard/risk information 【Priority Action 1-3】 Improve observation network and early warning system for seismic and tsunami
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks
«Strategy 2» Reflect research results to DRR policies and designate priority areas for earthquake and tsunami DRR
【Priority Action 2-1】 Formalize PuSGeN as National Agency for policy recommendation (permanent committee for reflecting latest knowledge on earthquake and tsunami into DRR policies) 【Priority Action 2-2】 Establish permanent Government Committee for DRR to discuss PuSGeN's recommendation 【Priority Action 2-3】 Enact legislation for designating priority areas for DRR (by above Government Committee for DRR) 【Priority Action 2-4】 Designate priority areas for DRR (under imminent earthquake/tsunami risks) following PuSGeN's commendation 【Priority Action 2-5】 Implement DRR measures in designated priority areas
«Strategy 3» Develop DRR plans dedicated to Earthquake and Tsunami
【Priority Action 3-1】 Develop Tsunami DRR Plan (5-year rolling plan) 【Priority Action 3-2】 Implement Tsunami DRR Plan 【Priority Action 3-3】 Develop Earthquake DRR Plan (5-year rolling plan) 【Priority Action 3-4】 Implement Tsunami DRR Plan
Priority activity 3(Pillar 3): Increasing DRR investment
«Strategy 4» Promote mainstreaming of earthquake and tsunami DRR in government policies
【Priority Action 4-1】 Establish inter-agency DRR forum chaired by BNPB 【Priority Action 4-2】 BNPB coordinates and integrate DRR policies for earthquake and tsunami 【Priority Action 4-3】 All stakeholders agree on and implement DRR policies for earthquake and tsunami
«Strategy 5 » Special Considerations: Use of advanced Japanese technologies
✧ High quality and advanced anti-seismic, base-isolation and vibration control technologies ✧ State-of-the-art tsunami evacuation tower with abundant experience all over the world ✧ Advanced equipment and systems for earthquake and tsunami observation and early warning
Disaster Preparedness and BBB
«Strategy 6» Foster DRR culture
【Priority Action 5-1】 Develop a strategy on DRR knowledge management 【Priority Action 5-2】 Build software and hardware for DRR knowledge management

6.3.1.1 Disaster Information (Understanding Disaster Risk) and Sharing Information

Disaster information is scientifically grasped to understand and share disaster risks.

«Strategy 1» Promote basic research as a national strategy

Considering disaster risk reduction for earthquake and tsunami that is still not well understood, basic research is indispensable to promote better understanding. The universities such as the Bandung Institute of Technology or Gadjah Mada University, as well as the government agencies such as BMKG, PUPR, LIPI or Geological Agency, are leading research on earthquake and tsunami disasters in Indonesia, with the support of various donors including Japan, and universities and research institutes in the world.

The update of the Indonesian Seismic Hazard Map in 2017 was implemented based on the PUPR Ministerial Regulation No. 364.1 / KPTS / M / 2016[144], following a common understanding in 2015, after 5 years passed since the previous update in 2010, between related government agencies and academics on the needs to

[144] Ministerial Regulation on establishing a team for seismic sources and seismic hazard map of Indonesia 2016, and preparation for National Center for Earthquake Study (PuSGeN), Pembentukan Tim Pemutahiran Peta Bahaya Gempa Bumi Indonesia Tahun 2016 Dan Penyiapan Pusat Studi Gempa Bumi Nasional

update the map. After one year of work, the "Seismic Sources and Seismic Hazard Map of Indonesia 2017" was published.

In the course of discussions, it was proposed to establish the National Center for Earthquake Study (PuSGeN), in order to bring together the wisdom in different government agencies, research institutes and universities of Indonesia regarding earthquake research and update of seismic map. Unfortunately, PuSGeN has not been approved and formalized yet as of today.

It is desirable that PuSGeN is established as an inter-organizational structure, and is funded by the government for conducting basic research on earthquake and tsunami as a national strategy so that a mechanism or system to coordinate and integrate the nation-wide research activities is established, which may also stimulate competitions between research institutes and universities.

For promoting research and studies on earthquake and tsunami, continuous improvement of the earthquake and tsunami observation networks and systems is needed.

6.3.1.2 Governance (Strengthen Governance for Disaster Risk Management)

Governance on disaster risk is strengthened.

«Strategy 2» Reflect research results to DRR policies and designate priority areas for earthquake and tsunami DRR

Probabilistic seismic hazard maps were developed in Indonesia, through the studies on seismic sources and seismic hazard evaluations in 2010 and 2017. The 2010 map was incorporated in the Indonesian building seismic design code (SNI 1726:2012), and the revision of the code is underway now for reflecting the update of the seismic hazard map in 2017. According to the earthquake studies in Indonesia, there is a seismic gap in the potential interplate seismic source along the Sunda Trench of offshore Padang, where any major earthquake has not occurred since 1797. There have been several major earthquakes occurred after hundreds of years of silence in the nearby sources since 2000, and it is considered that a major earthquake with a maximum magnitude of M8.7 may happen in the concerned area in the near future.

There is now enough knowledge in Indonesia to assess the time dependency or urgency of earthquakes, as the "Long-term Evaluations" of earthquakes performed by the above mentioned "Headquarters for Earthquake Research Promotion" in Japan. Legislation such as the "Act on Special Measures Concerning Countermeasures for Large-Scale Earthquakes" in Japan would be also effective in Indonesia that is subjected to risks of large-scale earthquakes, which promotes earthquake research and designates priority areas to implement DRR measures based on the evaluation of urgency of large-scale earthquakes.

The idea of PuSGeN seems more or less aligned with the "Headquarters for Earthquake Research Promotion" in Japan to promote earthquake research and to reflect the results to DRR policies. The responsibility of PuSGeN defined in the current conception can be extended, so that it functions similarly as the "Headquarters for Earthquake Research Promotion". In this regard, Japan can provide useful technical assistance for the establishment and operation of PuSGeN. It is also desired that PuSGeN gathers not only resources in the central government and universities (such as ITB) but all available resources across Indonesia, which enables to build a national network for earthquake research and develop capacities in each region and local government in Indonesia.

Given PuSGeN is established as equivalent to the "Headquarters for Earthquake Research Promotion" in Japan, a legal framework should be developed that the government can designate priority areas for earthquake and tsunami DRR, based on the assessment of tsunami and earthquake risks (equivalent to the "Act on Special Measures Concerning Countermeasures for Large-Scale Earthquakes" in Japan). It is also important that the DRR measures planned in the priority areas are backed up with sufficient budgets to implement them.

6.3.1.3 Disaster Risk Reduction (Promoting DRR Investment for Resilience)

Disaster risk reduction investment is made for resilience.

«Strategy 3» Develop DRR plans dedicated to earthquake and tsunami

Contrary to the fact that there are certain benefits to standardize the process for an emergency response regardless of the type of disaster, DRR policies and plans can hardly be standardized due to the vast difference in the measures depending on the disaster type. Therefore plans and policies specific to a certain disaster type should be developed. It has been demonstrated in Japan that disaster specific DRR planning, incorporating both structural and non-structural measures, promotes DRR investment and accelerates the implementation of DRR measures.

It is recommended that a 5-year plan for each disaster type (i.e. earthquake/tsunami) should be developed in Indonesia, which contains actions 1) to provide disaster information such as risk assessment in a form that local governments can utilize them for their DRR planning, 2) to plan and implement DRR programs covering both structural and non-structural measures, 3) to support evacuation planning of local governments, 4) to develop SOP and Contingency Plans, 5) to conduct regular and periodical earthquake and tsunami drills, and 6) to define numerical targets and quantitative monitoring indicators for progress monitoring (e.g. XX% of schools are seismic-resistant by year XXXX).

«Strategy 4» Promote mainstreaming of earthquake and tsunami DRR in government policies

In order to increase DRR investment to promote DRR measures, all governmental policies should be considered from a viewpoint of DRR. In this regard, BNPB should take initiative for mainstreaming DRR in policymaking at all ministries, government agencies and local governments, especially the ones having a strong relationship with DRR, such as the Ministry of Finance, OJK, PUPR, Ministry of Forestry, Ministry of education and Culture, Ministry of Health and etc. BNPB should coordinate between them for incorporating DRR in policymaking, and support them in promoting DRR policies and programs.

For example, one potential project can be formulated in collaboration with the OJK (Financial Services Authority) responsible for the insurance regulatory framework. Earthquake insurance is an important measure of earthquake risk management, which is still not common in Indonesia. Governmental earthquake insurance schemes have been developed in the countries and areas located in high seismic zones such as Japan, Turkey, and Taiwan, since potential economic losses due to large earthquakes can exceed the payout capacities of private insurance industries. It is worth considering the establishment of such governmental insurance scheme in Indonesia, which is highly prone to earthquake and tsunami disasters.

Earthquake loss modeling and analysis is a common practice today in the insurance industry. It calculates probabilistic financial loss amounts, using hazard model and vulnerability functions. For example, Expected Annual Loss that can be calculated in the analysis is a theoretical amount of insurance premium. The analysis model can provide useful information for underwriting earthquake insurance policies, and thus such modeling is most advanced in the property insurance industry.

MAIPARK[145], a reinsurance company in Indonesia, has developed its proprietary earthquake loss analysis model for Indonesia, named MCM (MAIPARK Cat Model), using the studies on seismic sources and hazards in Indonesia and the vulnerability functions such as ATC-13 developed in the US. MAIPARK underwrites reinsurance policies for 25% of the earthquake insurance undertaken in Indonesia, and thus knows the payouts of earthquake insurance (i.e. loss amounts) in Indonesia. Using this data, they are trying to develop vulnerability or loss functions optimal to Indonesia.

[145] MAIPARK was initially established as the earthquake reinsurance pool by the Insurance Association of Indonesia in 2003, and transformed into a public liability company or private reinsurance company

The MCM model can calculate potential loss amounts, which will be also useful for DRR planning and decision making in the central and local governments, especially in terms of the Target "(c) Reduce economic loss" of the Sendai Framework for DRR. According to MAIPARK, they have signed an MoU with BNPB for collaborating in risk analysis, and assumingly BNBP can benefit from the knowledge and modeling capacity of MAIPARK. BNPB should further pursue any opportunity to utilize knowledge of other ministries and agencies or to support them to deepen their knowledge, in order to promote DRR policies, plans, and programs.

«Strategy 5» Special Considerations: Use of advanced Japanese technologies

In view of Japanese assistance, considerations should be given to the use of advanced Japanese technologies in the DRR domain. For example, Japan has the most advanced technologies and products with the highest quality in the world related to anti-seismic, base-isolation and vibration control of structures. Japan is next to none in the number of constructed base-isolation buildings in the world (see Figure below). The abundant examples of constructing buildings using advanced base-isolation systems demonstrate the reliability and quality of this technology.

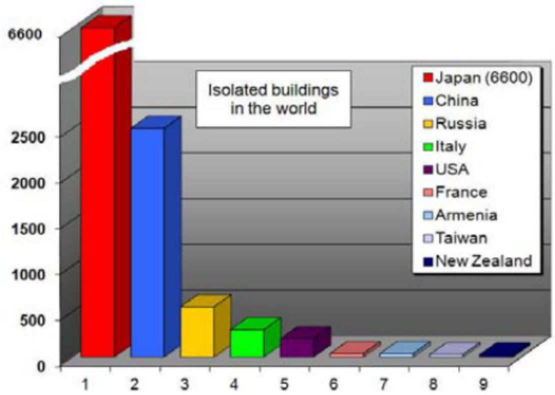


Figure 6-2 Number of Base-Isolation Buildings in the World (Martelli et al, 2012)

According to the Cabinet Office of Japan, there are 134 tsunami evacuation towers or shelters constructed in Japan as of December 2013 (and there are 10,384 buildings designated as tsunami evacuation shelter). Although there aren't any statistics available for other countries, the number in Japan must be considered large, since vertical evacuation using tsunami evacuation tower is not necessarily common in any other countries. A Temporary Evacuation Shelter (TES) for tsunami made of steel structures was constructed in the premise of BPBD Kota Banda Aceh, with the support of Nippon Steel and Sumikin Metal Products which provided the steel materials and technical assistance using their proprietary technology of "Safeguard Tower". Japan has also good experiences and tracks records of designating existing buildings as a tsunami evacuation shelter, which can be utilized in Indonesia.

As already several assistance projects have realized in Indonesia, Japan has the most advanced technologies in the world for earthquake and tsunami observation equipment and early warning systems that can be further deployed in Indonesia.

6.3.1.4 Disaster Preparedness and Build Back Better

«Strategy 6» Foster DRR culture

Low-frequent disasters such as the devastating mega-earthquake and tsunami typically have return periods of hundreds or even thousands of years. Once it happens, it will go down several generations until a similar event recurs in the same place. Therefore, in order to learn from the lessons in the past mega-disasters, we need to have inherited memories and lessons from generation to generation, or to look at the recent mega-disasters occurred in any other regions. It is important to transfer and share disaster memories beyond generations and locations.

Having said that, it is not easy to share and transfer disaster memories, and it requires a concrete mechanism and steady efforts. It has been practiced in Japan since long to install monumental stones at the highest points of tsunami inundation in order to warn the coming generations of the danger and threat of a devastating tsunami.

Various earthquake and tsunami memorial facilities and museums have been constructed in Japan. Among others, there are the "Great Kanto Earthquake Memorial Museum (1930)" in memory of the 1923 Great Kanto Earthquake, the "Nojima Fault Preservation Museum (1998)" and "Disaster Reduction and Human Renovation Institution (2002[146])" in memory of the 1995 Kobe Earthquake, the "CHU-ETSU Earthquake Memorial Corridor (2011)" memorizing the 2004 Chuetsu Earthquake, and many other memorial facilities and remains are now being planned following the 2011 Great Tohoku Earthquake. Especially in the recent disasters after the 1995 Kobe Earthquake, memorials are not necessarily in the form of buildings and facilities (e.g. disaster museum). Digital archives or databases using ICT technologies, such as interactive digital disaster archives, web-based applications for displaying data on PC screens or mobile terminals, digitalization of physical data/materials, Virtual Reality (VR) / Augmented Reality (AR) expressions of geographical or special data using graphical/audiovisual contents, and any other experimental methods have been implemented.

Today, disaster drills are regularly performed at schools in Japan. All Japanese understand the background of the Disaster Prevention Day on September 1st (anniversary of the 1923 Great Kanto Earthquake). The disaster prevention or DRR culture in Japan has been fostered through all these activities.

Since the 2004 Indian Ocean Tsunami, extensive efforts have been made in Indonesia. In Aceh, the establishment of Tsunami Museum, conservation of tsunami remains, the installation of Tsunami Memorial Poles, and creation of disaster archives were implemented in support of Japan. Japan's experience, knowledge, and technology for fostering DRR culture are definitely useful for Indonesia, as already demonstrated in Aceh, which can be deployed all over Indonesia until DRR culture is settled in the nation.

6.3.1.5 Strategy for Tackling Challenges in Local Regions

Banda Aceh

This section describes the proposed strategy for tackling challenges in Banda Aceh.

Table 6-7 Strategy for Tackling Challenges in Banda Aceh

Strategy for Tackling Challenges in Banda Aceh
«Strategy – Aceh 1» Develop Earthquake and Tsunami DRR Plans
«Strategy – Aceh 2» Strengthening building administration and enhance the seismic capacity of buildings
«Strategy – Aceh 3-1» Develop the capacity of BPBD for promoting DRR
«Strategy – Aceh 3-2» Make TDMRC a world center of excellence for disaster research
«Strategy – Aceh 4» Sharing and transferring disaster memories through the promotion of tsunami tourism

«Strategy – Aceh 1» Develop earthquake and tsunami DRR plans

The government of Banda Aceh should develop a tsunami DRR plan and an earthquake DRR plan to identify necessary actions for implementing countermeasures against tsunami and earthquake, and allocate necessary

[146] Renewal open in 2010

budgets in the development plan. Regarding measures for earthquake DRR, the plan should address the «Strategy – Aceh 2». For the tsunami DRR measures, completing the tsunami evacuation plan including the construction of Tsunami Evacuation Center (TES) should be addressed. As a structural measure for tsunami DRR, it should consider mangrove tree plantation and construction of embankment road for attenuating tsunami inundation based on multi-layer protection concept. Japan can provide useful insights and support here, with its experiences and advanced technologies on tsunami evacuation tower, legal framework, and guideline for designating existing buildings as TES, and tsunami analysis and simulation considering structural measures.

«Strategy – Aceh 2» Strengthening building administration and enhance the seismic capacity of buildings

As it is an urgent matter to enhance the seismic capacities of the buildings in Banda Aceh, revision of Building PERDA, capacity development of the officers in charge of building permit administration, and raising awareness of citizens for the construction permit process should be planned and implemented. This can be supported by JICA as a continuation of the "Project on Building Administration and Enforcement Capacity Development for Seismic Resilience".

«Strategy – Aceh 3-1» Develop the capacity of BPBD for promoting DRR

In general, local DRR capacity and resources are not sufficient, which might be a common issue across Indonesia. BNBP should establish a system or program, and even facilities for capacity development and training on DRR as a national policy. A technical cooperation project can be formulated for institutional strengthening of BNPB for capacity development in DRR, with pilot activities for developing DRR capacity in Banda Aceh.

«Strategy – Aceh 3-2» Make TDMRC a world center of excellence for disaster research

Tsunami and Disaster Mitigation Research Center (TDMRC) was established in Banda Aceh, based on the Syah Kuala University, in cooperation with the Indonesian and foreign universities, aiming to become a world center of excellence for tsunami and disaster research. TDMRC is contributing to the capacity development for DRR in Banda Aceh, through technical cooperation with the local governments (BPBD, BPBA), and is expected to play a key role in promoting DRR in Aceh. TDMRC has co-operated with Japanese universities and research institutes, which can be further strengthened through technical cooperation projects such as SATREPS and exchange programs. Japan is able to support the improvement of facilities such as laboratories for experiments in order to enhance the research capacity in TDRMC or Syah Kuala University.

«Strategy – Aceh 4» Sharing and transfer of disaster memories through the promotion of tsunami tourism

Significant efforts have been made since the 2004 Indian Ocean Tsunami for sharing and transferring tsunami memories, which should be further strengthened until DRR culture is fostered in Aceh. Utilizing the existing memorial facilities, tsunami remains and archives, tsunami tourism can be established in Aceh, which can be enforced by the other resources for tourism in the rich nature and culture in Aceh. It should be also considered to improve infrastructures for tourism such as the transportation and accommodation facilities. Keeping the memories of tsunami down to the coming generations will be enabled through sharing the tsunami memories with the people coming from all over the world by stimulating tsunami tourism in Aceh synchronized with sustainable regional development.

6.3.2 Meteorology & Early Warning Systems

The policies for each priority actions, which solve the problems of Indonesia's early warning disaster management, are described below. In general, EWS has been developed and maintained by itself in Indonesia recently, due to its low introduction cost and rapid development of IT technology. However, only information processing and information transmission are strengthened, and accuracy improvement and accuracy control of the most important disaster information in EWS such as observation and analysis are not sufficient. For example, in the current Risk Index, while EWS is as evaluated the contribution to inhabitant's disaster risk understanding and disaster preparedness (mental attitude), it is not mentioned that the necessity of enhancing the effectiveness of DRR capacity of EWS which is reducing human damage against disasters such as sediment disaster or tsunami. When implementing priority actions for solving matters, it is strongly required that the core of EWS, what mitigate human damage as much as possible, is always heeded.

In this section, the policies of solving matters concerning the disaster management of early warning and the direction of future support are described as shown in the table below.

Table 6-8 Direction for DRR and Future Support on Meteorology & Early Warning Systems

Priority activity 1(Pillar 1): Mainstreaming DRR	
«Strategy 1» Grasp disaster characteristics and establish effective EWS	
【Priority Action 1-1】	Appropriate operation management of observation equipment/system
【Priority Action 1-2】	Improvement of early warning contents and launching timing to public
【Priority Action 1-3】	Construction of record system for observation, analysis, transmission, and evacuation at the time of disaster
【Priority Action 1-4】	Enhance ability to improve EWS by disaster record
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks	
«Strategy 2» Promotion of strengthening of disaster reduction capacity through a collaboration of early warning disaster management related organizations	
【Priority Action 2-1】	Launching effective early warning based on disaster type characteristics
【Priority Action 2-2】	Construction of data sharing/communication system by related organizations
【Priority Action 2-3】	Association of meteorological and hydrological observations with national disaster management strategies
【Priority Action 2-4】	Formulation of EWS construction guidelines
Priority activity 3(Pillar 3): Increasing DRR investment	
«Strategy 3» Promotion of consideration for early warning disaster management to various policies by mainstreaming DRR	
【Priority Action 3-1】	Preliminary survey to improve alarm accuracy
【Priority Action 3-2】	Formulation of observation network development management plan
【Priority Action 3-3】	Formulation of EWS establishment plan
【Priority Action 3-4】	Human resource development and capacity building necessary for implementing weather analysis and early warning
Considerations: Climate Change and BBB	
«Strategy 4» Promoting the embodiment of climate change adaptation measures	
【Priority Action 4-1】	Accuracy improvement of the numerical weather prediction system
【Priority Action 4-2】	Long-term disaster risk assessment by the climate change model
【Priority Action 4-3】	Enhancement of climate change model and disaster risk verification/improvement capacity

6.3.2.1 Disaster information (Understand Disaster Risk and Share Information)

Disaster risks based on scientifically observed disaster information is understood and shared.

≪Strategy 1≫ Grasp disaster characteristics and establish effective EWS

In order to make DRR more effective by early warning disaster management, after understanding the characteristics of the disaster types and the affected areas, it is essential to estimate areas where human damage may occur and grasp disaster signs to secure evacuation time. Correlation analysis based on observation data accumulated over a long period of time and disaster history is necessary for grasping signs of the occurrence of disasters. However, in current observation systems, data-lacking at many observation stations and suspicious observation data are seen. Although BMKG dispatches staff from it headquarter, to carry out troubleshooting and device calibration work sequentially, the human resource is not sufficient in the current situation. In the future, BMKG plans to transfer the observation equipment management technology from headquarters to the regional offices of BMKG, and it is expected the observation situation is improved to a certain extent. However, it is necessary to construct a mechanism to monitor whether appropriate local observation network operation and observation data management are implemented sustainably.

Maintaining a stable observation system is the foundation for the understanding of disaster risk and improvement of the analysis technology for grasping signs of disaster occurrence. Taking floods as an example, the signs to be caught for evacuation are the upstream river water level, the upstream area rainfall, and predicted rainfall. Among these signs, the prediction due to the upstream river water level has a high accuracy of disaster occurrence in the evacuation target area. The accuracy decreases in the order of the upstream area rainfall, and the predicted rainfall, but it is possible to take the evacuation time longer, on the contrary. The evacuation time can be shortened to some extent by regular evacuation drills and formulating practical local disaster management plans. However, since it is assumed that it takes a certain time for evacuation, the signs to be caught are set inevitably when considering the disaster characteristics. Furthermore, in order to reduce disaster risks effectively, it is required that development of a recording system and analysis are implemented through the operation of EWS, and then improve the content and launching timing of disaster information. It is thought that it is necessary to establish the above process in order to reduce disaster risk effectively without losing EWS's substance.

6.3.2.2 Governance (Strengthen Governance for Disaster Risk Management)

Governance for organizational collaboration to strengthen disaster risk management is to be established.

