CLIMATE RISK ASSESSMENT AND MANAGEMENT

I. Basic Project Information

1. Indonesia is highly prone to flooding. Flooding has indeed become a growing annual occurrence throughout the country imposing heavy losses to the economy. Besides the increasing intensity and frequency of flood events due to climate change, poor operation and maintenance (O&M) of inadequate and sometimes outdated water infrastructure, improper land use zoning, unsustainable land management, limited community awareness and preparedness, and weak institutional coordination are key factors compounding the problem.

2. In view of growing economic losses from floods, the Government of Indonesia (the Government) requested ADB for support on flood risk management. In response, ADB in consultation with the government and other stakeholders formulated a project focusing on a process-oriented flood risk management (FRM) approach that balances non-structural interventions such as institutional strengthening and capacity building, and structural works to mitigate the negative impacts of floods. The project will support the Government and floodplain communities in river basins located in the Cidanau-Ciujung-Cidurian (3 Cis) river basin territory (RBT), Banten Province, and in the Ambon-Seram RBT, Maluku Province to better manage and mitigate flood risks and reduce economic and social damages. A preliminary assessment using the AWARE risk screening tool showed that climate change risks are high for the 3 Cis RBT, and medium for Ambon- Seram RBT.

3. Project interventions will (i) enhance data and information, management and institutional coordination for managing floods; (ii) upgrade and develop flood protection infrastructure; (iii) reduce erosion and improve watershed conditions; and (iv) prepare communities to manage floods. The Project will provide relevant information, tools, policies, infrastructure, and capacity building to address climate change impacts.

II. Impacts of Climate Change in Indonesia and the Project Area

4. As an equatorial tropical region, the annual variation of surface temperature in different parts of Indonesia is not significant. However, rainfall is much varied both spatially and temporally. Analysis of past rainfall data from 300 stations, with varying length of records between 20 and 50 years, showed a significantly decreasing trend in December–January rainfall in parts of Java, Papua, and Sumatra and large part of Kalimantan islands, and a significant increasing trend in most of Java and Eastern Indonesia such as Bali, Nusa Tengara Barat (NTB) and Nusa Tengara Timur (NTT). For June - August rainfall, significantly decreasing trends were observed in most of Indonesia except in Pandeglang (West Java), Makasar (South Sulawesi), Manokwari, Sorong (Irian Jaya) and Maluku. The Indonesia Country Environment Note identified the following areas as at extremely high risk for flooding in 2010: Java, eastern Sumatera, western, southern and eastern Kalimantan, eastern Sulawesi and southern Papua.

5. The project area in the 3 Cis and Ambon-Seram RBTs are respectively affected by long-duration riverine floods and flash floods. In the 3 Cis RBT flooding occurs on a relatively flat floodplain along virtually the entire reach of the river reach to the sea. River conveyance has

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1 Banten province is the most western province of Java island and Maluku Province is a group of islands located in Eastern Indonesia.
2 AWARE Reports for (i) 3 Cis RBT, and (ii) Ambon- Seram RBT. 2015.
decreased in the 3 Cis RBT due to the high rate of erosion in the upper watersheds in which deforestation and unsustainable farming practices occur. The Ambon-Seram RBT is prone to flash floods caused by (i) torrential rain, (ii) contraction of the river section in many locations, and (iii) backwater due to tidal effects. Landslides frequently occur in the highly fragile mountain slopes that are deforested. As representative structural sub-project, the construction of dikes along an 11 km stretch of the Ciujung River located upstream of the toll road and downstream of the Pamayaran weir was selected as the core subproject.

6. IPCC projections for much of the Indonesian archipelago indicate only small changes in average annual and seasonal precipitation by the late 21st Century. However, rainfall variations among regions can be significant. Median projections from CMIP 5 model ensemble indicate increases in wet season (October–March) precipitation of between 0% and 10% by mid- (2046–2065) to late (2081–2100) 21st century, with some regions (south Nusa Tenggara) possibly experiencing decreasing precipitation of up to -10%. Analysis based on 14 General Circulation Models (GCMs), using IPCC SRES A2 scenario, showed that in 2025 the wet seasonal rainfall (DJF) will increase in Java, Bali, NTB, NTT and Papua, while in other parts will decrease. By 2050 and 2080, most of Indonesian regions will experience higher rainfall than current condition, with exception in northern part of Sumatra and Kalimantan. Furthermore, dry season rainfall in most parts of Java might decrease in 2025, increase again in 2050, and then decrease in 2080, particularly in West Java and South Sumatra. For example, the World Bank estimated projected increases in rainfall of around 2% to 3% coupled with a shorter and more intense rainy season and increasing risk of flooding. In addition, global mean sea level is projected to rise by between 28 and 70 cm by 2100, and when coupled with more intense storm surges and local land subsidence is likely to result in increased damage to coastal areas.