≪Strategy 2≫ Promotion of strengthening of disaster reduction capacity through a collaboration of ea related organizations of in early warning disaster management

Regarding early warning disaster management, it is essential for the smooth operation of EWS to clarify the roles of related organizations in the time of disaster. In the early warning disaster management in Japan, the guidelines clearly indicate the roles of each organization. The organizations are Japan Meteorological Agency (JMA) which is an observation institute, river administrators (nation/local) which is an analysis institution, and municipalities which are information transmission institutions. Meanwhile, in Indonesia, the role sharing is ambiguous in the interagency collaboration. Regarding interagency collaboration, it is required to clarify the role in early warning disaster management through disaster management council which BNPB leads and related ministries and agencies attend.

As described above, because disaster risk analysis functions required for EWS are different according to disaster type and regional characteristics, it is effective for DRR to formulate EWS construction-guidelines for each disaster type such as floods, sediment-related disasters, earthquakes, and tsunamis. By clarifying the required observation system for EWS construction in this guideline, improvement of observation system as a part of the national strategy of disaster management and accuracy of EWS is expected to be promoted.

In addition, information communication of related organizations at the time of a disaster is currently done by general line using SNS such as WhatsApp. However, there is a possibility that communication may become impossible due to a concentration of access on the general line, and furthermore, communication disruption due to the damage of the communication network is assumed. Since disaster information communication is generally urgent and important, it is integral to build communication infrastructure that can secure data sharing and communication at related ministries in case of disasters.

6.3.2.3 Disaster Risk Reduction (DRR Investment for Resilience)

DRR investments are made for resilience.

≪Strategy 3≫ Promotion of consideration for early warning disaster management to various policies by mainstreaming DRR

In order to improve DRR effect by early warning disaster management, it is indispensable not only to develop the observation and analysis ability but also to conduct preliminary surveys to grasp the regional characteristics. In the areas where evacuation is required, information on topography, geology and land use is necessary, and it is necessary to utilize this information also in setting evacuation routes and evacuation places. Risk maps by disasters are being developed in Indonesia, but most of them are not available for practical evacuation. In some areas where large-scale disasters were experienced in the past, areas of the impact of disasters have been identified, but their scientific basis is not certain, and further improvement is expected.

On the other hand, in improving the observation and analysis capabilities, improvement the forecast accuracy through utilizing the observation data of radar or AWS, quantification of weather forecast using guidance, introduction of mesoscale numerical forecast model, improvement of warning criteria (reflection of disaster area characteristics on alarm standards and subdivision of alerts, etc.), and improvement of long-term forecasts are cited as support needs for early warning works. However, it is essential to provide technical assistance and human resource development to make effective use of AWS and radar in forecasting and warning. In the medium/long-term, the introduction of indices related to rainfall disasters such as soil rainfall index and basin rainfall index, which realize use of information obtained by preliminary survey and radar observation data, is considered effective.

6.3.2.4 Considerations: Climate Change and BBB

Adaptation countermeasures are implemented to the intensification of disasters caused by the environment and climate change.

≪Strategy 4≫ Promoting the embodiment of climate change adaptation measures

The intensification of disasters caused by climate change and adaptation to them are common issues in the world. Japan and Indonesia share the point that both countries are island countries and their assets are concentrated in the zero-meter area. Therefore, it is thought that sea-level rise shall bring an enormous impact. In Japan, there is an estimation that the cost of structural measures against 1 m sea-level rise exceeds 20 trillion JPY[147]. Climate change prediction model will continue to improve the accuracy in the future. In Japan, a Non-Hydrostatistical Regional Climate Model (NHRCM) with resolution 2 km by dynamic downscaling from global climate models[148] has been developed. It is thought that promoting concretization of adaptation measures based on prediction results is necessary. As seen in the case of Japan, in taking structural-countermeasures, a huge budget and a long-term construction period are required. Therefore, a risk assessment that tolerates a certain extent of damage is necessary. It is also concluded in "Data Collection Survey on Climate Change and Disaster Risk Finance, 2018", that the cooperation in the disaster risk finance field has high potential.

In case of tolerating a certain extent of damage, in the field of early warning disaster management, in addition to mitigating human damage caused by EWS as much as possible, it is necessary to minimize the economic

147 "Influence of sea level rise on global scale and measures", MLIT (http://www.mlit.go.jp/river/pamphlet_jirei/bousai/saigai/2006/36.pdf)
148 "Climate change observation / prediction and impact assessment integrated report 2018 Climate change in Japan and its impact", MOE

loss in the affected areas where assets are concentrated. For achieving this purpose, it is necessary to plan the construction of EWS considering the relation with BCP and BCRP.

6.3.2.5 Strategy for Tackling Challenges in Local Regions

Manado Aceh

Manado has been severely damaged by floods and Aceh has been severely damaged by the tsunami. Japan's cooperation has been implemented for their countermeasures. Based on the findings obtained from these cases, the following directions are proposed for the areas.

- It is necessary to strengthen self-help capabilities such as disaster prevention education, evacuation drills, and flood fighting brigades.
- In order to improve the effectiveness of EWS, it is essential to collect and organize detailed and scientific information from the perspective of local residents. Therefore, promoting DRR education for local residents is important. In addition, it is critical that such information is provided by the organizations in charge.
- EWS works effectively in coastal lowland areas susceptible to floods, storm surges, and tsunamis. On the contrary, for debris flow and landslides in the mountainous area, structural measures are more effective. This is because there is a problem in the accuracy of the prediction technologyy of occurrence of those disasters by snake curves. Basic data such as hydrological and geological data for prediction also lack. It is difficult to formulate an effective evacuation plan because the evacuation routes and evacuation facilities are limited.
- Regarding floods, areas are selected to promote EWS according to the situation of each river. In areas where flood damage frequently occurs in mountainous areas, evacuation is likely to be difficult due to rough road conditions and short run-off time of rainfall.
- Lead times vary by regions/districts. It is necessary to carry out the most appropriate EWS according to topographical factors, such as land use and capital concentration. It is important that this is improved through trial and error even after system installation.

6.3.3 Water Induced Disasters (Floods and Landslides)

6.3.3.1 Floods

Floods and water-induced disasters have particularly large social impacts because they have large inundation areas and long inundation time. Due to its high occurrence frequencies, it is necessary to adopt effective countermeasures and to plan and design an efficient investment plan.

As countermeasures against floods and water-induced disasters in Indonesia, measures to construct embankments/dikes are adopted. Although the flood control by dams is carried out in some cases, it is mainly the development of domestic water, irrigation, and power generation. It is hard to say that it contributes to flood control. Regarding the embankment construction, the design scale is important, but except for large rivers, the adopted design scale is 1/25. In the rehabilitation project of Krueng Aceh (River) in Aceh Province, the design scale of 1/5. Its design discharge 1,351 m3/sec is to be distributed through the original river channel with 496 m^3/sec and the floodway with 855 m^3/sec. According to the project evaluation report (February 2002), peak discharge at the time of flooding before and after the project is shown below.

Table 6-9 Discharge of Aceh River before the Project

<Before Project >

	Maximum flood discharge (m³/sec)	Flooded area (ha)	Flood damage (10^6 Rp.)	Inundation days (days)	Inundation height (m)
Dec. 1970	500	3,000	320	2	1.0
Jan. 1971	1,100	8,500	720	4	3.0
Dec. 1971	160	1,000	32	1	0.5
Jan. 1972	700	6,500	580	3	2.0
Dec. 1972	180	2,000	43	1	0.5
Jan. 1973	1,000	8,000	780	4	3.0
Mar. 1973	150	1,000	57	1	0.5
Nov. 1973	170	1,500	58	1	0.5
Jan. 1974	600	6,000	1,037	3	2.0
Dec. 1974	160	1,000	77	1	0.5
Jan. 1975	900	7,500	1,400	3	2.0
Mar. 1975	600	6,000	1,200	3	2.0
Dec. 1975	150	1,000	139	1	0.5
Jan. 1976	170	1,500	190	1	0.5
Dec. 1976	150	1,000	180	1	0.5
Feb. 1977	150	1,000	210	1	0.5
Nov. 1977	170	1,500	250	1	0.5
Feb. 1978	160	1,000	300	1	0.5
Jul. 1978	1,300	9,700	6,755	4	3.0
Dec. 1978	1,200	9,700	6,500	4	3.0
Jan. 1979	800	7,000	4,500	3	2.0
Nov. 1979	160	1,000	454	1	0.5
Dec. 1980	140	1,000	609	1	0.5
Jan. 1981	150	1,000	820	1	0.5
Feb. 1982	180	1,500	1,100	1	0.6

Source: Evaluation Report (Krueng Aceh Urgent Flood Control Project (I), October 2002)

In the above flood record, it is estimated that 1300 m^3/sec is the maximum discharge, and the project scale was set based on this historical discharge. Regarding the occurrences of the flood after the completion of the project (1991), flooding of 2,000 m^3/sec occurred on December 2000 and brought damages to the surroundings.

According to the above evaluation report, the flood scale of 2,000 m^3/sec is evaluated to be 1/50, which is larger than the design scale (1/5, Q=1,351 m3/sec) in this river. In addition, the project manager commented that the cause of inundation resulted from no working of stations installed at three sites for flood forecasting and warning system (FFEWS). This system failed in a short period of time after the completion of the project. After that, manual monitoring has been practiced.

Table 6-10 Discharge of Aceh River after the Project

<After Project >

	Maximum flood discharge (m³/sec)	Flooded area (ha)	Flood damage (10^6 Rp.)	Inundation days (days)	Inundation height (m)
1991	--	--	--	--	--
Year of Completion 1992	--	--	--	--	--
1993	--	--	--	--	--
1994	--	--	--	--	--
1995	500	600	3,000	2	1
1996	--	--	--	--	--
1997	--	--	--	--	--
1998	--	--	--	--	--
1999	--	--	--	--	--
2000	2,000	2,400	50,000	3	3

According to the survey in BWS Sumatera I by JICA Team, it was revealed that the dredging works will be carried out to improve the diteriorated flow capacity due to the sedimentation. But the design scale, that is, "the design level for safety of flood control" did not increase. The JICA Team also confirmed that the real-time monitoring station was increasing but manual observations still remains.

In Manado where severe flood damage occurred in 2014, survey, plan and design and implementation of the project are being carried out by JICA loans. The scale of this project is to be 1/5. Taking into account the future development in the Manado, with respect to design scale, it was increased to 1/25 in the feasibility study carried out in 2016. Regarding the hydrological monitoring system, the river water level recorder has been installed through the procurement of equipment from JICA. It is now possible to respond to floods by monitoring the river water level in real-time.

The progress of urbanization in Indonesia also has a major impact on the occurrence of floods. As countermeasures against floods accompanied by urbanization, not only countermeasures by river infrastructures but also basin measures including a spatial plan on afforestation, watershed conservation area, and runoff storage facilities should be considered.

It is expected that it will take a lot of time and cost to implement the flood mitigation structures including the basin countermeasures as mentioned above. From the point of view on effective DRR, non-structural measures should be taken into account.

As for non-structural measures, the introduction of FFEWS, preparation of hazard mapping, formulation of community evacuation plan and planning for local disaster prevention are to be considered. Among them, the importance of community disaster prevention has been drawing attention during flooding in 2007 in Jakarta. It has been developed by activities of PROMISE (Program for Hydro-Meteorological Disaster Mitigation in Secondary Cities in Asia) in Ciliwung River under cooperation activities of DKI Jakarta, Bandung Institute of Technology (ITB), Asian Disaster Prevention Center (ADPC) and USAID. Similarly, activities on preventing flood disasters in Klaten, Central Java province are also drawing attention. It is a remarkable activity in flood disaster mitigation/prevention. Disaster mitigation activities by these communities are judged to be useful and effective for flood occurrences due to climate change and large-scaled flooding excessing design flood.

The Disaster Management Policies and Strategies, (DMPS), 2015-2019 based on SFDRR formulated in 2016 advocates to reduce disaster risk and disaster vulnerability and to improve disaster prevention capacity at each disaster prevention level. Directions of policies and strategies based on these strategies are organized as follows. The measures related to floods and landslides are shown below. PUPR is the line ministry, related to the flood disaster management. Among measures shown in the table, such measures as preparing risk maps, developing emergency response plans, setting environmental conservation, progressing regional disaster prevention and introducing an early warning system are included as nonstructural measures.

Table 6-11 Floods Related Disaster Management Policies and Strategies

Strategy	Policy and Strategy Direction (RPJMN) with Regional Indicators
S1: Disaster risk reduction within the framework of sustainable development at the central and regional levels	1) Disaster risk identification, assessment, and monitoring through the preparation of studies and risk maps with a scale of 1:50,000 for regencies and 1:25,000 for municipalities
	2) Preparation of contingency plan for regencies/municipalities
S2.Disaster vulnerability level reduction	1) Improving the quality of life through rehabilitation of residential homes
	2) Environmental conservation and engineering in natural disaster-prone areas (river restoration for flood, slope strengthening for landslides)
	3) Developing and fostering local wisdom in disaster mitigation (Optimization of surface water use, establish periodic monitoring)
S3.Government, Regional government and public disaster management capacity building	1) Provision disaster early warning system in high-risk regions
	2) Development and utilization of science and technology for DRR (Construction of dikes, ponds, reservoirs)
	3) Provision of disaster mitigation and preparedness infrastructures in disaster-prone areas

Note:RPJMN:Rencan Pembangunan Jangka Menengah Nasional (National Medium Term Development Plan)
Source: Disaster Management Policies and Strategies (Kebijakan dan Strategi Penanggulangan Bencana, 2015-2019)

Based on the current status and issues on floods and water-induced disasters in Indonesia, in response to the SFDRR, directions on a solution for issues and assistance are arranged and shown as follows.

Table 6-12 Directions on Solution for Issues and Assistance on Water Induced Disasters

Priority activity 1(Pillar 1): Mainstreaming DRR
«Strategy 1» Identification of flood risk and introduction of FFEWS
【Priority Action-1】 Risk identification and assessment 【Priority Action-2】 Improvement of FFEWS on flood 【Priority Action-3】 Capacity development on community-based disaster management
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks
«Strategy 2» Promoting the enhancement of disaster mitigation capability through cooperation among related agencies on flood
【Priority Action-1】 Strengthening coordination among disaster-related agencies, data sharing and establishment of communication system on flood information 【Priority Action-2】 Formulation of flood management plan focusing on disaster preparedness 【Priority Action-3】 Creating a mechanism to reflect the risk assessment in BNPB in the flood disaster management plan in PUPR
Priority activity 3(Pillar 3): Increasing DRR investment
«Strategy 3» Promoting Investment in DRR
【Priority Action-1】 Measures that focusing on disaster prevention and implementation of projects 【Priority Action-2】 Implementation of projects with implementation priorities from the standpoint of disaster prevention
Consideration： Disaster Preparedness and BBB
«Strategy 4» Implementation of measures for climate change adaptation and large-scaled flood excessing design flood
【Priority Action-1】 Examination on appropriate design scale on flood management 【Priority Action-2】 Examination on large-scaled flood excessing design flood

6.3.3.2 Disaster Information (Understand Disaster Risk and Share Information)

«Strategy 1» Identification of flood risk and introduction of FFEWS

In order to reduce flood risk, it is important to identify flood risks. The flood risk can be identified based on past flood records. Regarding flooding beyond the floods that occurred in the past, a series of analysis ranging from hydrological analysis, runoff analysis and hydraulic analysis on flood analysis including river facilities are necessary. It is expected that there will be much time and cost in these. Therefore, as the first step, the JICA Team would like to propose a simple way to set up the possible flooding area by comparing the design water level in the river and the elevation of inland area.

As for the flood forecasting and warning system, since it takes time and cost to install perfect systems, the JICA Team propose to establish simple forecast and warning system by water level correlation method at the main reference point for the first stage. By considering the water level at the upstream reference point and the arrival time of river water, the water level at the main downstream point and its occurrence time are estimated. In the case of rivers with small river basin and rivers with many inflows from tributaries, the prediction is difficult due to the margin of errors on discharges, but in many rivers, this method can be applied. This method is adopted as a part of the flood forecast method even in the Ciliwun River flowing DKI Jakarta.

Community-based disaster prevention is the mainstream of disaster mitigation activities in the future. Implementation of workshops based on the contingency plan prepared by BNPB / standard preparation procedures (SOP), simulation desk exercises, and field drills, are effective in flood disaster mitigation. These activities should be carried out periodically before the rainy season. In order to establish community DRR, motivation for disaster prevention activities is also necessary, and a funding support system such as flood fund should be established.

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

«Strategy 2» Promoting the enhancement of disaster mitigation capability through cooperation among related agencies on flood

BNPB and PUPR are the apex institutions concerned with flood disasters. At the time of flooding, the input of weather information from BMKG and river water level information from PUPR are important information for BNPB. BNPB is required to clarify the role sharing in the acquisition and transmission of information such as collection and transmission of weather and hydrological information, trend analysis on the river water level, forecasting of river water level based on analysis, information on evacuation, and so on. Regarding the information transmission method, at least two methods should be prepared, in addition to ordinary SNS and telephone, the establishment of other dedicated lines (hotline) is also required.

Regarding DRR plans with an emphasis on disaster preparedness, emphasis should be placed on the preparation of hazard maps and the development of evacuation plans based on a scale of 1 / 50,000 or 1 / 25,000.mentioned in the Disaster Management Policies and Strategies (DMPS). Construction of evacuation centers is also important, and improvement measures should be taken based on a survey for the current capability for stowage of shelter, the number of days for staying in an evacuation, the food and water supply capacity, and sanitation environments.

BNPB is the apex agency for DRR, the fact that the effect of embankment construction in PUPR is not sufficiently reflected in the risk indices. In order to promote the effect of the construction of embankments in PUPR, the risk indices should be improved. It is necessary to create a mechanism whereby risk assessments leads to investment in flood mitigation facilities.

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

«Strategy 3» Promoting DRR investment

As mentioned above, although many budgets should be allocated for preventing and mitigating flood disasters, in Indonesia, the priority is given on water resource development, and the budget allocated to the construction of embankments has been less. In consideration of river basin changes in urbanization areas, it is assumed that flood countermeasures dependent only on embankment and dam construction cannot be handled.

Flood management measures should be taken with basin measures including land use such as securing the water retention function in the basin and regulating building construction in low land areas in Indonesia. In this regard, it is not clear on institutional demarcation among related agencies such as ATR (Agraria dan Tata Ruang, Land and Spatial Planning Ministry), BAPPENAS (National Development Planning Agency) and PUPR. In the future, it is also necessary to respond to these basin countermeasures including role demarcation among related ministries and agencies, including legislation. Comprehensive flood management measures including spatial planning are necessary for DRR. Regarding DRR investment, investment should be directed towards planning for DRR policy, establishing a legal system, and implementing programs through enforcement of laws.

Regarding flood-related budgets, since it is large in project scale, it often depends not only on its own budget but also on foreign loans, and it is often selected and implemented based on the economic rationality such as the economic internal rate of return (EIRR). As it is clear from an example of the flood event in Manado, due to raising awareness of residents, it takes time to negotiate resettlement of housing and it is becoming a situation where the effective project cannot be implemented. From this point of view, concerning implementing the flood management project, an organization involving residents should be set up at an early stage of the project. Through organization such as stakeholders committee, problems and opinions on the project should be clarified and built consensus for a solution. Solving the problems through such activities is necessary for the promotion of the project.

(3) Consideration: Disaster Preparedness and Buil Back Better

«Strategy 4» Climate change and excess flooding response

As mentioned in the previous chapter, the design scale of flood management infrastructures in Indonesia is often applied for the scale of 1/5 to 1/25. With regard to excessive floods such as "floods beyond the design scale" and due to climate change, structural measures are not sufficient.

Regarding excess flooding and climate change response, basically, non-structural measures such as community-based disaster management should be adopted. For that purpose, it is important to communicate prior information, and it is urgent to introduce the system in which river water level information and inundation warning are transmitted from the responsible institution to the residents at an early stage.

Regarding climate change adaptation as well as excess large-scaled floods, the following policy is adopted.

a. Since disaster impact cannot be sufficiently dealt with only structural measures, non-structural measures are given priority as major measures.
b. For non-structural countermeasures, assuming situations that cannot be dealt with by structures alone, it is necessary for the entire community to share disaster information risk, mobilize all measures, and tackle measures against disasters.
c. Non-structural measures are focused on minimizing the number of casualties by floods so that measures are taken to strengthen the communication system at the time of the flood.
d. As a structural measure in the local area, taking into account the cost recovery, protection of embankment with appropriate measures such as bioengineering measures as well as river management activities by local people are to be adopted.

The image of countermeasures for excess flooding and climate change is shown as Figure below.

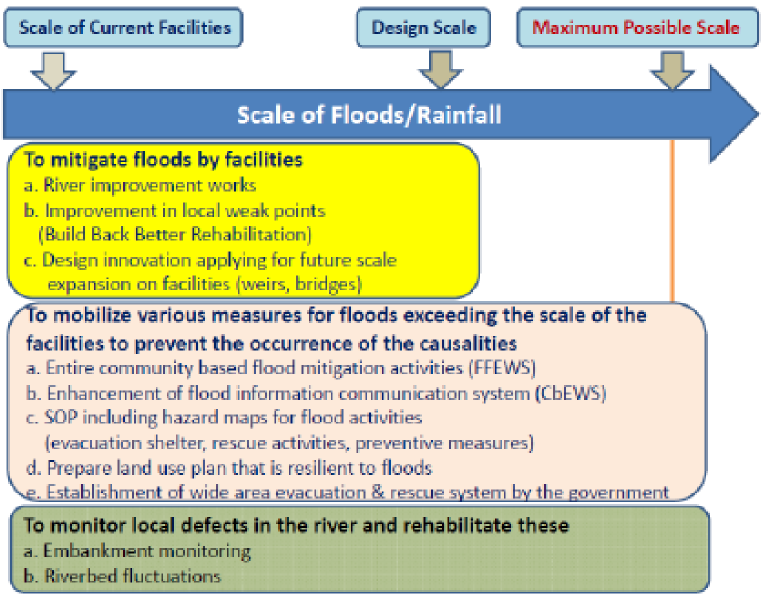


Figure 6-3 Image of Countermeasures for Excess Flooding and Climate Change Adaptation

In Aceh, it is planned to implement the dredging project in the floodway, and this project should be promoted and “the design level of flood management” should be raised at an early stage. Floods exceeding the design scale are expected to occur, so implementation of disaster mitigation activities are focused on community-based disaster management. The early transmission of flood warning information from related agencies should be carried out.

In Manado, the project should also be implemented in rivers other than the Tondano River (Sario and Mahawu Rivers). It is important to advance securing relocation areas for residents including negotiations on resettlement through stakeholder’s committee. Proceeding with the project of Milangodaa River which has been investigated and designed already at BWS shall be considered to be implemented.

The river water level information dissemination system is carried out in river mainly in Manado City. The early flood warning system should be introduced by establishing the monitoring system focusing on the river water level. Flood experiences in 2014 are conscious among residents. Awareness of disaster mitigation is also spreading. Collaboration monitoring activity between BPBD Manado and the community in Manado City is ongoing and community-based monitoring of water level at Tondano River is underway. These activities should continue.

	
Flood Water Level Monitoring Station	**Staff Gauge**

Figure 6-4 Flood Water Level Monitoring Station (Water Front City) in Tondano River

6.3.3.3 Landslides

As mentioned in Chapter 4, 3,191 landslide disasters occurred in Indonesia for over 10 years, and occurrence frequencies are 35 events/year per year. The landslide is caused by rainfall and earthquake, but since the occurrence frequency of the earthquake is low, it is assumed that most of the landslides are caused by rainfall.

The landslide is flow phenomena of the earth, sand, and clay materials constituting the slope. Its damage is characterized by a large number of the death toll. In recent years, the flash flood (33 death toll) in the West Java (Garut) in September 2016, the landslide (47 death toll) in Central Java on June 2016, a landslide of Central Java (Banjarnegara) (93 death toll) in December 2014 are accompanied with many death tolls.

According to landslide risk in Indonesia (Global Assessment Report (GAR) on Disaster Risk Reduction, 2011), 49 landslides occur annually based on data from1981 to 2007. The data of "DesInventar" reported that from 1998 to 2009, 890 landslides occurred and 1,280 death toll (victims) were reported. In particular, the Geological Agency of Indonesia (GAI) said that the death toll per event (per event) has reached 32 people in the landslides from 2003 to 2007. In any events, it is a feature of the landslide disaster that the death toll is enormous.

Hazard study starts from specifying the susceptible site of the landslide. Regarding the susceptible sites, the signal of occurrence can be confirmed by installing devices and monitoring disaster factors. In the rainy season, when the occurrence of landslides due to rainfall is expected, it is a basic measure to evacuate at first and prevent damage. PVMBG practices effective disaster education program by socialization for residents with the recognition that understanding geological phenomena and disaster management are important. However, according to the Asian Disaster Reduction Center (ADRC) report, there are still many villages and cultivated areas in the "high-risk area" to “medium risk area” of the landslide shown in the susceptibly map. The fact that the activities of the residents are carried out in these areas makes the landslide disaster to be hardly reduced.

In the SFDRR, as ‘increasing the DRR Investment including structural measures’, the investment in structural measures is emphasized. Structural measures are effective for areas where relocation are difficult within the urban area. For adopting structural measures, technical efficiency, as well as economic efficiency, shall be examined.

Based on the current status and issues on landslides in Indonesia, in response to the SFDRR, directions on a solution for issues and assistance are shown as follows.

Table 6-13 Direction for DRR and Future Support on Landslides

Priority activity 1(Pillar 1): Mainstreaming DRR
«Strategy 1» Identification of landslide risk and introduction of effective EWS
【Priority Action-1】Risk identification and assessment on landslide 【Priority Action-2】Improvement of EWS on landslide
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks
«Strategy 2» Promoting the enhancement of disaster mitigation capability through cooperation among related agencies on landslide
【Priority Action-1】Strengthening regulation on land use and residential area by decree 【Priority Action-2】Strengthening disaster mitigation capability in school education
Priority activity 3(Pillar 3): Increasing DRR investment
«Strategy 3» Promoting Investment in DRR
【Priority Action-1】Promoting investment in DRR of landslide
Priority activity 4(Pillar 4): Strengthening Residual Risk Management
«Strategy 4» Countermeasures for frequent landslides
【Priority Action-1】Implementation of preparedness for frequent landslides

(1) Disaster Information (Understand Disaster Risk and Sharing)

«Strategy 1» Identification of landslide risk and introduction of effective LEWS

As mentioned for issues on landslides shown in the previous Chapter, in Indonesia, there are many households and cultivation areas within the landslide risk area. Regarding areas where the risk level is categorized to be high, measures should be taken in the spatial plan to regulate the construction of residence and cultivation. As a realistic task on relocation, since it is difficult to implement these plans at once, it is necessary to gradually take action by securing a new relocation site. Regarding the cultivation area, it is possible to apply landslide early warning system (LEWS).

Due to the similarity of geology, soil quality, and topographical characteristics, landslides give damaged repeatedly on the sites where many disasters occurred in the past. Under the regional strategic and long-term plan, it is necessary to design the utilization plan (spatial plan) to regulate the construction of residences. In areas where the budget for structural measures are limited and construction works cannot be implemented, disaster mitigation systems with EWS should be established. Regarding issues on LEWS, lack of budgets, lack of management system in the community, and lack of periodical inspections were pointed out by the PVMBG officials. These were also revealed by interviews with local officials.

Landslide disasters are "disasters that can be prevented". With regard to early LEWS, it is possible to prevent it from occurring by installing devices such as rain gauges, extensometers, inclinometers, and piezometers. Management and operation of these devices and communication systems should be conducted by the community located at the susceptible area. For incorporating these to the disaster prevention activities, it is necessary to establish effective warnings and evacuation information by setting criteria or thresholds.

(2) Governance (StrenghenGovernance for Disaster Risk Management)

«Strategy 2» Promoting the enhancement of disaster mitigation capability through cooperation among related agencies on landslide

There is a fact that the susceptibly map (landslide risk map) is not utilized in spatial planning and regional development plan. It is necessary to urgently improve these situations. Regarding disaster prevention, it is the responsibility of BPBD. Land development policy, spatial planning, and development plan (RPJPD, RPJMD) formulation are mandated by the local governments, BAPPEDAs. Countermeasures for structural measures is done by Dinas PU (BWS in the case of large scale works). Cooperation among the related organizations is integral.

As pointed out by PVMBG, for strengthening the disaster prevention capacity, a curriculum of landslide disasters should be added in disaster education at schools. Regarding community disaster prevention, implementation of workshops by BPBD and simulation drills at the desk / on-site drills are effective. Before the rainy season, by regularly implementing these, the disaster prevention capacity on landslides should be strengthened.

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

«Strategy 3» Promoting Investment in DRR

As mentioned above, as measures against landslide disasters in Indonesia, major countermeasures are non-structural measures such as creating landslide susceptible maps, monitoring, and inspection of susceptible sites, and evacuation measures using the LEWS. There are very few implementation examples of measures to prevent structural measures such as retaining walls and drainage works.

The scope and scale of landslide disasters tend to be large. When implementing structural measures to the entire area, the project cost is supposed to increase. Therefore, rather than implementing projects including construction works, relocations for housing and buildings are often more advantageous in terms of economic feasibility. Regarding DRR investment in landslide measures, it is necessary to examine the implementation from the viewpoint of economic feasibility.

(4) Disaster Preparedness and Build Back Better (BBB)

«Strategy 4» Countermeasures for frequent landslides

As mentioned in Chapter 4, the occurrence of a landslide which greatly exceeds the scale of current disaster scales due to land change and climate change as well as the devastation of forests and expanding of urbanization is expected in the future. Large disasters assumed in connection with landslide disasters include the formation of river natural dams due to landslides and slope failures, mudflow disasters caused by slope failures, and flash floods (Banjir Bandang).

Since, these phenomena are an occurrence of the large scale earth bodies, collapse/surface slides, premonitory phenomena such as cracks, blow out of muddy water, abnormal water level rising in the wells and vibrations appear before occurrence. In addition, areas where landslide damage often occurs repeatedly are similar in topography and geological characteristics. Issuance of alarm and evacuation based on the establishment of an inspection system on such premonitory phenomena are the basis of disaster prevention.

After the disaster, though the rehabilitation of public infrastructures and housing and restoration of public civil engineering facilities are carried out by the provincial government, there are many cases where countermeasures against the occurrence of similar sediment-related disasters in the future are hardly carried out. In areas that have suffered major sediment damage in the past, it is necessary to prepare for the upcoming disasters. In particular, as preventive measures to mitigate and minimize death toll, the introduction of Landslide Early Warning System (LEWS) and establishment of evacuation center are very important.

Regarding areas and villages that are judged to be vulnerable, countermeasures such as group relocation should also be carried out.

6.3.4 Coastal Disasters (Storm Surge and Coastal Erosion)

Storm surge occurs as the result of sea-level rise due to tropical low-pressure storms. Rising of sea level with several meters as well as strong winds and high waves may cause tremendous disasters to human lives and assets. Under current climatic situations, frequency of storm surge is low in Indonesia which is located within 10 degrees north and south. However, it is important to conduct proper daily monitoring and optimal warning issuance considering the scale of possible damage. Besides, effects of climate change to increase of disaster risk shall be examined and necessary structural measures shall be taken such as costal embankments. To implement these, coordination among relevant agencies, such as BMKG which is responsible for monitoring and warning, PUPR responsible for construction and BNBP who is the coordinator of disaster-related issues, is inevitable.

There are many coasts where there are no erosion countermeasures taken. Prioritization shall be conducted in a proper way to maximize the effects of a limited budget. For the implementation of structural measures, capacity building of coastal engineers and technology innovation which is suitable for natural conditions and situation of engineering technology in Indonesia is integral. Technology improvement is important to prepare enlargement of waves due to climate change. Non-structural measures are to be taken as well as structural measures. As storm surge countermeasures, coordination among related agencies such as BNPB, PUPR, KLHK and so on are important.

Table 6-14 Direction for Problem Solution and Future Support on Coastal Disasters

Priority activity 1(Pillar 1): Mainstreaming DRR
«Strategy 1» Evaluation of Storm Surge and Coastal Erosion Risks and Establishment of Storm Surge Warning System
【Priority Action 1-1】 Risk Evaluation of Storm Surge 【Priority Action 1-2】 Evaluation of Current Situation and Risk of Coastal Erosion 【Priority Action 1-3】 Establishment of Storm Surge Warning System considering Climate Change
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks
«Strategy 2» Improvement of Disaster Management Capability by Collaboration of Related Agencies
【Priority Action 2-1】 Enhancement of Coordination System, Data Sharing and Establishment of Communication System
Priority activity 3(Pillar 3): Increasing DRR investment
«Strategy 3» Promoting DRR Investment
【Priority Action 3-1】 Quality Improvement of Structural Measures by Establishment of Design Standards 【Priority Action 3-2】 Project Implementation with Proper Budgetary System and Prioritization 【Priority Action 3-3】 All stakeholders agree on and implement DRR policies for earthquake and tsunami
Consideration: Storm Surge Disaster by Climate Change
«Strategy 4» Evaluation of Climate Change
【Priority Action 4-1】 Risk Evaluation of Storm Surge with Considering Climate Change 【Priority Action 4-2】 Risk Evaluation of High Tide and Coastal Erosion with Considering Climate Change

6.3.5 Volcanic Eruption

A volcanic eruption disaster is an extremely high natural disaster with complexity. Movement of materials are the main cause of other natural disasters, but the volcanic eruption is a phenomenon in which magma that was located in the under the earth is blown out to the surface, so new materials suddenly join the surface and move further.

According to the "Detailed Study on the Comprehensive Research Project on Reduction of Disasters due to Volcanic Ejecta (JICA Global Environment Department, 2014)", the issues on volcanic eruption disaster are summarized as follows

a. Even if the volcanic eruption is small at the initial stage, it is shifted to different eruption types afterward and the eruption scale explosively increases, so promptly response by expanding the evacuation area is needed. The development process of the eruption activity has not been scientifically clarified.

b.The ejecta that deposited on the mountain have diversity such as volcanic ash, pyroclastic flow, lava flow, and their flow mechanisms are different. Furthermore, sediments caused by the collapse and river bed fluctuations make sediment flow movement complicated. Even though the movement of the individual form of ejecta can be predicted, research on complex sediment transportation features has not progressed at present.

c.Although the earth and sand movement after the eruption is often caused by rainfall, after the eruption of Mt. Merapi volcano in 2010, the rainy season started and mudflow frequently occurred. As a result of global climate change, the dangers of sediment-related disasters beyond previous experiences are increasing due to excessing scale of rainfall.

d.In Indonesia, PVMBG issues the warning level of a volcanic eruption. PUPR has taken measures for the sediment materials such as lahar deposit. In addition, the problem of diffusion of volcanic ashes into the atmosphere has been mandated and judged by BMKG. Since the scale of volcanic disasters depends greatly on the scale of the eruption, even if there is collaboration among ministries and agencies, countermeasures by ministries and agencies may lack the promptness and efficiency.

In Mt. Merapi volcanic eruption (Type A volcano) in 2010, it was a large-scale event producing 140 million m^3 of earth and sand. (source: 2010 Eruptions at Mt. Merapi and Sinabung Volcanoes in Indonesia, Annual Report on Disaster Preventions, DPRI, Kyoto Univ. 2012) Debris flow and pyroclastic flow occurred due to the eruption sediments, causing sediment flooding and bridge broken, but fortunately, there were almost no death tolls. This is a good lesson for preventing major damages by the eruption beforehand by improving disaster prevention capacity in local governments. On the other hand, residents who did not evacuate believing the traditional warning signals were swallowed up in the pyroclastic flow. In the future, it is necessary to deepen understanding the risk of a volcanic eruption to foster "volcanic hero" promoted by local governments, and to issue evacuation alarms based on scientific monitoring and analysis. It is also necessary to make an effort to eradicate non-scientific warning signs.

For Type B volcanoes like Mt. Sinabung volcano, it was a sudden eruption after a long-term dormancy and prediction of eruption activity were difficult. Quick response to installing monitoring devices and monitoring these are required.

As measures against evacuation system, construction and expansion of evacuation centers/shelters should be urgently made from the perspective of strengthening disaster risk management. As mentioned in the previous chapter, in the case of Jogjakarta, the sufficiency rate is 9% of the total target population, and it is necessary to continually expand its capacity. In addition to these, measures to restrict residences in the hazard area are also necessary. It is important to formulate the spatial plan including the solution to these issues.

As countermeasures against sedimentations and sediment discharges, sabo dams, sand pockets, channel works, and other excess sediment volume countermeasures are to be planned assumed as structural measures. With regard to the construction of these, large project cost (10-20 Billion JPY) has to be secured. It is insufficient to implement by Indonesia's own budget alone, so other international financial resources should be secured.

Regarding sabo dam, according to the damage survey of the Mt. Merapi disaster, phenomena in which the sabo dam and consolidation dam were destroyed were seen due to extreme river bed fluctuations. This destruction spread further to the upstream part, and chain-like destructions occurred at series of sabo dams. It is presumed that the causes are the design of floating type basement for sabo dam under the condition of extreme river bed fluctuations. There are also damages due to excessive sand mining at downstream of sabo dams and toes of training dikes. It is necessary to periodically monitor and inspect sabo facilities and sand mining areas.

Based on the current status and issues on volcanic eruptions in Indonesia, in response to the SFDRR, directions on a solution for issues and assistance are shown as follows.

Table 6-15 Direction for DRR and Future Support on Volcanic Eruption

Priority activity 1(Pillar 1): Mainstreaming DRR
«Strategy 1» Identification of volcanic eruption risk and introduction of effective disaster mitigation system
【Priority Action 1】Identification of volcanic eruption risk 【Priority Action 2】Introduction of an effective disaster mitigation system
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks
«Strategy 2» Promoting the enhancement of disaster mitigation capability through cooperation among related agencies on volcanic eruption
【Priority Action 1】 Strengthening disaster prevention infrastructures and cooperation among related agencies on volcanic eruption 【Priority Action 2】Continuous monitoring for volcanic activities
Priority activity 3(Pillar 3): Increasing DRR investment
«Strategy 3» Promoting Investment in DRR
【Priority Action 1】Improvement and renewal for aging SABO facilities 【Priority Action 2】Effective investment in monitoring devices for volcanic activities
Priority activity 4(Pillar 4): Strengthening Residual Risk Management
«Strategy 4» Countermeasures for large-scale eruption
【Priority Action 1】Countermeasures against volcanic disasters beyond the assumed disaster scale

(1) Disaster Information (Understanding Disaster Risk and Share Information)

«Strategy 1» Identification of volcanic eruption risk and introduction of an effective disaster mitigation system

As volcanic phenomena, many phenomena are assumed. Debris flow and mudflow, ash deposit, ashfall, pyroclastic flow, and lava flow are assumed as main phenomena. Based on historical volcanic phenomena that occurred in each volcano, it is judged that the hazard map is prepared on individual volcanic phenomena (disaster types) within their hazard areas. Hazard map should be prepared for each volcano and risk management of volcanic eruption should be based on this.

In risk management, as mentioned above, there are cases where it was damaged without evacuation information believing in the traditional warning signals. It is necessary to take measures to deepen the understanding of volcanic eruption risk. Alarms are issued based on scientific monitoring and analysis, and efforts to eliminate non-scientific warning signs are necessary.

Although it is desirable to establish an effective disaster prevention system, disaster types in which the forecast and warning system operate effectively are generally targeted for debris flows and mudflows which are caused by rainfall. Regarding other volcanic disaster types except these, since the forecasting and warning system does not work, it is necessary to prepare advanced issuance of evacuation warnings and directions to relocate the residents.

Regarding community-based disaster mitigation, implementation of workshops by BPBD, and evacuation simulations at the desk/field drills are effective and should be carried out periodically. Volcanic disasters are characterized by a broad range of influence due to the eruption, long-term evacuation and physical influence by gas and ashfall. Disaster response by cooperation activities among BNPB, the local governments including local communities and NGOs are very important.

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

«Strategy 2» Promoting the enhancement of disaster mitigation capability through cooperation among related agencies on volcanic eruption

To respond to a volcanic eruption, BPBD under the local government takes an initiative in managing disaster response, and in the case of a large scale of eruption, BNPB under the central government takes an initiative and manages disaster response to the local government. In the case of volcanic eruption, there is no way to alleviate the damage other than evacuation. The capacity of the evacuation shelter/center affects the damage conditions. According to the data on the population within the 15km area from the crater organized by the BPBD DI Yogyakarta, the target population for evacuation is more than 56,400 people, and the population for available of evacuation is to be only 9% of the total population. It is a big issue that the number of evacuation people is much less, and urgent additional plans are necessary. Regarding evacuation centers/shelters, as pointed out in the JICA evaluation report, it revealed that doors and windows at the center were broken because of insufficient management under normal circumstances, and it is necessary to improve these as soon as possible. (FY2016 Ex-Post Evaluation: Urgent Disaster Reduction Project for Mt. Merapi / Progo River Basin and Mr. Bawakarareng)

Most of the deaths in the past volcanic disasters are caused by the direct eruption. From this point of view, emphasis should be placed on the prevention of fatalities in the hazard planning including an evacuation plan. There was a request for technical cooperation by JICA with regard to the preparation of "comprehensive hazard map" showing evacuation routes and evacuation centers like the “Mt. Sakurajima” Volcano Hazard Map in Japan. At the same time, there is also the request for the introduction of radio alarm system including technical assistance.

Regarding the volcano monitoring, with respect to Mt. Merapi volcano (Jogjakarta), monitoring devices has been established by preparing sufficient budget, and monitoring is also being carried out on a 24-hour system for monitoring. Regarding the Mt. Agung volcano in Bali, data from the monitoring center is sent from the monitoring post, furthermore, it is transferred from this place to PVMBG. It is necessary to continuously monitor the volcanic activities and strengthen the disaster prevention capability by securing adequate budget so that sufficient evacuation response to the volcanic eruption can be taken.

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

«Strategy 3» Promoting Investment in DRR

In the JICA project implementation area of Mt. Merapi and Mt. Kelud volcanic areas, improvement, and updating are required for sabo facilities constructed in the 1980s. Normally, the sabo facilities are designed and installed on the premise of maintenance-free, and maintenance and repair are not considered, but by carrying out repair work, the storing capacity for sediment discharge and sediment control functions can be secured. The concrete phenomena on the deterioration of sabo facilities include a decrease in the sediment capacity of the sabo dam and the sand pocket and the fact that the structures (dam body and embankment of channel works) are aging. In the field survey at Mt. Merapi, the JICA team identified sabo dams which were destroyed by the 2010 disaster. The method of construction using aggregate revealed quality problems, but the deterioration of the dam is mainly due to aging after 30 years or more.

As countermeasures against sedimentations and sediment discharges, SABO dams, sand pockets, channel works, and other excess sediment volume countermeasures are assumed as structural measures, but with regard to the construction of these, large project cost (10-20 Billion JPY) has to be secured. It is insufficient to implement these by Indonesia's own budget alone, so other international financial resources should be secured.

Regarding SABO dam, according to the damage survey of the Mt. Merapi disaster, phenomena in which SABO dam and consolidation dam were destroyed were seen due to extreme river bed fluctuations. Technical improvement (construction method for "key SABO dam" which can cope with lowering of the river bed) is also necessary.

For rehabilitation financial assistance, in reference to Mt. Kelud volcanic eruption disaster event, IFRC (International Federation of Red Cross) recommends implementing Cash Transfer Programming (CTP) for procurement of foods and other relief supplies. It is also necessary that appropriate activities with the CTP stimulate the regional economy and contribute to the early recovery of the regional economy.

Sand mining (sediment excavation) of volcanic ejecta is carried out in many volcano areas, and by selling and purchasing sediment materials as construction materials, employment is created and it contributes to the promotion of the local economy. In the area of sand mining, there is a case where excavation is performed in such a way as to lead to the collapse of SABO facilities without appropriate guidelines for excavation. Guidance of appropriate sand mining management plan by the government is to be desired.

Monitoring of volcanic activity is carried out with priority by PVMBG. Regarding active volcanic activities, continuous monitoring is integral. Regarding volcanic eruption after a prolonged period of inactivity, it is needed to install monitoring devices as soon as possible to analyze volcanic activities for evacuation and warning. Continued investment in the monitoring devices and hiring staff for monitoring is necessary.

(4) Consideration: Preparedness (Effective Countermeasures against Volcanic Eruption) and BBB

«Strategy 4» Countermeasures against volcanic disasters beyond the assumed disaster scale

As mentioned in Chapter 4, the scale of the volcanic eruption can be indicated by the volcanic explosion index (VEI). According to the GVP (Global Volcanism Program), VEI = 4 or more is defined as "Cataclysmic" like eruptions of Mt. Merapi volcano in 2010 and Mt. Kelud (Kelut) volcano in 2014. In Indonesia, when it dates back to the past 100 years (1910), eruptions of the scale of VEI = 4 or more occurred eight (8) times, of which VEI = 5 (Ultra large eruption defined as “Paroxysmal”) was only 1963 event at Mt Agung volcano. The volcanic eruption volume for VEI = 4 is estimated to be about 100 million m^3. For VEI = 5, it is estimated to be 1 billion m3 with an additional one order increase. An increase in the number of the death toll due to a large amount of ejecta is expected, and response at the time of eruption is important.

The flow of disaster response at the time of volcanic eruption starts from eruption prediction based on volcano monitoring and analysis. Then transmits eruption information is transmitted and evacuation activated. Although eruption prediction is expected to further improve accuracy in the future, there are still many uncertain factors. On the other hand, the evacuation activity has a problem related to the “elapsed time” until the evacuation is completed. It is possible to cope with volcanic disasters by taking prompt action through the training such as drills.

As evacuation countermeasures, several methods such as evacuation to the outside of the hazard area and evacuation to facilities such as shelters within the hazard area can be considered. But in the case of the scale of the eruption exceeding the assumed scale, it is necessary to formulate an evacuation plan in a broad area. In broad area evacuation, cooperation and communication among stakeholders on eruption prediction by PVMBG, transmit evacuation information by BNPB and disaster prevention activities by the local government are particularly important. In Mt. Merapi Volcano (Jogjakarta), Mt. Kelud Volcano (Kediri) and Mt. Agung Volcano (Denpasar), which have urban areas in the vicinity of the volcano, it is necessary to formulate broad-area disaster prevention plan beyond the boundary of the district. In formulating the broad-area disaster prevention plan, specific volcanic events, such as debris flow, mudflow, pumice stone, ash, pyroclastic flow, and lava flow, are to be identified based on past history and VEI of eruptions. Regarding the identified frequent events, it is necessary to develop evacuation plans assuming evacuation scenarios.

6.3.6 Forest and Peatland Fire Control

The following is proposed as a draft mid-term strategy in cooperation for forest and peatland fire control by JICA Data Collection Survey 2017[149].

The proposed mid-term strategy is “Integrated capacity development of stakeholders to contribute to mitigating emission from fires and haze disaster in Indonesia”. In order to drive effective cooperation which can contribute sustainable impact in an extensive area in a short time, a draft strategy is proposed as follows.

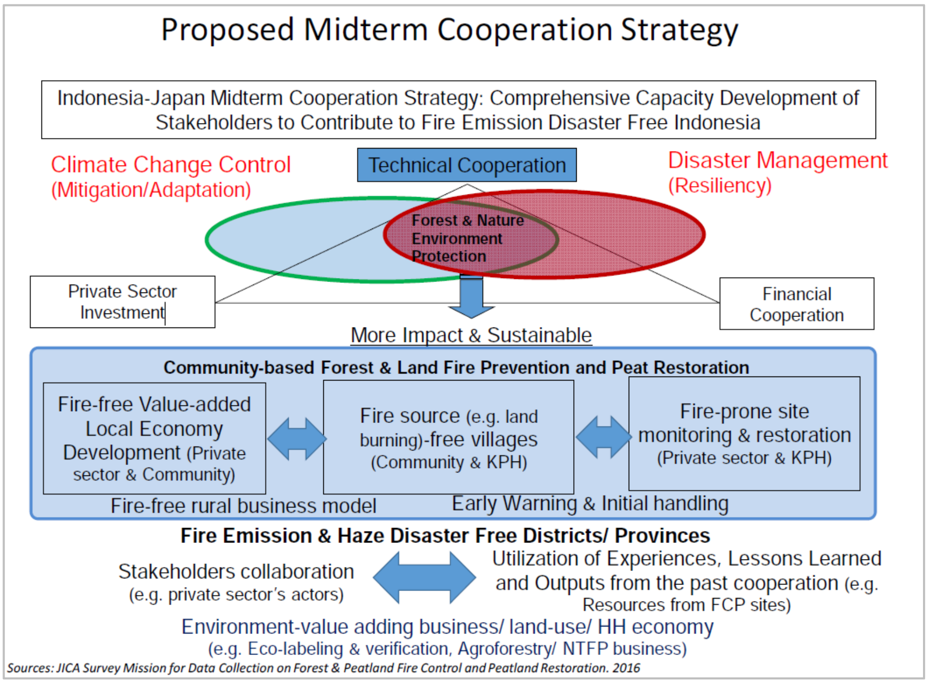
149 JICA Data Collection Survey on Forest & Peatland Fire Control and Peatland Restoration in Indonesia. 2017

a) To promote a combination of the perspectives of climate change control and disaster management
b) To build collaboration with private sector investment and financial cooperation

Following will be prioritized as a cooperation strategy for fire prevention and peatland restoration.

a) To focus on community-based fire prevention that can contribute to preventing fire outbreak causes based on the past experiences and lessons learned
b) To support early warning and initial response by enhancing restoration and monitoring fire-prone sited because fire outbreaks tend to distribute at fire-prone sites.
c) To try to develop rural business model without land burning in order to obtain attention by industries by promoting land management without land burning.

In order to promote the above strategies, it will be tired to visualize the impact of fire prevention and peatland restoration quantitatively by creating added values as a business, land management and household economy in collaboration with stakeholders as private sectors in addition to utilize the past experiences and lessons learned effectively.



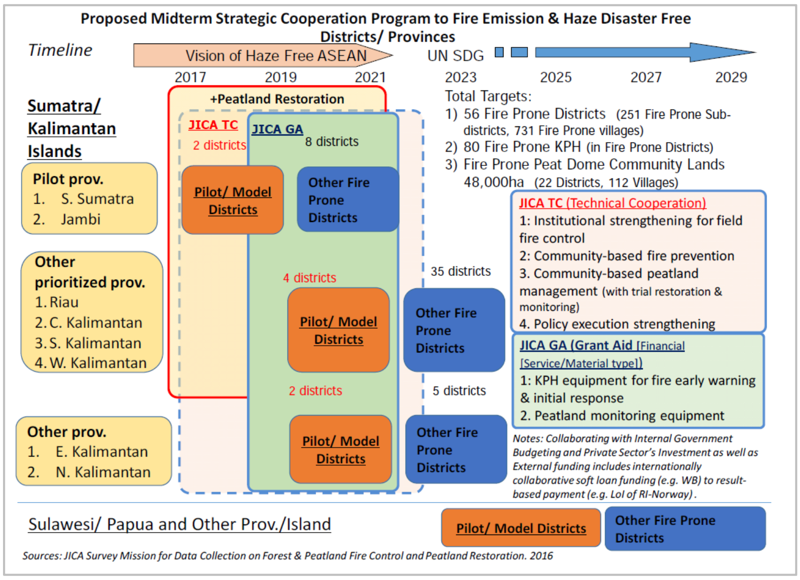
Source: JICA Data Collection Survey on Forest & Peatland Fire Control and Peatland Restoration in Indonesia. 2017

Figure 6-5 Draft Strategies in Cooperation for forest and Peatland Fire Control

The following figures show the proposed draft midterm strategic program in cooperation for forest and peatland fire control by applying the strategies above.

The proposed midterm cooperation program is "Fire Emission & Haze Disaster Free Districts and Provinces" The target is fifty-six (56) fire-prone districts (731 fire-prone community members) and related eighty (80) fire-prone KPH in ten (10) priority provinces in Sumatra and Kalimantan Islands that are important from the perspectives of impact to ASEAN countries as Singapore and Malaysia. In order to drive effective cooperation which can contribute sustainable impact in an extensive area in a short time, a draft strategy based on the following approaches is proposed as follows.

a) To begin by building model districts in fire prevention in each province
b) To duplicate the same program in other fire-prone districts in each province
c) To reduce major fire-prone sites in each province by the end of ASEAN Haze Free Vision through a) and b) above



Source: JICA Data Collection Survey on Forest & Peatland Fire Control and Peatland Restoration in Indonesia. 2017

Figure 6-6 Draft Midterm Strategic Program in Cooperation for Forest and Peatland Fire Control

Indonesia has been working on measures against haze, suppression of GHG emissions from fires and degraded land, and restoration of ecosystems in the ASEAN 2015 Vision. In particular, with regard to peatlands that are likely to cause haze damage to neighboring countries such as Singapore and Malaysia, the seven (7) priority provinces (Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, South Kalimantan, Papua province) are selected and has taken intensive measures. In the post-ASEAN 2015 vision, efforts to focus on disaster prevention, such as re-wetting peatland and strengthening the disaster prevention capacity of communities, are expected.

The priorities for prevention against forest and peatland fires are summarized as follows based on the issues of forest and peatland fire control and the proposed draft midterm strategic program for the project "Fire Emission & Haze Disaster Free Districts and Provinces".

Table 6-16 Priorities for Prevention against Forest and Peatland Fires

Priority activity 1(Pillar 1): Mainstreaming DRR
«Strategy 1» Focusing on community fire prevention to control the cause of fires by making use of past experiences and lessons
【Priority action 1-1】 Effective use of firefighting equipment / Improvement of firefighting tactics
【Priority action 1-2】 Patrol of the site
Priority activity 2(Pillar 2): Enhancement of recognition of hazards/risks
«Strategy 2» Strengthening of organization and system for forest and peatland fire control
【Priority action 2-1】 Clarification of role for each organization
【[Priority action 2-2】 Improvement of the ability of forest and peatland fire control
«Strategy 3» Comprehensive Capacity Development of Stakeholders on Peatland Restoration
【Priority action 3-1】 Organizing peatland restoration measures in the Directorate of Peat Damage Control (PKG: Direktorat Pengendalian Kerusakan Gambut), The Peatland Restoration Agency (Badan Restorasi Gambut: BRG), Public Project / National Longitudinal Lowland Division Pekerjaan Umum danPerumahan Rakyat(PUPR)
Priority activity 3(Pillar 3): Increasing DRR investment
«Strategy 4» Promotion of re-wetting peatlands
【Priority action 4-1】 Construction of dams
【Priority action 4-2】 Summary of the activities of re-wetting peatlands and implementers
«Strategy 5» Promote recovery and monitoring of frequent fire area and accelerate early warning and initial response for the disaster
【Priority action 5-1】 Fire Danger Prediction System
【Preferred action 5-2】 Early Fire Outbreak Detection System
«Strategy 6» Use of fire prevention methods which shows no putting fires into the forest and peatland is valuable
【Preferred action 6-1】 Utilization of FCP community-based fire prevention method

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

«Strategy 1» Focusing on community fire prevention to control the cause of fires by making use of past experiences and lessons

Fire control can be roughly classified into Prevention, Response or Firefighting, and Post Outbreak. While preparedness approach to be ready for disaster including preparing firefighting equipment was prioritized in the past, preventive approach to prevent from fire outbreak beforehand has been put the importance in recent years.

Among them, there are two approaches to early warning. One is related to the improvement of stakeholder's ability for fire prevention and on-site patrol, and the other is considered to be early detection and monitoring HS by early warning system. The early detection and monitoring system will be discussed later in policy 5.

With regard to the improvement of stakeholder's ability for fire prevention and on-site patrol, the military and police have actively participated in after the establishment of the current administration. However, there is an aspect that the working efficiency of the fire department is weakened by the fact that the army and the police who do not have firefighting equipment and experience of specialized firefighting training cooperate with the fire department. Therefore, the problem is to improve the ability of appropriate firefighting tactics that can effectively use firefighting equipment. In addition, there is a problem that effective fire extinguishing activities cannot be performed because fire information is not effectively transmitted to the target who acts as an agent for initial fire extinguish. In response, FCP's community fire prevention facilitation team applied the TPD approach, and a comprehensive patrol project was launched, in which six (6) stakeholders on-site were patrolling. In patrol, a community level fire control command operation room called Posko was established, and it was a hub to transmit fire risk information at the community level. In addition, a fire prevention group called MPA has also been active, and its role has also become important.

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

«Strategy 2» Strengthening of organization and system for forest and peatland fire control

Indonesia has developed decentralization. There are various stakeholders and related agencies also in the disaster control since Indonesia regards fires as disasters. Therefore, it is necessary to clarify and organize their respective roles and to improve their capabilities and strengthen their systems for forest and peatland fire control in their respective stakeholders.

BNPB manages disasters in Indonesia and they work on disaster risk reduction and preparation for disaster prevention. In the event of a disaster, the central system in BNPB takes charge of operations, and in the event of an emergency, the site is instructed by BNPB. In addition, BNPB is good at artificial rainfall, aircraft fire extinguishing, fire spot reconnaissance, and firefighting tactics. BPBD has been established under BNPB, Ministry of Home Affairs, Fire Department under Public Works Services, and the firefighting officer and fire brigade are organized.

Meanwhile, land use manager should do self-defense fire affairs and should organize self-defense fire brigade. Ground firefighting is done by the autonomous fire affairs and self-defense fire affairs systems. However, Indonesia regards fires as disasters. When the regional heads apply for Disaster Preparedness Status, BNPB and BPBD strengthen preparation to disaster response. At the application of Disaster Emergency Status, emergent response power concentrate with BNPB and BPBD and implement large scale response including rainmaking and firefighting by air.

Integrated fire management approach has also developed a system to support the local governments' fire control especially fire prevention by each ministry and agencies based on the Presidential Instruction. The duty of MoEF divers including as coordinator in fire control in usual status, as the focal point of AATHP Agreement, and as MoF and MoE to provide guidance of fire control. Manggala Agni, the fire brigade developed originally from self-defense fire brigade of Conservation Forests where the central government directly manages, has increased the function to support all forest and land fire controls including ground firefighting due to the recent revision of regulation. The self-defense fire brigade for Conservation Forests should newly be strengthened in the situation few fire outbreaks in Conservation Forests.

«Strategy 3» Comprehensive capacity development of stakeholders on peatland restoration

Three (3) organizations; Directorate of Peat Damage Control (hereinafter referred to as PKG), The Peatland Restoration Agency (hereinafter referred to as BRG) and Public Project / National Longitudinal Lowland Division (hereinafter referred to as PU-PR), are the main organizations to conduct peatland restoration activities. In particular, it is necessary to strengthen the capacity of these three institutions and strengthen cooperative relationships to achieve more effective peatland restoration.

PKG was organized by the merging two ministries: Ministry of Environment and Ministry of Forestry. The main activities are domestic peatland restoration activities and monitoring. The targets are peatlands throughout the country, including concessions and land owned by communities.

BRG is the 5-year-limited organization, which has been established by Presidential Decree No.01/2016, in order to facilitate the peatland restoration in the seven (7) high priority provinces, and coordinate with related ministries and national agencies.

PUPR is one of the main actors on peatland restoration in Indonesia. The Sub-Directorate of Lowland under Directorate of Irrigation and Lowland has responsibilities to protect and maintain especially lowland swamp areas, including peatland.

Furthermore, in addition to these three (3) institutions, there are organizations related to peatland restoration ; ①BIG (Badan Informasi Geospatial: Geospatial Information Agency), which carries out mapping and satellite data acquisition, ②BBSDLP (Balai Besar Litbang Sumberdaya Lahan Pertanian : Center for Research and Development on Agricultural Land Resources), which carries out soil surveys and peat depth maps, community-owned land etc. ③BPN (Badan Pertanahan Nasional: National land Agency), carries out the mapping of land conditions of different scales and so on.

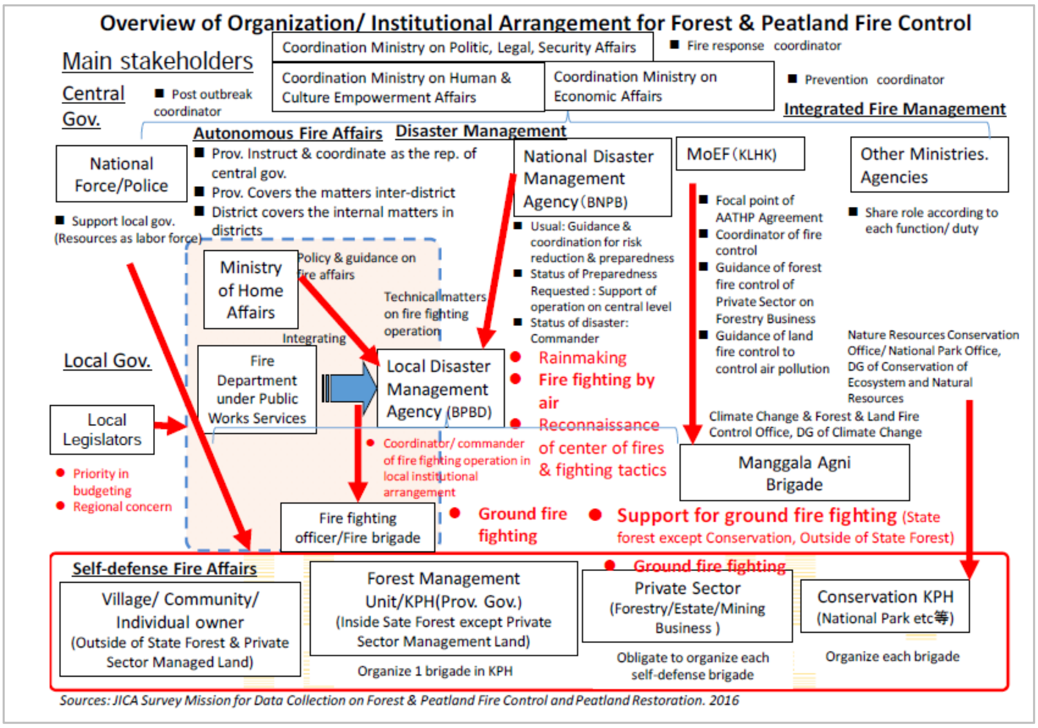


Figure 6-7 Outline of Stakeholder Concerned with Forest and Land Fire Control (As of Dec. 2016)

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

«Strategy 4» Promotion of re-wetting peatlands

With the background of the fact that fires are likely to occur due to peatland drying, there has been a move to re-wet peatland in the past. The method is to raise the groundwater level of the peatland and re-wet the peatland. In particular, in the areas in the seven (7) priority provinces, it is carried out by the relevant organizations and is implemented with the construction of a dam for blocking water. According to JICA Data Collection Survey on Forest & Peatland Fire Control and Peatland Restoration in Indonesia,2017, MoE, PKG, UNDP, CIMTROP / UNPAR, Ministry of Public Works and Housing (PUPR) and Concession holders are respectively carrying out the construction of the dam. In particular, many multiple sheet pile dams (box-type dams) are constructed.

This type of construction method has the advantage of being able to be produced in a relatively short time and at a low cost, with the cooperation of the community members, as compared to concrete dams and peat compaction dams. Multiple sheet pile dams (box-type dams) can be made in a few weeks to a month using wood, sand, etc., and the cost is only 5,000 USD per unit. However, since it does not last for a long time, periodical rebuilding or maintenance will be required. There will also be issues such as the need for a spillway through which boats can pass during construction. The details of the activities of each organization are as follows.

Table 6-17 Examples of Re-Wetting Activities in Indonesia

Implementers	Locations	Details of Re-wetting
MoE through ASEAN Peatland Forest Project (APFP)	Riau, Central Kalimantan, West Kalimantan	- Multiple sheet pile dams (box-type dams) were constructed as the model projects in four (4) provinces in 2014.
PKG	Riau, Central Kalimantan, West Kalimantan	- Degraded Peatland Rehabilitation Model Project in accordance with the target, stipulated in RENSTRA - Multiple sheet pile dams (box-type dams) were constructed as the model at five (5) sites in three (3) provinces in 2015 by the government budget - Plans to construct eighty (80) canal blockings in five (5) provinces in 2016.
UNDP	Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan	- Community-based construction of multiple sheet pile dam - Multiple sheet pile dams (box-type dams) were constructed by communities at eighty-nine (89) sites in twenty-tree (23) communities in three (3) provinces. - Also, thirty (30) sets of water pumps were installed in one (1) province, and 118 numbers of bore wells were dug in four (4) provinces. - As of August 2016, no activities are conducted in Jambi province.
CIMTROP/ UNPAR	Central Kalimantan	- Multiple sheet pile dams (box-type dams) were constructed as the model at Kalimantan Trial Site.
Ministry of Public Works and Housing (PU-PR)	Central Kalimantan	- Pilot construction of concrete-type dams and Multiple sheet pile dams at the Ex-Mega Rice Project site in 2013 - Construction of concrete-type dams and multiple sheet pile dams at the Ex-Mega Rice Project site in 2015, based on the Master Plan for the Rehabilitation and Revitalization of the Ex-Mega Rice Project Area in Central Kalimantan. - Rehabilitated/ re-constructed the box-type dam, at the same location of the box-type dam, which was constructed by CIMTROP, - Plans to construct four (4) concrete-type dams in 2017, based on the Master Plan for the Rehabilitation and Revitalization of the Ex-Mega Rice Project Area in Central Kalimantan
Concession holders	Riau, etc.	- Peat compaction dams are constructed in cooperation with the private consulting firms (i.e. Deltares) - Riau Andalan Pulp & Paper (RAPP) and Sinarmas have created blocking canals at a 500m distance in their concession for HTI (main canals).

Source: JICA Data Collection Survey on Forest & Peatland Fire Control and Peatland Restoration in Indonesia. 2017

«Strategy 5» Promote recovery and monitoring of frequent fire area and accelerate early warning and initial response for the disaster

In order to address forest and peatland fire control and early warning in Indonesia, there are two kinds of activities including (1) Fire Danger Prediction System and (2) Early Fire Outbreak Detection System. Based on the decision by the Minister of Environment and Forestry, MoEF and BNPB will be users of data of early detection system. LAPAM will be the sole analyzer of satellite data as HS while BMKG will be the sole analyzer of fire danger rating since 2016.

The system is called Fire Danger Rating System (hereinafter referred to as FDRS) and calculates the rate of four (4) fire occurrence possibility levels including low, moderate, high, and extreme. The system calculates danger rates based on four weather parameter including daily temperature, relative humidity, wind speed, and twenty-four (24) hour-rainfall data collected by 177 BMKG Weather Ground Stations (hereinafter referred to as WGS) nationwide. Based on these weather parameters, Fire Weather Index (hereinafter referred to as FWI) is calculated and published through BMKG's website including FAX, SNS, and mailing list.

On the other hand, FWI is also calculated by Automatic Weather System (hereinafter referred to as AWS) at field level and it is operated by *Manggala Agni* (hereinafter referred to as MA). It is used for fire prevention at field levels. Currently, FDRS of BMKG as officially published in national and province levels and FDRS managed by MA at field levels have been separately operated.

Furthermore, as far as the interview to BMKG in June 2016, there are several needs for improvements. Firstly, 177 WGSs of BMKG are unevenly distributed nationwide and mainly located in city areas that are far from actual fire outbreak areas. Secondly, fire danger rate does not consider land cover and use types. The scales of fire outbreaks partially rely on materials covering the ground. Ground materials such as grasses and trees become fire fuels. Hence, it is important to consider land cover and use. Additionally, as far as the interview to PKHL in June 2016, the causes of fire outbreaks derive from mostly human activities for their livelihoods. It would be effective if FDRS was convened with these human activity patterns such as the seasonal trends that people often put fires. Moreover, the FDRS managed by BMKG do not respond to FWI in district or community level, and this affects to the fire prevention implementation. Such matters are one of the rooms for improvement in the early warning system.

Early Detection System is to detect fire outbreaks as soon as possible using HS where higher temperature sites analyzed on satellite imagery as follows. Forest and peatland HS information from LAPAN and MOEF is mainly used for fire detection until firefighting.

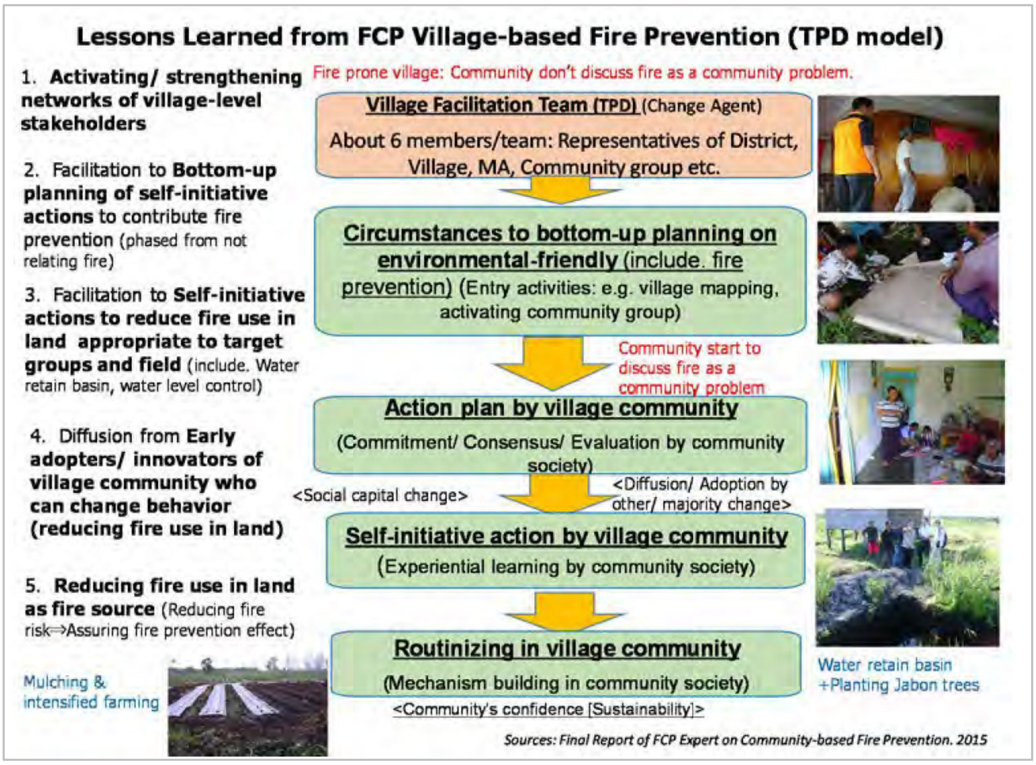
LAPAN is the only agency to provide officially satellite data and remote sensing information including HS data according to the decision by the Minister of Environment and forestry in Apr. 2016 (S.218/MENLHK/PPI/PPI.4/4/2016). By getting data through LAPAN, MOEF publishes HS data through own website named "Sipongi". Moreover, the points to detect wildfires by satellites is frequent observation objects and accurate location detection. The frequency helps to quick detection of HS. Accurate detection of location provides firefighters to figure out the best route to access HS. Once HS was detected, this information goes to Manggala Agni. Then, they go to check the HS area for its validation. In order to verify whether or not there is a fire outbreak, HS verification has started by fire patrol team by PKHL using Smartphone-based application called HS Verifier.

As for the matters that LAPAN faces are the accuracy of HS and the lifetime of MODIS satellite which is conducting HS observation. While one of the needs in field level is to pinpoint the initial stage of fires which can be easily extinguished. Satellite data cannot provide the information currently. As an improvement of these issues, cooperation with a satellite with higher accuracy, etc. can be considered.

«Strategy 6» Use of fire prevention methods which shows no putting fires into the forest and peatland is valuable

As past results that JICA project has been conducted, there are FCP and TPD methods. In those methods, brigades (Manggala Agni) has been organized in the target area (Riau, West Kalimantan) and community-based fire prevention model (TPD model) as a facilitation team reduced land burning behaviors and HS. The details of the TPD model is below.

The MoEF established "Integrated Patrol (Patrol Terpadu)" for the seven (7) priority provinces focusing in Sumatra and Kalimantan Islands utilizing TPD method and collaborative patrol method with community members by the MoEF's fire brigade (MA), which were developed through FCP. According to Ministerial Decree of Environment and Forestry on Standard of Forest and Land Fire Control No. 32/2016, it has stipulated the definition of TPD. Although it is difficult to change behaviors every time, it worked effectively when it has limited in a certain community in a certain term in a certain land burning indicator like frequency. In order to further activate the TPD model, it is important to focus on group strengthening with the aim of improving economics. From the Indonesian side, there is also a need for more effective method development that can show fire prevention effects in a wide area such as prefecture-level.



Source: JICA Data Collection Survey on Forest & Peatland Fire Control and Peatland Restoration in Indonesia. 2017

Figure 6-8 Outline of TPD Model

Chapter 7. Formulating DRR Risk Index/ Sub-Index

7.1 Current Situation and Problem of Risk Index

The Risk Index (hereinafter referred to as RI) is listed as the degree of achievement of the goal of IDMMP, which is the National Disaster Management Master Plan of Indonesia. Therefore, while the reduction and evaluation of RI are politically important and critical issues, the current RI evaluation contents are focused on the improvement of the ability of BNPB. For example, although the RI evaluation is useful to prepare disasters, it cannot directly increase the budget for the preparedness since the budget for the disaster preparedness is controlled by PUPR, and not by BNPB. These issues of RI are not easily solved because factors such as lack of ability of line ministries, inter-ministerial collaboration/information sharing, and jurisdiction/responsibility are related in complexity. However, RI itself is important to measure DRR and it is hoped to be developed / improved in mid-long term prospective with reflection investment on infrastructure. In this chapter, the proposal for the improvement of the current situation is explained.

7.1.1 Current Situation of Risk Index

7.1.1.1 Calculation Methodology for Risk Index

The Risk Index in Indonesia is defined in the RBI[150] with the three indices : Hazard, Vulnerability and Capacity, incorperated into the following equation. Risk Index is calculated in each unit of District/City and targeted to calculate the following 10 disaster types; earthquake, tsunami, volcano, flood, landslide, drought, forest fire, abnormal weather, tidal surge, coastal erosion, and flash flood.

$$\text{Risk Index} = \frac{Hazard \times Vulnerability}{Capacity}$$

(1) Hazard

The calculation methodology for hazard is mentioned as a flow chart for each disaster type on RBI. For an example, Figure 7-1 shows it for a flood. An elevation data (DEM) and a flow path data are used as a data source. The inclination angle and the inclination direction of each mesh are calculated from the elevation data. From the flow path data, regions where the river slope is less than 15% and within 300 m from the river are extracted. Flood prone areas are extracted from these two data and the flood hazard index is calculated.

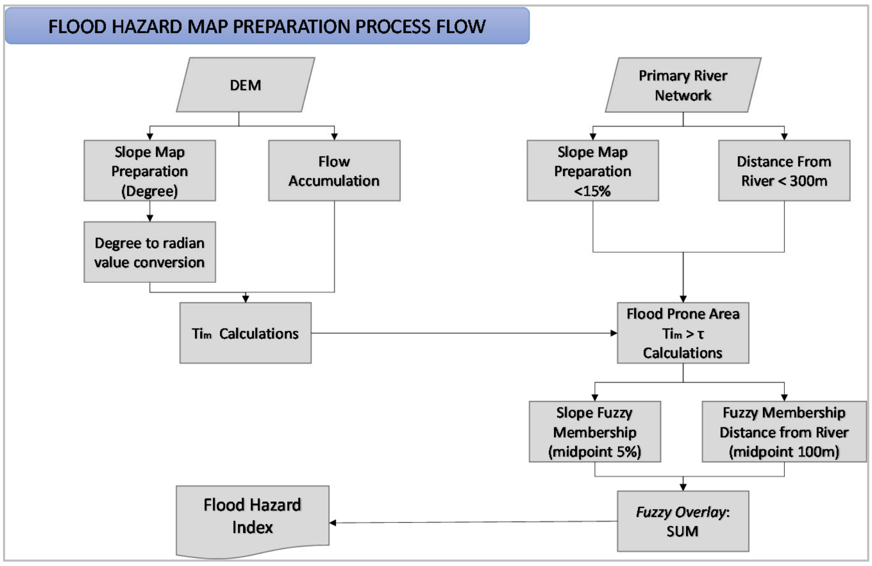


Figure 7-1 Calculation Method for Flood Hazard

150 BNPB (2016), RISIKO BENCANA INDONESIA

(2) Vulnerability

As shown in Table 2-1, Vulnerability Index is calculated by evaluating four elements of social, physical, economic and environmental vulnerability. The social vulnerability consists of population density, sex ratio, population ratio of socially vulnerable people and handicapped population ratio. The physical vulnerability consists of assumed house damage amount, public facilities and assumed important facilities. The economic vulnerability consists of assumed farm damage and GRDP amount. The environmental vulnerability consists of areas of protected forests, natural forests, mangrove forests, bushes, and swamps.

Table 7-1 Four Elements to Evaluate Vulnerability

Vulnerability	Parameter	Ratio
Social Vulnerability	Population Density	60%
	Sex Ratio	10%
	Vulnerable Age Group Ratio	10%
	Poor Population Ratio	10%
	Handicapped Population Ratio	10%
Physical Vulnerability	Housing	40%
	Public Facilities	30%
	Critical Facilities	30%
Economic Vulnerability	Productive Land	60%
	GRDP	40%
Environmental Vulnerability	Protected Forests	Depending on disaster type
	Natural Forests	
	Mangrove Forests/mangroves	
	Bushes	
	Swamps	

The weight of the four elements of Vulnerability is different for each disaster type. Regarding the weight of vulnerability for flood as an example, 40% is assigned to social vulnerability, 25% to physical vulnerability, and 25% to economic vulnerability. On the other hand, in case of an earthquake, 40% is assingned to social vulnerability, 30% to physical vulnerability and 30% to economic vulnerability.

(3) Capacity

By answering the 71 Indicator questionnaire[151] issued by BNPB, the capacity index of each District/City is calculated. The 71indicator is classified into seven priority items as shown in Table 7-2. The number of Indicators in "strengthening disaster prevention and emergency response" is 24 so it accounts for more than 30% of the total, which indicates that the number of items that can be implemented mainly by BNPB is large.

Table 7-2 7 Priority Items of 71Indicator

	Priority	Number of Indicator
1	Strengthening the Policy & Institution	9
2	Risk Assessment and Integrated Planning	4
3	Development of Information System, Education & Training and Logistic	13
4	Thematic handling for disaster prone area	5
5	Increasing the effectiveness of Prevention and Mitigation	12
6	Strengthening the Disaster Preparedness and Emergency Response	24
7	Development of disaster recovery system	4
	Total	71

Each Indicator consists of four Yes/ No questions, which means it is necessary to answer a total of 281 questions. The four questions are structured as shown in Figure 7-2. The first question of each Indicator is a

151 BNPB (2016), QUESTIONER PENILAIAN KAPASITAS DAERAH 71 INDIKATOR

general question. Specific contents appear as the questions advances. If Yes is selected, the responder proceeds to the next question. On the other hand, if No is selected, you select, further questions are not required. Each indicator is evaluated with 1 to 5 points as shown as below.

Indicator 1
Local Government Regulation (PERDA) on Disaster Management

Indicator	No	Key Question (detailed question)	Response Yes	Response No	Verified Evidence
1	1	Any *PERDA* on Disaster Management (DM) ? (If "NO', proceed to question No. 5. If "YES", proceed to next question			General
	2	Is this *PERDA* had been supported by derivative regulation, which describe the DM at local level? (If "NO', proceed to question No. 5. If "YES", proceed to next question			
	3	Is this *PERDA* had been used as reference in the implementation of DM (If "NO', proceed to question No. 5. If "YES", proceed to next question)			
	4	Is this *PERDA* had been adopt to other local policies (i.e. Spatial Planning, Building Permit, Industrial complex permit, etc.)? (proceed to next question)			Specific

Figure 7-2 4 Questions of Indicator No.1

Table 7-3 Evaluation Methodology for each Indicator

Value 1	→	If the first question is no
Value 2	→	If the first question is yes and the second is no
Value 3	→	If the first and second is yes, and the third is no
Value 4	→	If 1 - 3 is yes and the fourth is no
Value 5	→	If all answer is yes

Capacity is evaluated for each Priority item as the output of 71 Indicator questionnaire. The purpose of calculating the value for each item of Priority is that the local government understands which items meet the requirement and what field need to be strengthened. Figure 7-3 is the Capacity evaluation result of Manado City in 2017. "Thematic handling disaster-prone area" of Priority 4 and "development of the disaster recovery system" of Priority 7 are fulfilling. However contrary to that situation, it is a problem for the implementation of "Strengthening the policy and institution" of Priority 1.

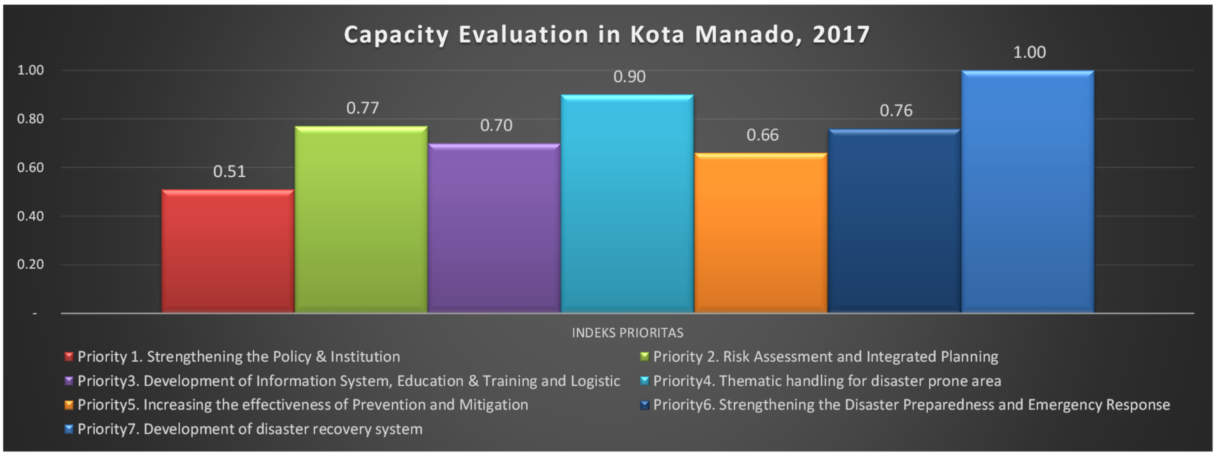


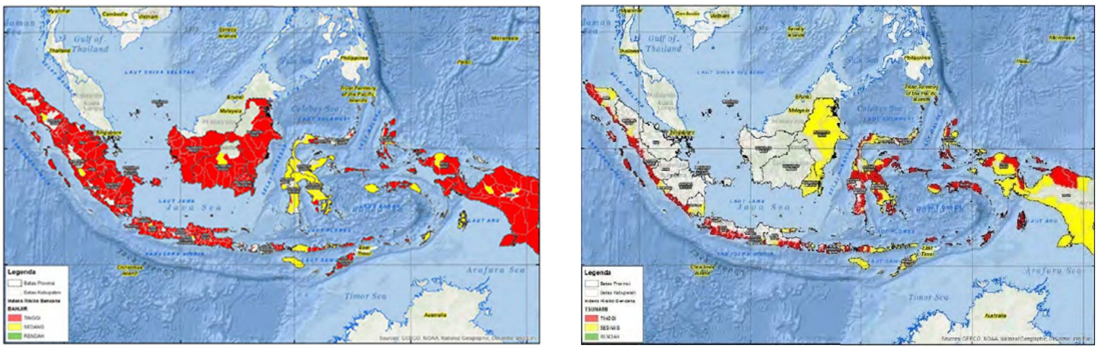
Figure 7-3 Result of Capacity Evaluation for Each Priority in Manado City in 2017

7.1.1.2 Evaluation Results by Risk Index

In IDMMP, 136 Districts/ cities which are the center of economic growth of the regions with High/ Moderate RI values, is set as the priority cities. Forum group discussion sponsored by BNPB took place for three days in November 2017. The stakeholders of 136 Districts/ Cities, as priority cities, were convened and their capacity was evaluated in the forum. According to the staff of BAPPEDA Kota Manado who participated in the forum, the stakeholders of each Districts/ Cities answered the 71Indicator's Yes/ No questionnaire for the evaluation of Capacity, and the value of RI of each Districts/ Cities was calculated with the result of 71Indicators and the values of Hazard and Vulnerability was calculated by BNPB. The event was on November 2018.

RI targets 10 disaster types and is calculated for each disaster type. As an example, the risk index maps of flood and tsunami are shown in （Left: **Flood, Right: Tsunami**）

Figure 7-4. The hazard map of the tsunami shows a moderate risk in the coastal areas of Aceh province and East Nusa Tenggara province.



（Left: Flood, Right: Tsunami）

Figure 7-4 Risk Index map （IRBI 2013, BNPB）

The RI calculated for each disaster type are accumulated for each administrative bureau of Districts/ Cities and the multi-hazard risk map is made as shown in Figure 7-5. RI is calculated for Indonesia's 497 Districts / Cities and value of RI indicates high in 388 Districts/ Cities which accounts for 78% of the total. Compared with the scores of multi-hazard RI by each administrative district, the highest score is 250 in Tianjur County of West Java province, while the lowest score is 45 in central Mamberamo province of Papua province.

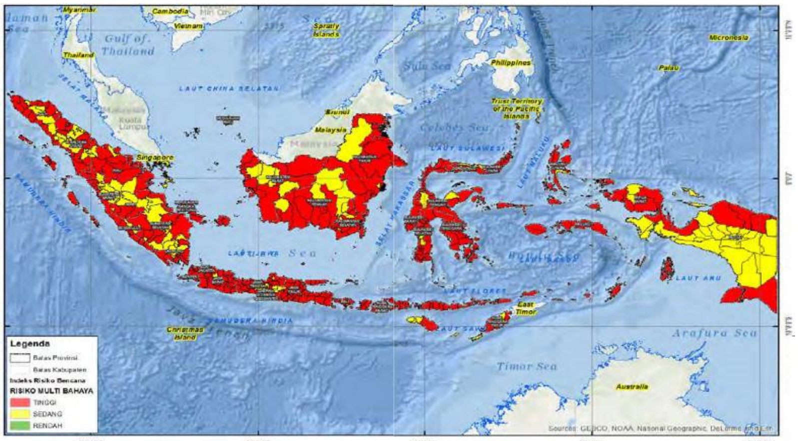


Figure 7-5 Multi-Hazard Risk Index Map (IRBI 2013, BNPB)

When calculating the RI of each disaster type into multiple hazards, the weighting is performed as shown in Figure 7-6, taking into consideration the threat level of each hazard, by the frequency of occurrence and availability of hazard forecasting and warning. Weighting is the largest for landslides due to the high occurrence frequency and difficulty of forecasting and warning. Volcanic eruptions are lowered in weighting due to less frequency of occurrence and more viability of forecasting / warning.

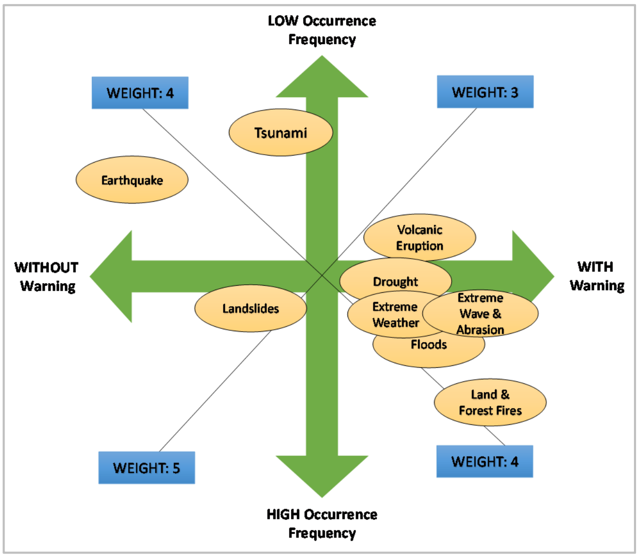


Figure 7-6 Weighting by Disaster Types[152]

7.1.1.3 RI as Numerical Target

As mentioned at the beginning, RI is a numerical target as achieving the goal of IDMMP. Specifically, as shown in Figure 7-7, RI is reduced by 30% during the last five years from 2015 to 2019. In BNPB's Disaster Management Policies and Strategies 2015-2019, among the three elements that compose RI, Capacity and Vulnerability including Capacity elements are regarded as adjustable elements. The strategy for RI reduction is to improve the Capacity value. Three strategies for RI reduction and related organizations are defined as shown in Table 7-4.

NO.	LEVEL	NUMBER OF REGENCIES/ MUNICIPALITIES	INDEX AVERAGE (2013 BASELINE)	INDEX REDUCTION TARGET (30%)	YEAR					INDEX TARGET (2019)
					2015	2016	2017	2018	2019	
1	NATIONAL	497	156.3	46.9	9.4	9.4	9.4	9.4	9.4	109.4
2	NATIONAL PRIORITY REGENCIES/ MUNICIPALITIES	136	169.4	50.8	10.2	10.2	10.2	10.2	10.2	118.6

Figure 7-7 Target for RI reduction

In BNPB's policy and strategy, reduction of Disaster Risk Index is achieved through disaster management capacity-building activities in regions (regencies and municipalities) by various parties, namely the central government, the provincial governments, regency/municipality governments, the general public, and private sector. The central government is tasked to establish NSPK (Norms, Standards, Procedures, and Criteria), to establish central and regional facilitators, to undertake the implementation of activities in regencies/ municipalities, and to conduct monitoring and evaluation. The provincial governments are tasked to establish facilitators in regions together with the central government, to conduct the implementation of activities in regencies/municipalities, and to report its activities to the central government. The regency/municipality governments are tasked to establish facilitators in regions together with the central government and provincial

[152] BNPB (2016), DISASTER MANAGEMENT POLICIES AND STRATEGIES 2015-2019 P.9

governments, to undertake the implementation of activities in regencies/municipalities, and to report its activities to the central government. [153]

RI is defined as not only a national numerical target but also a target for the local regions. For example, BAPPEDA Kota banda Aceh uses RI as its goal in the next medium-term disaster prevention policy, from 146.9 in 2016 to 130 by the year 2022.

Table 7-4 3 Strategies and Related Agencies for RI Reduction

Strategy		Involved ministries/ agencies
1.	Disaster risk reduction within the framework of sustainable development at the central government and regional levels	BNPB, BAPPPENAS, KEMENDAGRI, BMKG, KEMEN PUPERA,KEMEN ESDM, BIG, KEMENTAN, BPPT, LAPAN,KEMENKES, KEMENSOS, KLHK, KEMENDES PDTT,KEMEN ATR, TNI, POLRI, KKP
2.	Disaster vulnerability level reduction	BNPB, BAPPENAS, KEMENDAGRI, BMKG, KEMEN PUPERA, KEMEN ESDM, BIG, KEMENTAN, BPPT, LAPAN, KEMENKES, KEMENSOS, KLHK, KEMENDES PDTT, KEMENDIKDASBUD, KEMENAG, KOMINFO, TNI, POLRI, KEMENKEU
3.	Government, Regional Government and Public disaster management capacity building	BNPB, BAPPPENAS, KEMENDAGRI, BMKG, KEMEN PUPERA, KEMEN ESDM, BIG, KEMENTAN, LAPAN,KEMENKES, KEMENSOS, KLHK, KEMENDES PDTT, KEMEN ATR, TNI, POLRI, KKP, KEMENRISTEKDIKTI, BRG

7.1.2 Current Problem of RI

RI has already been operated in Indonesia. It is defined as a national numerical target. The challenges in Hazard and Capacity evaluation are as follows;

<u>(Problems in Hazard Evaluation)</u>

- According to the BNPB, a method which enables evaluation over the whole country with a uniform value has been selected. However in principle, scientific analysis based on hydrological meteorological data such as rainfall data that affects flood characteristics has not been sufficient and should be conducted to carry out flood hazard assessment.

<u>(Problems in Capacity Evaluation)</u>

- Only few questions about structural measures are included in 71 Indicator. For an example, as shown in Figure 7-8, despite the fact that the frequency of large-scale floods has been decreased greatly due to structural measures in Banda Aceh city, the 71Indicators' questions contains only one question on structural countermeasures against flood.

- 71Indicators' question are not quantitative. All of the questions are to answer by Yes/ No, but the boundary between yes and no is not clear. In the second question in Figure 7-2, there is a question that is, "Is PERDA (local government regulation) consistent with other disaster prevention-related rules ?". What kind of situation is defined as "being consistent" is not defined.

- Basis of answers to the71 Indicators' questions are inadequate. As shown in Figure 7-2, it is necessary to indicate the answer basis to each of the questions. However, according to the staff of BAPPEDA Kota Manado who actually responded 71 Indicator questions, some agencies submitted all the documents of policies and regulations, but didn't mention where the corresponding parts were stated.

- Overlapping questions exist. The question items of Indicator 2 and Indicator 7 have the same contents as "Establishment of BPBD".

153 BNPB (2016), DISASTER MANAGEMENT POLICIES AND STRATEGIES 2015-2019 P.26-P.27

- Capacity is evaluated by the same 71 Indicators even if disaster types are different. Hazard is evaluated by different flows for each disaster type, and Vulnerability also changes the proportion of items for each disaster type. On the other hand, Capacity is evaluated with the same questions even if disaster species are different.

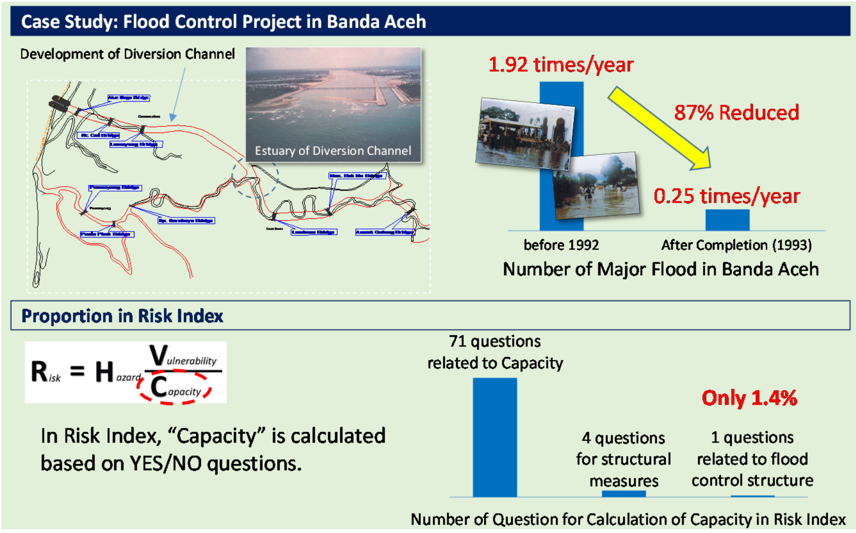


Figure 7-8 DRR investment in Aceh and Capacity Evaluation

7.2 Direction of Improvement for Risk Index

RI revision in this examination mainly focuses on improvement in hazard assessment. Regarding floods, it is being done by hazard assessment based on scientific evidence such as hydraulic analysis and flood analysis based on hydro-meteorological data. An overall story is established to link DRR investment promotion and organizational collaboration based on risk index revision. As a specific revision, a sub-index is proposed. Its purpose is to evaluate the direct economic loss, as explained in Figure 7-9 out of the four quantitative indicators (the number of deaths, affected people, economic damage, infrastructure and service disruption) of the seven global targets of the SFDRR. Sub-index would be formulated in Manado and Aceh as case studies. Its dissemination to the whole Indonesia is expected.

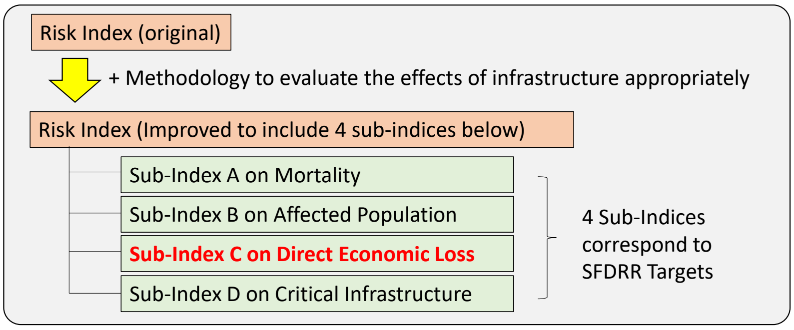


Figure 7-9 Formulating Sub-Index Based on Four Quantitative Indicators of SFDRR

In order to monitor the direct economic loss, it is necessary to accurately simulated the flood phenomena, to evaluate the effect of the structural measures and to incorporate its effect into the plan. For that purpose, various analyzes are required as shown in Figure 7-10. Accurate and sufficient amount of data (hydrologic data, topographical data, socio-economic data, etc.) is required to carry out these analyzes. In addition, since each analysis is not carried out independently, even one data missing affects the entire analysis.

Through improvement of RI, understanding the importance of data by related institutions in Indonesia is enhanced. Clarifying responsible agency of each kind of data, and intergroup collaboration coordinated by BNPB which is RI management agency are also integral.

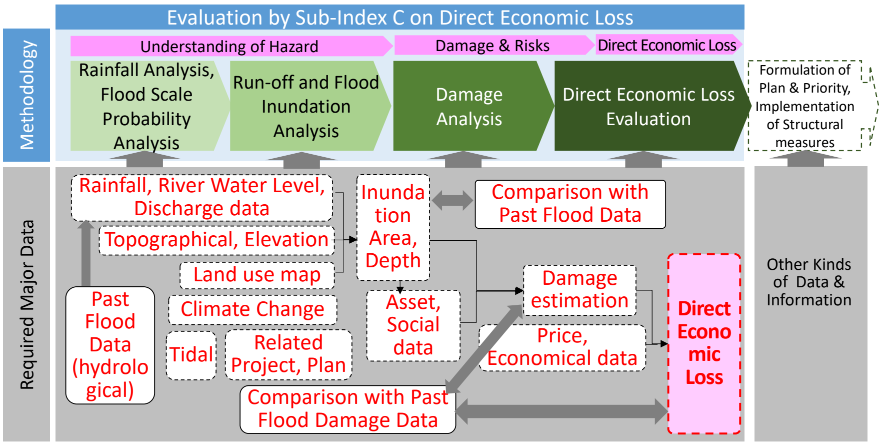


Figure 7-10 An Example of Data and Analysis to Evaluate

7.2.1 Basic Concept for Improvement of Risk Index (Formulating Sub-Index)

If sub-index to be constructed requires analysis method, accuracy and high quality which are beyond the current capacity of Indonesia, it is an unrealistic proposal and may not be applicable.

Therefore, as the the short term target, the process that is accepted by the Indonesian side should be adonpted. In the medium to long term perspective, the current situation of Indonesia shall be improved. In the short term perpective, sub-index will be formulated with simple evaluation method that is being practiced at present in Indonesia (Figure 7-11 and Figure 7-12). In the case of simple methods, considering its accuracy, possible erros should be anticipated. The difference in accuracy between the simple and advanced methods is to be taken into account.

		Temporary Method	Interim Method	Permanent Method
Accuracy of Analysis	Detail	Very Rough	Between both	Detailed
	Error	Large Error	Between both	Small Error
Requirement	Data to use	Pre-existing data such as damage records and past calculation	Complementary data such as satellite data	Accumulated direct observation data
	Difficulty of calculation	No need for simulation	Need to handle simple simulation	Need to handle advanced simulation
Target time for preparation		By 2020 for all BPBDs	By 2025 for half BPBDs By 2030 for all BPBDs	By 20% for BPBDs with heavy-risk

Figure 7-11 Three Step for Sub-Index

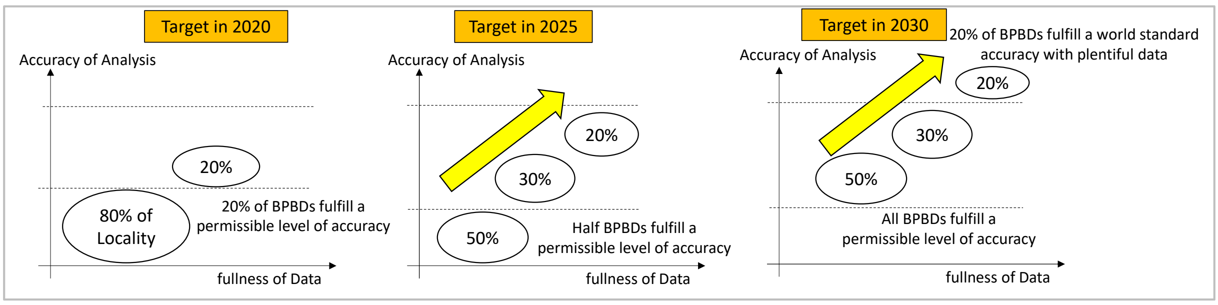


Figure 7-12 Annual Plan for the Sophistication of Analysis Method

7.2.2 Outline of Formulating Sub-index

The positioning of Sub-index constructed in this project is shown in Figure 7-13. The sub-index does not replace the existing RI but is proposed as a complement to the RI and a risk management agent in Indonesia. The existing RI is mainly constructed by BNPB and has already been positioned as the disaster prevention goal of the nation. Sub-index is not to replace the existing RI. It is thought that Sub-index is a tool for comprehensive risk management in Indonesia. The capacity of RI is evaluated by questionnaire of 71Indicators. As described in 7.1.2, the contents of the question of 71Indicators are focused on a non-structural countermeasures. Meanwhile, sub-index is set up as a tool to measure the achievement of quantitative evaluation of SFDRR based on scientific evidence by evaluating structural countermeasures.

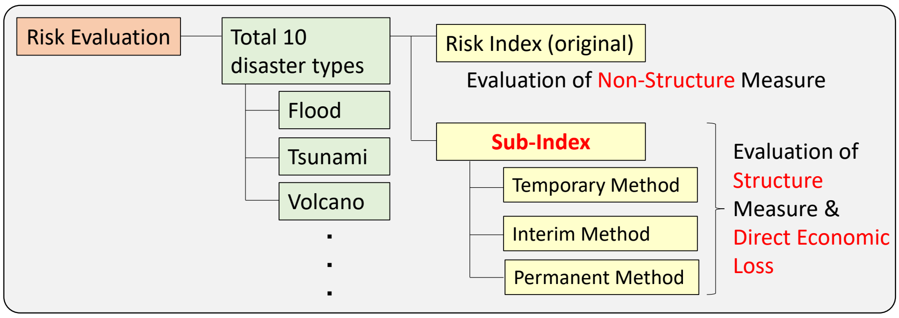


Figure 7-13 Position of Existing RI and Sub-index

7.3 Formulating Sub-index as a Case Study

In formulating sub-index throughout Indonesia, It is decided to conduct a case study in Manado City and Banda Aceh City as pilot areas. The following seven items were considered when selecting the pilot areas.

i. PUPR priority city
ii. Past large-scale disaster impacted areas / epoch-making land
iii. Maturity and enthusiasm of local organizations (BBWS, BPBD, etc.)
iv. Social and regional conditions (number of rivers and municipalities)
v. Risk Index score
vi. Data availability for sub-index construction

Among the natural disasters in Indonesia, the number of occurrences of floods is 171, from 1980 to 2017 [154] The economic loss caused by floods during the periodreached 6.7 billion US $. Earthquakes has the second largest number of occurrance frequency, 87 times during the same period. From the viewpoint of the frequency of occurrence and economic loss, it is judged that the flood be the target disaster type.

In addition, in the city of Banda Aceh, due to the large-scale damage caused by the 2004 tsunami, local organizations are highly interested in tsunami DRR. Therefore, tsunami is also targeted.

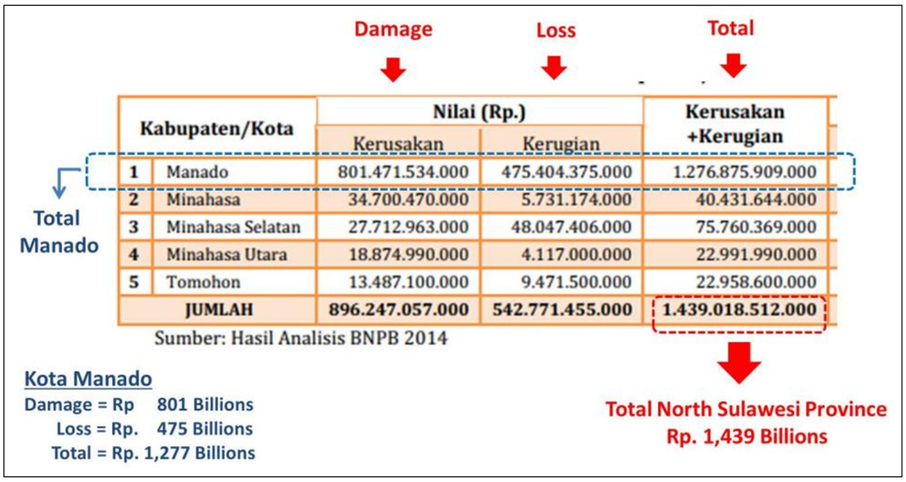
7.3.1 Manado City（Flood）

7.3.1.1 Temporary Method

In formulating sub-index in Temporary Method in Manado City, a field survey was conducted in this study. PDNA data created at the time of flooding in 2014 from BPBD Kota Manado (Figure 7-14) and an inundation area map prepared by field survey (Figure 7-15) was obtained. Therefore, in Manado City, Sub-index as Temporary Method was formulated from the actual value in 2014 flood as a case study incorperating actual disaster records.

[154] EM-DAT Disaster List http://www.emdat.be/disaster_list/index.html

According to PDNA, the damage amount of 1,276 billion IDR occurred in Manado City at the time of the flood in 2014. The inundation area map revealed that the flooding area reached 647 Ha.



	Kabupaten/Kota	Nilai (Rp.)		Kerusakan +Kerugian
		Kerusakan	Kerugian	
1	Manado	801.471.534.000	475.404.375.000	1.276.875.909.000
2	Minahasa	34.700.470.000	5.731.174.000	40.431.644.000
3	Minahasa Selatan	27.712.963.000	48.047.406.000	75.760.369.000
4	Minahasa Utara	18.874.990.000	4.117.000.000	22.991.990.000
5	Tomohon	13.487.100.000	9.471.500.000	22.958.600.000
	JUMLAH	896.247.057.000	542.771.455.000	1.439.018.512.000

Sumber: Hasil Analisis BNPB 2014

Figure 7-14 PDNA Conducted in 2014 Flood in Manado

Figure 7-15 Inundation area Map of 2014 Flood in Manado

The master plan has been made in UFCSI (Package-1)[155] in Manado city. Therefore, the master plan was referred regarding structural countermeasures. Although the MP targets 25-year probability rainfall, since the flood in 2014 was a scale exceeding the 25-year probability, it is necessary to convert the damage amount and flooded area of PDNA to MP scale. As a conversion method, as shown in Figure 7-16, the depth of flooding in 2014 at the outbreak of the Tondano River was compared with the height of the planned embankment height of MP at the same point, and the ratio between them was 1: 0.71.

155 Comprehensive Flood Management Study in Manado City and Tondano River Basin under Urban Flood Control System Improvement in Selected Cities (UFCSI)(Package-1), 2016

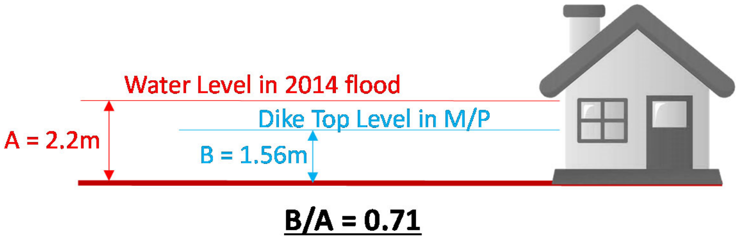


Figure 7-16 Comparison between the Actual Inundation Depth in 2014 and the Height of the Planned Embankment of MP

Based on the above, the calculation conditions of the Temporary Method in Manado City are summarized in Table 7-5.

Table 7-5 Calculation Conditions of Temporary Method in Manado City

Main Item	Temporary Method	Permanent Method
Target Flood	• Set the flood in 2014 (past largest flood) as the target.	Set the historical maximum floods etc. from analyzing sufficient past rainfall and flood data.
Inundation Area by Target Flood	• Inundation Area is set as 647 (ha) from past PDNA data	Calculated by Inundation analysis
Damage Amount by Target Flood	• Inundation Area is set as 1,277 (IDR Billion) from past PDNA data	Calculated by Inundation analysis and Damage Analysis
Plan of Structural Measures	• Assuming the structures in the Master Plan (M/P)* *Source: Comprehensive Flood Management Study in Manado City and Tondano River Basin under Urban Flood Control System Improvement in Selected Cities (UFCSI) (Package-1) 2016	Through each flood analysis and economic analysis, etc., an integrated flood control plan is formulated throughout the basin.
Outcome (Reduced inundation area and damage amount) by Structural Measures	• At first, Assuming the inundation area and damage amount at the M/P dike Level by using the ratio between the channel flow area at the flood in 2014 and that of M/P dike Level. (Refer to Figure.1) • Then, the damage at the M/P level is conversely regarded as the effect achieved by the M/P. <Assumed Outcome by M/P> Reduced Inundation Area: 459 (ha) Reduced Damage Amount: 907 (IDR Billion)	Outcome is confirmed by comparing the difference of inundation area and damage between by without project and by with project in inundation analysis.

The calculation results by Temporary Method in Manado City are shown in Table 7-6. As shown in the red frame, when the MP is completed, it is expected to reduce the inundation by 459 ha and the economic damage amount by 907 Billion IDR when 25-year probability rain occurs. On the other hand, if the maximum historical rainfall of 2014 scale occurs, even after the implemetation of the MP, the inundaed area risk of 188 ha and the economic damage risk of 370 Billion IDR would remain.

Table 7-6 Result of Temporary Method

Scale	Construction Program	Output (Improved Length)	Outcome by Master Plan		Remarks	Ratio
			Reduced Inundation Area	Reduced Damage Amount		
		(km)	(ha)	(IDR Billion)		
Target (Flood in 2014)	Current Situation (Base Line)	-	647	1,277	(A) by PDNA	100%
Master Plan Level	Total	27.1	459	907	(B) by Temporary Method	71%
		Remainings	188	370	=(A)-(B)	29%

7.3.1.2 Interim Method

In formulating the Interim Method in Manado City, the status of data was surveyed through interviews to BPBD, BWS, BMKG, and BAPPEDA. The result is shown in Table 7-7. The data situation in Manado City is insufficient with lack of observation stations for hourly rainfall data, the fact that water level observation stations aren't operating at large floods and that the topography data is not prepared. However, the Interim Method aims to conduct analysis by complementing data in the this situation. Data supplementing method is shown in Table 7-8. Rainfall data and topographic data can be supplemented by downloading from GSMaP[156] and USGS[157] respectively which are free databases on the Internet.

Table 7-7 Comparison Current Data Situation in Manado City and Ideal Data Situation for Analysis

Analysis	Data	Item	Ideal Data & Information for precise analysis	In Indonesia: Current situation of data Preparation in Manado	In Indonesia: Related Organizations
Rainfall Analysis, Rainfall Probability Analysis	Rainfall Data	Recommended Number of Stations and Frequency	・ **It is necessary to install observation stations (Hourly Data) so as to cover the whole river basin.** ・ For forecasting and EWS, Every 10 minutes is preferable	・**Hourly: 7 stations** (About 4 of them are newly installed in 2017 by BWS) **but they does not cover the whole river basin. Therefore, several stations are need to be installed to cover the basin.** ・Daily: 14 stations	BWS, BMKG
		Data Accumulation	・**Data as long as possible**	・**Hourly: 1 year (4 stations), 13 years (2 stations), 16 years (1 station)** ・Daily: About 7 to 16 years in each	
Runoff Analysis, Flood Scale Probability Analysis, Inundation Analysis,	River Water Level (WL) Data	Recommended Location of Stations and Frequency	・**Hourly Observation covering the whole river basin at** 1. Before and after a confluence point 2. Upstream/Downstream of weir, gate etc. 3. The location of discharge observation 4. The require location for WL such as location of reservoir, retention pond, estuary etc. ・ For forecasting and EWS, Every 10 minutes is preferable	・**Hourly: 4(5) stations** (4 stations are newly installed in 2017 by BWS. Before 2013 flood, One station observed hourly data for 1.5 year but it had broken at the 2013 flood and no longer used (New one is installed 1km from previous in 2017)) ・3 times per day: 15 stations	BWS, BMKG
		Data Accumulation	・**Data as long as possible**	・**Hourly: 1 year (4 stations), 1.5 year (1 station but no longer used)** ・3 times per day: About 4 to 20 years in each	
	Flow Velocity (Discharge)	Recommended Location of Stations and Frequency	・**Observation at** 1. Locations where the flow is calm, where changes in river channels and river beds are small, and where observations even in dry seacon can be also possible, etc. ・**Frequency** 1. During flooding time, to observe as much as possible including small and medium scale floods. Observe not only peaks but also during ascent and descent.	・**There is no data that can be used immediately. However, there is a possibility that it is observed temporary when a donor project etc. is implemented.**	BWS
		Data Accumulation	・**Data as long as possible**		
	Topographical data	River Channel	・Plan: 100m×100m is better ・Cross sections, Longititudinal：200m pitch is better	・**There are no series of data that can be used immediately. However, there is a possibility that it may be carried out partially by each construction or project basis.**	BWS, BIG
		River Basin	・ If surveyed, 100m×100m is better ・ If satelite image is used, 25m×25m is better	・**There is no data that can be used immediately.**	
	Land use		・**Detailed** Land use Map	・**Rough Land Use map**	BWS, BAPPEDA Forest & Enviroment
Damage Analysis, Direct Econoic Loss Evaluation	Asset Data		・House, Industry, Civil, Agriculture, etc.	・**There is no data that can be used immediately. However, there is a possibility that it can be used by making full use of related data.**	BWS, BPS, BAPPEDA
	Economical Data		・Each Unit Price for damage calculation, Deflator, etc.		
	Damage Ratio		・Damage Ratio by Inundation Depth	・**There is damage ratio by damage but no ratio by inundation depth.**	BWS, BPBD

Table 7-8 Supplement Method for missing part of data

Data	Method of Data Complement
Rainfall Data	Utilize satellite rainfall data after checking correlation with ground observation rainfall
River Water Level (WL) Data	Complement from flood marks etc.
Flow Velocity	If there is a moving image which shooted drifting object like driftwood at fixed direction and perpendicular direction to the river channel, the flow rate is estimated by image analysis.
Topographical Data of River Basin	Utilize satellite data (Global degital elevation data)
Land use	Land use is classified by aerial photograph interpretation.
Asset Data	To count the number of buildings by interpretation of aerial photographs, and to estimate each asset using past damage rate by PDNA, various official socio-economic data, their ratio and so on.
Economical Data	
Damage Ratio	Estimate the damage rate by inundation depth with the relationship between the past damage ratio and past inundation depth

As stated at the beginning of this section, the Interim Method aims to carry out hydraulic analysis while complementing the data. Here, an outline of the master plan with the target probability of 1/25, formulated based on the hydraulic analysis in the existing ODA loan is shown in Table 7- 9 and Figure 7- 17. The results

156 GSMaP (http://sharaku.eorc.jaxa.jp/GSMaP/index_j.htm)
157 USGS (https://earthexplorer.usgs.gov/)

of the 1/25 probability analysis are shown in Figure 7-18. The master plan also defines a priority project with 1/5 probability, and the flagged section in Figure 7-18 corresponds to that.

Table 7-9 Outline of Master Plan

River	Section	Length	Current Flow Capacity	Design Scale	River Area Width*1	River Width
Tondano	0.0-7.2k	7.2km	Less than Q5	Q25	33-112m	27-98m
Tikala	0.0-7.2k	6.9km*2	Less than Q2	Q25	61-73m	51m
Sario	0.1-5.3k	5.0km*2	Less than Q2	Q50	26-34m	20-28m
Malalayang	0.0-2.42k	2.4km	Less than Q5	Q50	31 - 34m	25-28m
Bailang	0.56-1.59k	1.0km	Q50(min Q2)	Q50	38 m	32m
Mahawu	0.0-4.6k	4.6km	Less than Q2	Q50	21 -23m	15-17m

Notes ; *1:River Area Width: River course + Inspection passage
*2: River Length : the Tikala River and the Sario River :after river normalization

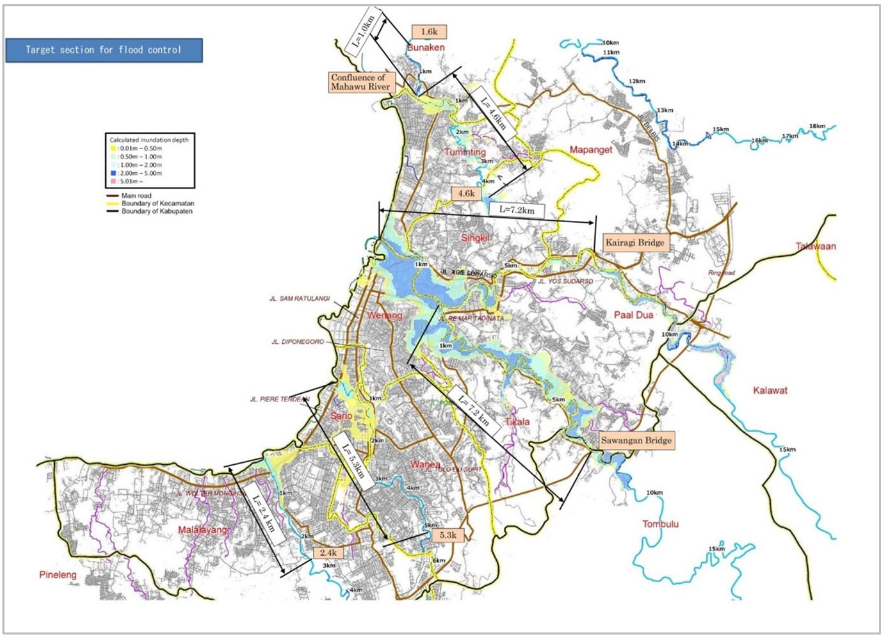


Figure 7-17 Outline of Master Plan

The results of the 1/25 probability inundation analysis are shown in Figure 7-18. In the same master plan, priority projects with 1/5 probability rainfall are also defined, which corresponds to the flatted section shown in Figure 7-18.

Table 7-10 shows the economic damage amount in case of implementing a priority project of 1/5 probability, implementing a master plan of 1/25 probability and not implementing any river improvement.
Without structural countermeasures, rainfall of 1/25 probability would cause economic damage of 1,145 IDR Billion, whereas if a priority project of 1/5 probability is implemented, the economic damage would be reduced to 485 IDR Billion. The economic damage wouldn't occur after the implementation of the master plan with 1/25 probability.

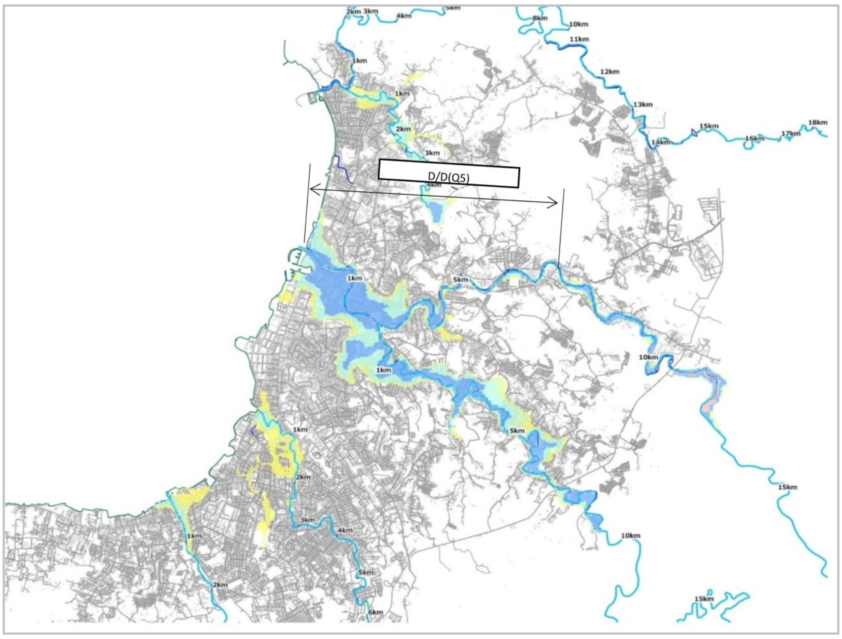


Figure 7-18 Result of Inundation Analysis（1/25 Possibility Rainfall）

However, in the event of a 50-year probability rain exceeding the largest flood in 2014, 235 IDR Billion's economic damage would occur even after the completion of the master plan, which means that the residual risk is about 17% (1,351.5 / 235.6 = 0.174) [158].

Table 7-10 Comparison of Economic Loss with/without Structure Countermeasures

With /Without	Case	Design Return Period of the Structure	Flood Occurrence probability Scale	Damage Amount (IDR Billion)	Remarks
Without Project	Base Line	—	2 year [1)]	345.7	Damage Amount by PDNA in 2014 is 1,277 (IDR Billion)
			5 year	596.6	
			10 year	823.1	
			25 year	1,145.3	
			50 year	1,351.5	
With Project	Priority Project (FS)	5 year	2 year	27.2	Flood might be occurred outside the priority project area. Therefore, damages still remains
			5 year	113.1	
			10 year	269.5	—
			25 year	485.0	
			50 year [2)]	699.7	
	Master Plan	25 year	2 year	0	—
			5 year	0	
			10 year	0	
			25 year	0	
			50 year [2)]	235.6	

[1)] Regarding Flood Occurrence Probability Scale, "2 year"means a flood with the scale, which has the possibility to occur once in 2

[2)] Supposing that structures aren't broken in case of a flood exceeding the designed scale.

158 The residual risk calculated by the Temporary Method in the previous item is 370 Billion IDR, and differences in calculation results occur due to differences in calculation methods.

7.3.1.3 Permanent Method

The Permanent Method is a method that is expected to be implemented in the future based on observation and accumulation of sufficient hydrological meteorological data, advanced analysis, etc., and will not be discussed in this study.

7.3.2 Banda Aceh City（Flood, Tsunami）

The Aceh River is a major river in the northern part of Sumatra Island with a total length of 145 km and a catchment area of 1,775 km^2. It flows into the Malacca Strait through Banda Aceh City. The river caused floods every year, with serious damage to the Special Region of Aceh (population: 1.65 million as of 1980) including the city of Banda Aceh. The damage caused by such floods was attributable to the lack of flow capacity of the Aceh River (250 m^3 / s) against the 5-year probability flood discharge of 1,300 m^3 / s. The floods that occurred in 1953, 1971, 1978, 1983 and 1986 caused considerable damage to the surrounding areas and resulted in deaths. Under these circumstances, the yen loan project has resulted in the construction of new river improvement and drainage channel (9.7km) along the 43km section from the mouth of Aceh River to Indlapari. The frequency of occurrence of floods has been significantly reduced.

7.3.2.1 Sub-Index（flood）

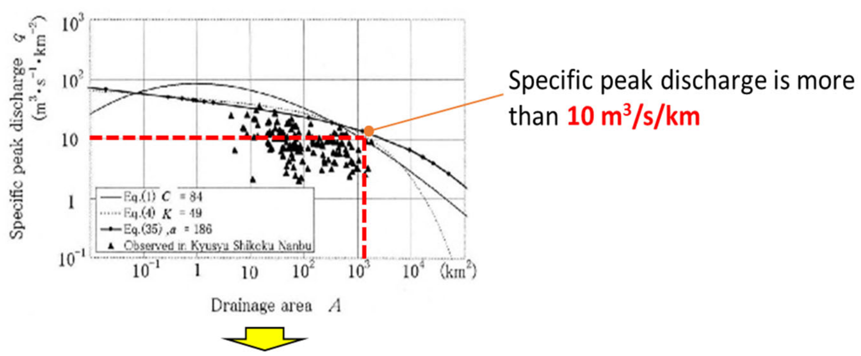
(1) Temporary Method

At the time when the above-mentioned ODA loan project was implemented, it was assumed that some hydraulic analysis was carried out using available data. However, the Sumatra earthquake that occurred in 2004 at the time of this survey and all reports / data were lost due to the tsunami. Hydraulic analysis based on hydrological / meteorological observation has not been possible.

The identical situation that the hydrological / meteorological observation and data accumulation are insufficient and therefore hydrological analysis based on the scientific information is not well performed, may prevail in Indonesia which has a vast land area and more than 7,900 rivers.

Under such circumstances, as a method to estimate flood hazard (flow) in Indonesia, the Creager's equation shown in the figure below has been adobpted in this report.

e.g.) Krueng Aceh (A=1,775km^2)



Peak discharge becomes 1,775 × 10 = **17,775 m^3/s**

Figure 7-19 Estimation of Flood Discharge by Creager 's Equation

As a result, the flood discharge rate was calculated to be 17,775 m^3 / s, but the interview result to BWS Sumatera1 suggests that the flow rate is much higher than 2,582 m^3 / s which corresponds to 1/1000 scale flood. Validity of the method is not confirmed. In order to improve this, it is necessary to analyze and arrange a standard specific flow rate according to the flood characteristics in Indonesia, and it is hoped that it will be organized in PUPR in the future.

(2) Interim Method

Interim Method is evaluated using RRI model. The RRI model is a method for rapidly predicting large-scale flooding in lowlands. It is a model that predicts the phenomenon that rain falls on rivers, floods flow down rivers, and water flowing in rivers overflows floodplains. It is also published on the ICHARM website and is available to everyone free of charge. The results of reproducing the flood control effect of the flood channel using the RRI model are shown in the figure. The flood channel is planned to divide 900 m^3 / s out of the 1,300 m^3 / s flood discharge of the Aceh River. The effect of the flood channel was simulated with the RRI model in the figure.

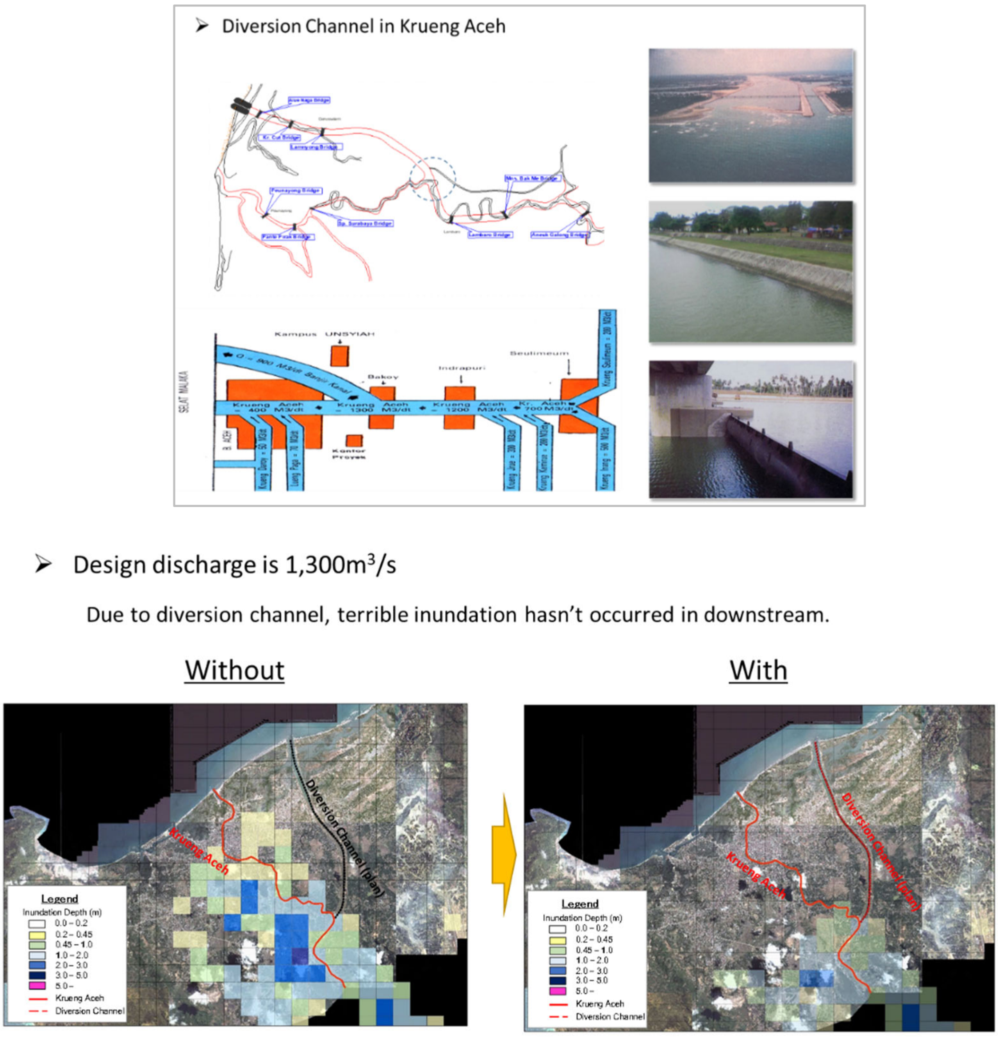


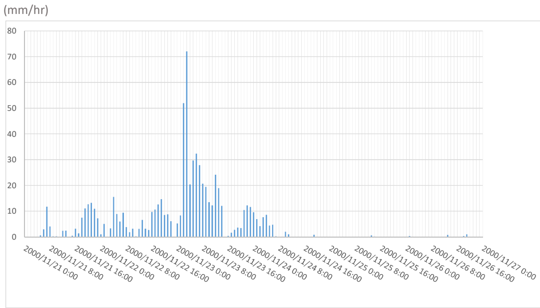
Figure 7-20 Reproduction of Aceh River Flood Channel Effect

Subsequently, the maximum flood phenomenon that occurred in recent years was analyzed. The analysis was targeted at the flood that occurred on November 23, 2000. Rainfall data were complemented by GSMap, and flood discharge was calculated by the RRI model. The flood is estimated to have a maximum discharge of 2,000 m^3 / s , equivelat to a 50-year flood, which is much larager than 1,300 m^3 / s (equivalent to a 5-year flood), which has been adopted for Aceh Rever's flow capacity. The floods in 2000 caused serious floods in Banda Aceh City and the surrounding area, with 5 deaths / casualties. The flood was so large that the project facility (dikes) could not accomodate the flood in the river channel. Some of the dikes and revetments have been damaged in a large scale.

➢ Rainfall data

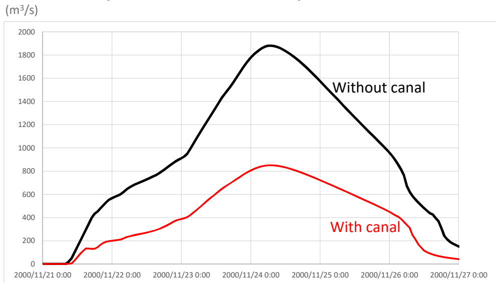
Hourly rainfall data is complemented from GSMaP.

Rain on November 23, 2000 is the biggest rain record after 2000.



Pos Curah Hujan Kp. Lheue

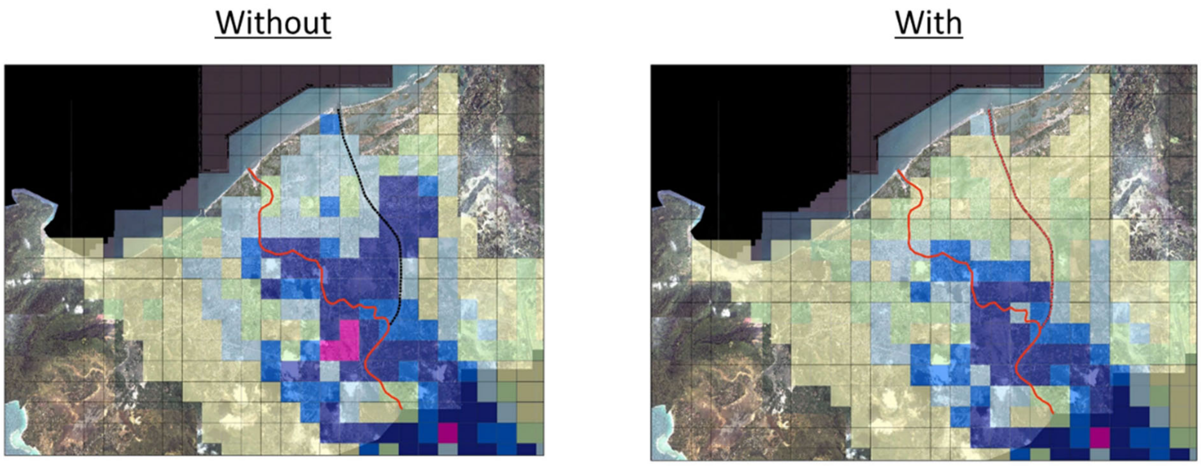
River discharge is calculated by RRI automatically



@ diversion point

Figure 7-21 Assumption of Flood Discharge in the November 2000 Flood

The following figures show the comparison of two cases regarding the flood: with and without a floodway. The effect of reducing the damage in number of houses was confirmed by 40% with the floodway.



Direct Economic Loss

		床下	床上				
浸水深		Less Than 0.45m	0.45m～0.49m	0.5m～0.99m	1m～1.99m	2m～2.99m	More than 3m
Damage coefficient		0.032	0.092	0.119	0.266	0.58	0.834
浸水家屋	House（without）	22,034	1,382	13,543	28,983	9,191	21,574
	House（with）	33,775	4,296	24,627	15,462	11,514	7,033
Economic loss	家屋数（without）	158,645	28,607	362,614	1,734,633	1,199,426	4,048,361
	(million IDR)						7,532,285
	家屋数（with）	243,180	88,927	659,388	925,401	1,502,577	1,319,742
	(million IDR)						4,739,215

40% reduction

Unit price for housing is 225 million IDR according to field survey

Figure 7-22 Runoff Effect and Damage Estimation in the November 2000 Flood

7.3.2.2 Sub-Index（Tsunami）

(1) Temporary Method

As a simple method, it is assumed that the inundation area is determined by leveling back the wave height of the tsunami based on the actual phenominan and the amount of damage in the inundation area is calculated. However, there is also the possibility of the flooded area being over-estimated due to the attenuation of the tsunami on land.

(2) Interim Method

Associate Professor H. Yanagisawa of Tohoku Gakuin University was reassigned to conduct a quantitative analysis on the risk assessment of the tsunami disaster in Banda Aceh city to evaluate the effect of structural measures and to calculate the amount of economic damage based on the tsunami simulation.

1) Consideration of assumed Tsunami

Figure 7-23 shows a calculation range for Tsunami simulation.

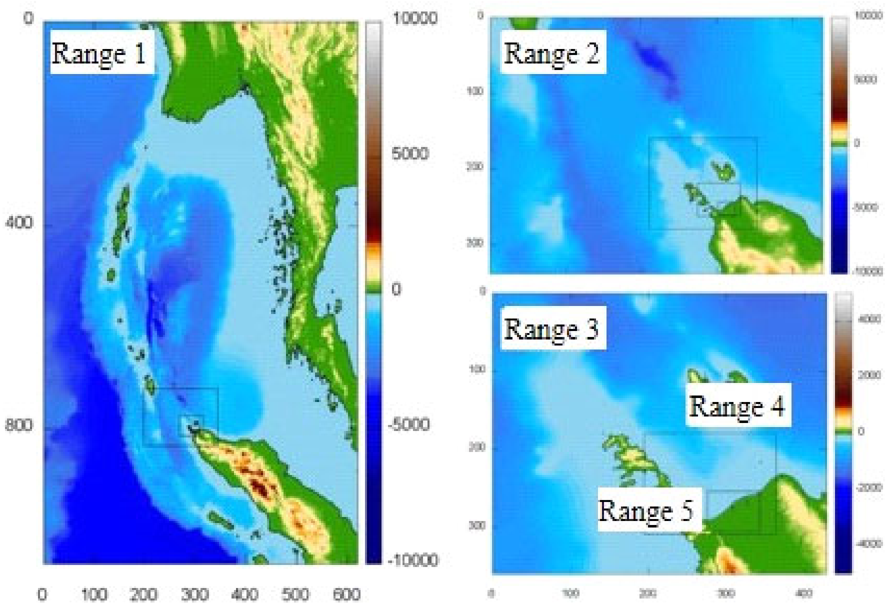


Figure 7-23 Calculation Range

Past tsunami events are analyzed based on the Tsunami Inundation Assumption Set-up Guide (p21) established by the Ministry of Land, Infrastructure, Transport and Tourism to make L2 and L1 tsunami assumptions (Figure 7-24). Using the simulation results for the past tsunami disaster, the relationship between the height of the tsunami obtained at the coast of Banda Aceh city (mesh position: X = 200, Y: = 230) and each historical occurrence is plotted in the figure. From this figure, it can be seen that the 2004 tsunami is the highest and the largest. Therefore, the 2004 tsunami should be L2 class. (L1 class is currently under consideration)

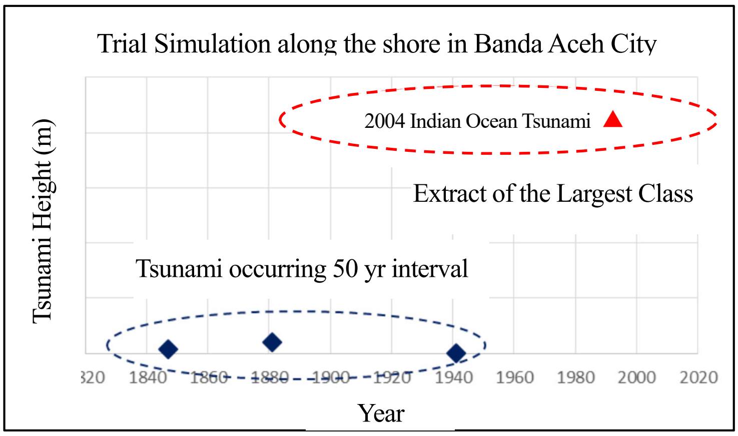


Figure 7-24 Comparison of Tsunami Height Occurred by Earthquakes around Banda Aceh City

2) The Effect of Structural Measures against Assumed Tsunami

The structural measure considered in this study is Ring Road planned by BAPPEDA Kota Banda Aceh in the Aceh Spatial Plan (Figure 7-25, Figure 7-26). Dr. Syamsidik belonging to Tsunami and Disaster Mitigation Research Center (TDMRC) was also involved in the plan concerning the study of the Ring Road. An interviews survey for him was conducted during this study. Regarding the embankment height of the Ring Road, since there was a comment in the interview, "It is set at 3 m in consideration of recuring potential in Aceh", the embankment height in the inland area is set as ground height + 3.0 m in the simulation.

However, since ground level of the wetland area along the cost shaply decreases, elevation of the top of the ring road was set at 5.5 m along the coastal area considering that the rubbing part with the inland part became gentle. (the inland site ground height is about 2.5 m)

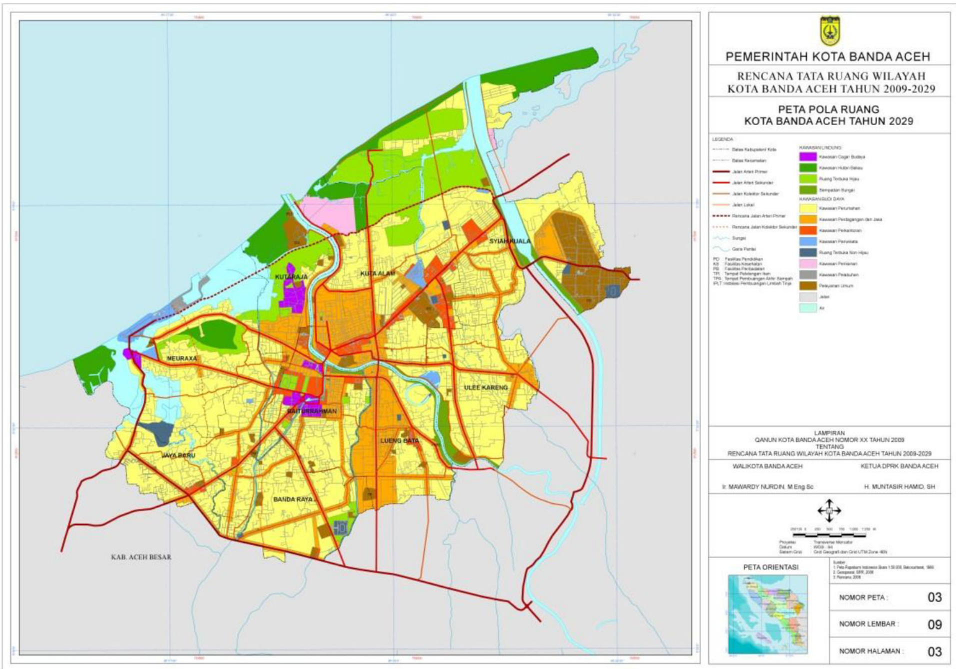


Figure 7-25 Ring Road Plan in Banda Aceh City

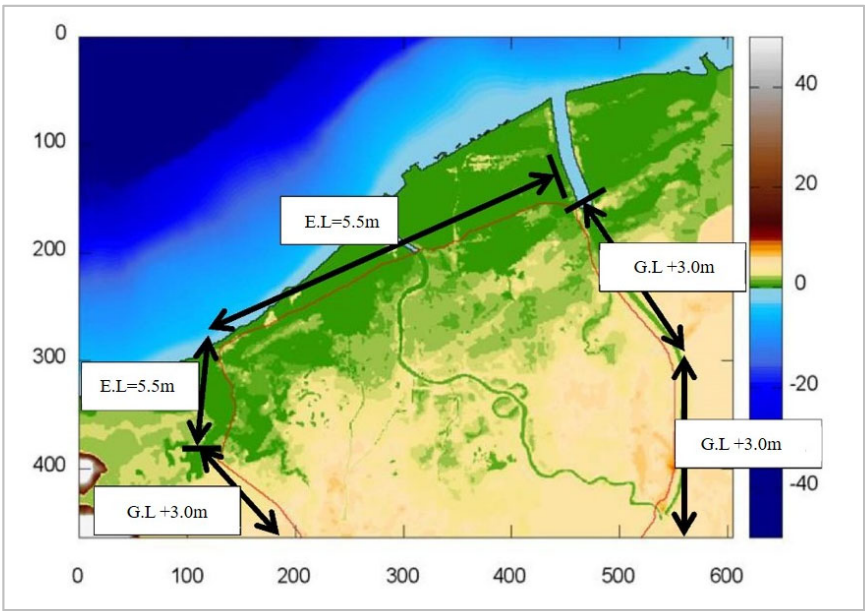


Figure 7-26 Topography and Ring Road (Redline)

3) Simulation Cases and Results

For the simulation cases, 3 simulation cases were conducted as shown in Table 7-11.

Table 7-11 Simulation Case

Tsunami Class	Structure Condition and Broken Term		
	Without Structure	With Structure (broken at the same with overflow)	With Structure (no broken even after overflow)
L2 Class	Case 1	Case 2	Case 3

Figure 7-27 to Figure 7-29 mentions the simulation result. The effects of the structural measures wouldn't be expected. There was no difference between without structure (Case 1) and with structure (Case 2). On the other hand, in case of structure (Case 3), the result indicates possibility of drastical attenuation of the tsunami height in the ring road. However, outside of the ring road, the reflected waves cause the tsunami height to increase. There is a danger that the damage would expand beyond the ring road

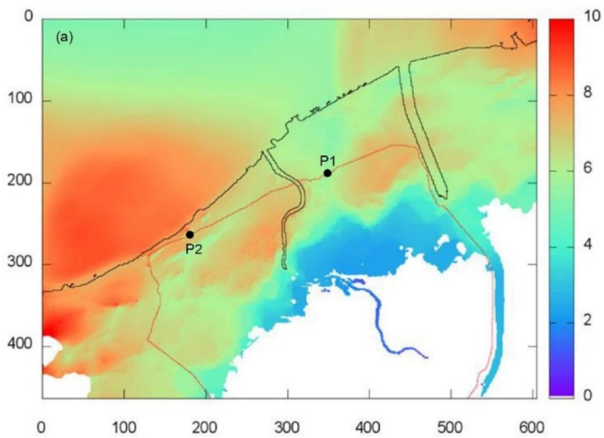


Figure 7-27 Case 1 （Without Structure）

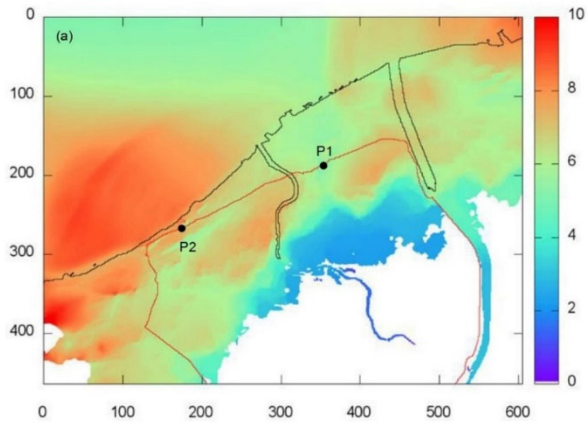


Figure 7-28 Case 2 （With Structure - broken at the same with overflow）

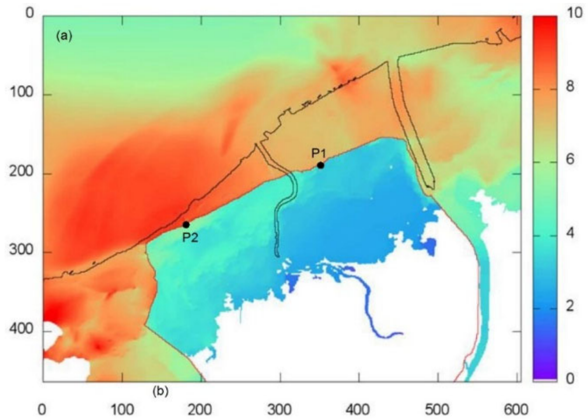


Figure 7-29 Case 3 （With Structure - no broken even after overflow）

4) Consideration of Direct Economic Loss

Economic loss on houses is calculated using current building data in Aceh City(Figure 7-30). A part of the southwest of Aceh city isn't included in the analysis area. Since it is a region which is not substantially flooded, it is excluded in this simulation. According to Koshimura et al(2009), building damage is noticeable if flooding depth is 2 to 3 m or more. In the case of 4m, 80% or more houses are flowed out. Therefore, in this study, the damage is calculated assuming that the building are flooded by more than 2 m in deapth. The reconstruction cost per unit is 2.5 million rupiahs (tentative).

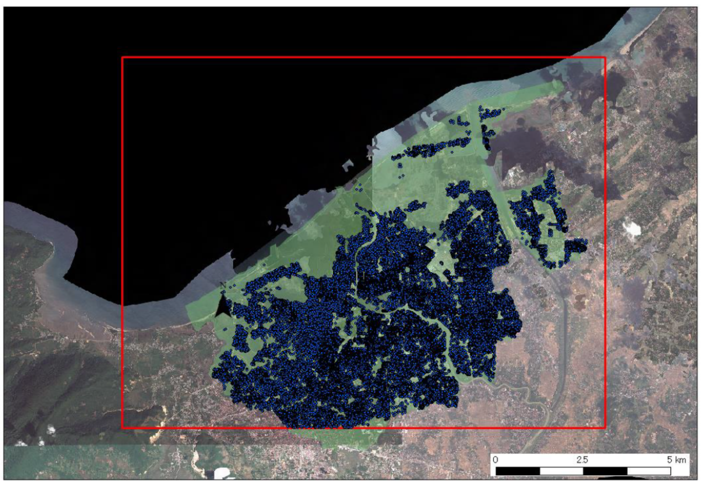


Figure 7-30 Building Point Data in Banda Aceh City (Greened Area)

The number of inundated buildings in each case (flooding depth> = 0 m) and the number of damaged buildings (flooding depth> 2 m) and the damage amounts calculated from the values are shown in Table 7-12. Comparison between Case 1 and Case 3 shows 10347 damaged buildings were reduced It was estimated that 35% of the economic damage would be alleviated by constructing the ring road that is not broken / breached.

Table 7-12 Simulation Result & Economic Loss

Simulation Case		Number of Inundated Houses (>=0m)	Nunmber of Damage Houses (>=2m)	Amount of House Damage (Billion IDR) (Number of Damage House × Unit Cost for Reconstruction)
L2	Case 1 Without Structure	40,360	29,308	7,327
	Case 2 With Structure (broken at the same with overflow)	40,135	29,050	7,263
	Case 3 With Structure (no broken even after overflow)	36,785	18,961	4,740

7.4 A Study on Indexing

In this section, an initial study of indexing will be conducted using the case study of Manado City (flood). This study is an initial study aimed at indexing, and does not define the concept nor method of indexing.

7.4.1 The basic concept of indexing

It is assumed that the basic idea of the initial study for indexing is as follows.

- In order to match with the Sendai Framework for Disaster Risk Reduction (economic damage), it is indexed (scored) based on the estimated damage amount and the appropriateness (roughness) of the actual damages.
- Given the case where accuracy is high (Permanent Method, Interim Method) and the case where it is low (Temporary Method), set score =80 by assuming the baseline which is an estimated damage amount calculated by Permanent Method and Interim Method
- The score is roughly divided into risk (Score = 80) which can be dealt with by structural measures (Level 1) and score (Score = 20) of residual risk * such as excessive flood (Level 2). (*, In order to make the residual risk, recognized even after maintenance.) For example, structural measures correspondence: 80%, residual risk correspondence: allocation of 20%
- The temporary method's roughness is considered to be a premium over the permanent method and the interim method, assuming a maximum premium of 10.
- For convenience, it is assumed that the evaluation method by the Permanent Method and the Interim Method is valid, and the roughness is zero.
- It is assumed that the final goal of the full-scale structural measures (Level 1) score is the maintenance of the master plan scale (1/25 (in the case of Manado)) and that the damage amount is zero, and that the baseline is the current damage amount.
- It is assumed that the final goal of residual risk (Level 2) is the response status of non-structural measures and structural measures (performance specification) targeting the expected maximum scale.
- The composition of the sub-index is as shown in the figure.

7.4.2 Method of Indexing

7.4.2.1 Permanent Method and Interim Method

In the case of Permanent Method and Interim Method, the amount of damage is calculated through analysis of flooding. Therefore, an index will be made targeting the average annual damage amount. The damage amount is calculated through flooding analysis.
Hereinafter, it is assumed that the basic idea in the indexing of the results by the Permanent Method and the Interim Method is as follows.

- It is assumed that the final goal is the implementation of the scale of a master plan (1/25, Level 1) that result in no damage, and the baseline is the current damage amount(Score = 80).
- It is assumed that if implementation progresses, the damage amount will decrease → the score will decrease.

The image of annual average damage and score (index) is as below figure.

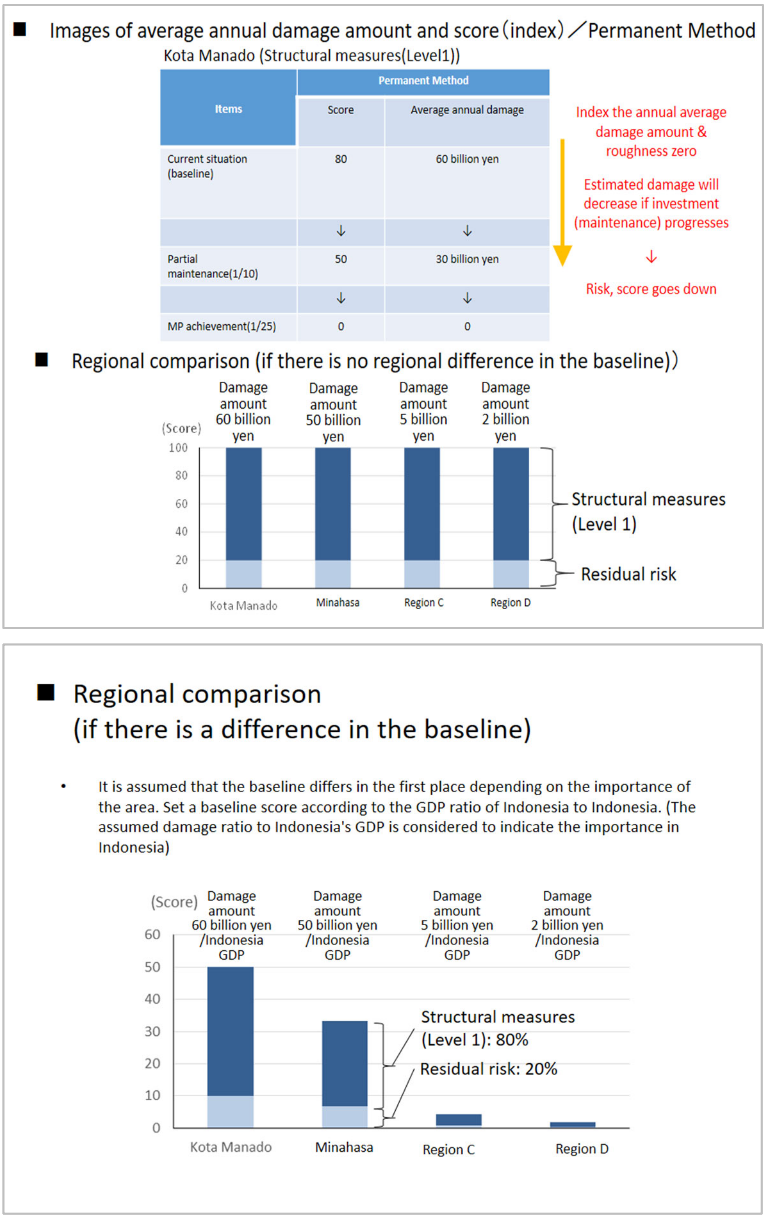


Figure 7-31 Average Annual Damage and Score

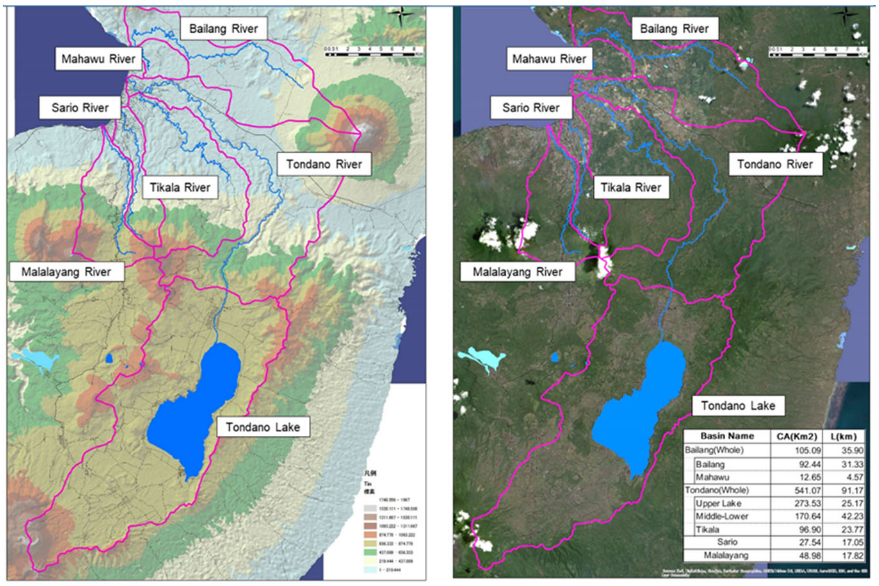


Figure 7-32 Manado City, Tondano River Basin

7.4.2.2 Temporary Method

The Temporary Method is based on a method that can be developed in Indonesia, and that enables horizontal development even when data, methods, etc. The assumed damage amount calculated by those methods is indexed (scored).

Hereinafter, it is assumed that the basic idea in the indexing of the result by the Temporary Method is as follows.

- As compared with Permanent Method and Interim Method, points with poor accuracy of Temporary Method (engineering / scientific) are added (added) as scores. (Assuming maximum added score = 10)
- The following examples are assumed as the point where the accuracy of the Temporary Method is poor (engineering and science).

Table 7-13 Poor accuracy of Temporary Method (engineering / scientific)

Item	Poor accuracy (engineering / scientific)
1. Not performing probabilistic statistical analysis	- Basically, it is necessary to calculate the damage amount for each probability scale and calculate the annual average damage amount, but it has not been done
2. The validity of the countermeasure facility scale is unclear	- Even if its implementation effect is sought, the validity of the scale of the facility, or its basis is unclear at all
3. The effect of implementation of the countermeasure facility is simplified and estimated (ha / km)	- Basically, it is necessary to evaluate its implementation effects through analysis of flooding. In addition, even if the maintenance effect is simplified and evaluated, it is not necessarily per unit dike extension. The evaluation unit differs depending on the gravel characteristics (diffusion, storage, flow-down type) and the

		maintenance content (building embankment, river channel widening/drilling, water reservoir development, dam, etc.).
4. The damage amount is assumed to be the reverse of the effect (\ / ha)	-	Basically, it is necessary to set some damage function, appropriate unit price, etc. and calculate the damage amount according to the inundation area and inundation depth.
5. Lack of hydrological observation data, topography data, etc.	-	The plan is originally based on the accumulation of hydrological observation data and scientific analysis and evidence using them, but there is no data at all.

- It is assumed that the evaluation score of Temporary Method is worse because the accuracy of Temporary Method is worse. It is assumed that the method of reflecting on the score is as follows.

a) Assuming that the current state is Step 0 (current state), the highest score is added, and the incremental increase is reduced each time the evaluation method is improved (Temporary, Interim, Permanent ...). – It is assumed that the division increment is zero when the method is the same as the Permanent Method and the Interim Method.

b) The increment is assumed not to offset the reduction of damage from the original effect (infrastructure development).

c) Since the causes of the above-mentioned deterioration of accuracy are not mutually dependent and are independent, it is assumed that the incremental increase is the addition method. The image of the incremental increase is as follows.

Table 7-14 Image of Extra due to Poor Accuracy

■ Reflecting on the score of "roughness"

Items	Temporary Method, Interim Method			Permanent Method
	Current situation	Step1	Step2	
①Probability calculation	+ 2.0	+ 1.0	+ 0.5	+ 0
②Facility scale	+ 2.0	+ 1.0	+ 0.5	+ 0
③Maintenance effect evaluation	+ 2.0	+ 1.0	+ 0.5	+ 0
④Damage calculation	+ 2.0	+ 1.0	+ 0.5	+ 0
⑤Hydrogeographic data, etc.	+ 2.0	+ 1.0	+ 0.5	+ 0
⑥、⑦、⑧···	···	···	···	···
Sub-Total	+ 10.0	+ 5.0	+ 2.5	+ 0

※ The addition condition of Step 1 to 3 may be different, but it is set uniformly to simplify the method.

例） In the case of ①=Step0, ②=Step1, ③=Step0, ④=Step0, ⑤=Step1
+ 2 + 1 + 2 + 2 + 1 = + 8 Increment (add) the score

- It is assumed that the score is reduced due to the progress of improvement or improvement of the estimated damage evaluation method.
- It is assumed that the score (risk) remains as it is, if the evaluation method remains as a simplified formula, even if the maintenance is completed.

7.4.2.3 Image of Indexing

The comparison image of the score of Permanent Method and Interim Method and Temporary Method is shown below. The assumed damage amount was assumed to be 60 billion yen for the Permanent Method / Interim Method, and 50 billion yen for the Temporary Method for convenience.

Items	Permanent Method		Temporary Method, Interim Method	
	Score	Estimated damage amount (Level1)	Score	Estimated damage amount (Level1)
Current situation	100	60 billion yen	100+max.10=110	50 billion yen
	↓	↓	↓	↓
MP completed(1/25)	20	0	20+6=26	0
	↓	—	↓	—
Dealing with residual risk	10	—	16	—

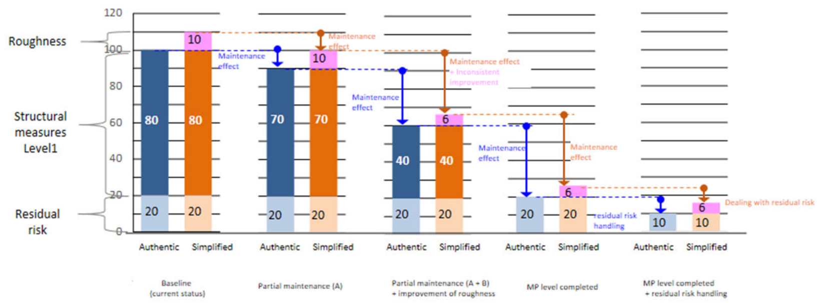


Figure 7-33 Score Comparison between Permanent Method and Interim Method and Temporary Method

7.5 Future Challenges for Subindex Construction

In this study regarding Manado and Aceh as case studies, the temporary method for assessment on hazard / structural countermeasure effect, initial examination of Interim method, and initial examination for indexing, were conducted.

7.5.1 Issues in hazard assessment and assessment of structural countermeasures

Even if there is no hydrological observation data or basic data, the Temporary Method can estimate the effects of hazards and structural measures from past disaster damage results, etc. If a subindex created by TemporaryMethod requires any analytical methods / accuracy / certain level of quality different from what are currently practiced in Indonesian, the method may be unrealistic and unacceptable for the Indonesian side.

Disaster characteristics vary by region. It is necessary to correct / study Indonesia's past disasters' information. In the Interim Method, information such as satellite data are used to supplement basic data. Hazard assesmet is conducted and effects of structural countermeasures are analyzed based on the scientific evidence. It is a method that can be applied if sufficient data and analytical capabilities are available.

However, these methods need to be studied and devised in various ways according to the target disaster types and areas. These are not easily developed equally all across Indonesia.

7.5.2 Issues in Indexing

The index is a relatively comparable figure, and to some extent, it only makes sense if there are multiple comparison targets. In this study, a case study was conducted as an initial study of a method to index the assumed damage calculated from the above-mentioned method as a case study. However, there are many issues to be solved, such as the idea of the validity of using the damage amount as a score, the score distribution for the effect, the concept of residual risk, dealing with the incremental increase when it is low accuracy, uniformization of evaluation in variously different countermeasure facilities and effect manifestation. Furthermore, horizontal development across the country is not easy. Because the damage amount is also affected by price increases, it is necessary to make it non-dimensional when evaluating it over the years. Furthermore, baseline scores may differ primarily due to regional disparities, regional importance, etc. In order to be indexed as an index that can be evaluated uniformly throughout the country, it is necessary to include academic experts, etc., and it is necessary to carry out thorough examinations and analysis and to conduct examinations while sufficiently discussing with not only BNPB but also government officials. Need to move forward.