7. More significantly, the intensity of heavy rainfall during storms is likely to increase, by as much as 5% per °C. Changes in peak rainfall and/or sea level (as downstream control on river water levels) associated with climate change have been considered during the project preparatory technical assistance (PPTA) by the hydrologist responsible for analyzing historical rainfall and flood records, with a focus on changes occurring in the general areas of Jakarta and Banten Province. It has been concluded that some limited increases in heavy rainfall would lead to increases in peak floods, but that the magnitude of such changes would be much less than changes clearly associated with intensification of land use.

8. Projected increases in sea level associated with global climate change are subject to less uncertainty than changes in rainfall and rainfall intensity. Sea level rise will likely affect flooding patterns in the flat, low-lying coastal plains and estuary of the 3 Cis RBT and at the estuary of the rivers in the Ambon-Seram RBT.

9. The detailed climate risk and vulnerability (CRVA) study prepared by the Indonesian National Council on Climate Change (DNPI) in 2013 for Banten and West Java provinces concluded that (i) more extreme rainfall might occur and (ii) sea level might increase by 60 cm by 2050. The results of the CRVA in general confirm the PPTA findings. A more detailed CRVA will be prepared for both RBTs under RETA 7581: Supporting Investments in Water and Climate Change. The results of the CRVAs will support preparation of candidate sub-projects in this area.

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III. Climate Risk Management Response within the Project

10. The Project directly addresses one important category of climate-related disaster (flooding) and will improve the resilience of exposed communities. The Project encompasses adaptation to climate change in several respects. First, flood management measures reduce risks to life and economic assets even in the absence of climate change, but Project benefits increase if climate change results in more frequent and/or severe flooding. Second, the project utilizes a comprehensive risk management approach, and FRM plans will be prepared that encompass combinations of structural and non-structural measures. Non-structural measures, such as the development of flood risk maps will be undertaken to guide the location and design features of the structural flood risk reduction measures, and other non-structural measures such as improved community preparedness and enhanced early warning system will be implemented to manage the residual risk if the standard of protection provided by structural measures decline as a consequence of climate change. Third, the land use management, soil and water conservation measures incorporated within the project will counter many of the negative impacts of climate change within river basins by e.g., increasing floodwater infiltration and retention and reducing flood peak discharge. Finally, a safety margin (freeboard) will be built into the design of dikes and embankments that will provide a level of protection beyond the design event which will provide a buffer against future (and uncertain) increases in flood discharge over the design life of the structures.

11. During preparation of the FRM plan for the 3 Cis RBT, the impacts of projected sea level rise on the coastal plain, estuary and dependent livelihoods will be considered and appropriate mitigation or adaptation measures formulated. For the Ambon-Seram RBT, a CRVA is proposed to assess regional changes in precipitation and flooding in response to these changes. The study findings will be used in the design of structures identified in development of FRM plans. For the Ciujung core the design of the 11 km of dikes took into account a potential increase in flood discharge due to climate change, and flood simulation modeling confirmed that the freeboard is sufficient to provide flood protection in the event of such climate-induced variations\(^7\). The investment in infrastructure will be complemented by non-structural interventions.

12. In summary, the project has not only considered and allowed for the possible implications of climate change, but is supporting a package of overall other structural and non-structural interventions that will increasingly be able to respond to actual and predicted climate changes.

\(^7\) Specifically, the simulations assumed that the 20-year design rainfall event became a 1 in 15 year event due to climate change impacts, equivalent to a 6.3% increase in Ciujung Basin and 7.2% increase in Batu Merah Basin relative to the 15-year rainfall event estimated from historical data.
<table>
<thead>
<tr>
<th>Season/Period</th>
<th>Variable (quartile)</th>
<th>2016-2035</th>
<th>2046-2065</th>
<th>2081-2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>December-Feb</td>
<td>Temp 25%</td>
<td></td>
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<tr>
<td>December-Feb</td>
<td>Temp 50%</td>
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<tr>
<td>December-Feb</td>
<td>Temp 75%</td>
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<tr>
<td>June - August</td>
<td>Temp 25%</td>
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<tr>
<td>June - August</td>
<td>Temp 50%</td>
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<tr>
<td>June - August</td>
<td>Temp 75%</td>
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</tr>
<tr>
<td>October – March</td>
<td>Precip 25%</td>
<td>0% to -10% (a)</td>
<td>0% to -10% (c)</td>
<td>0% to -10% (c)</td>
</tr>
<tr>
<td>October – March</td>
<td>Precip 50%</td>
<td>0% to +10% (b)</td>
<td>0% to +10%</td>
<td>0% to +10%</td>
</tr>
<tr>
<td>October March</td>
<td>Precip 75%</td>
<td>0% to +10%</td>
<td>0% to +10%</td>
<td>0% to +10% (d)</td>
</tr>
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<td>April – September</td>
<td>Precip 25%</td>
<td>0% to -10%</td>
<td>0% to -20% (f)</td>
<td>0% to -20% (f)</td>
</tr>
<tr>
<td>April – September</td>
<td>Precip 50%</td>
<td>0% to -10% (e)</td>
<td>0% to +10% (g)</td>
<td>0% to +10% (g)</td>
</tr>
<tr>
<td>April - September</td>
<td>Precip 75%</td>
<td>0% to +10%</td>
<td>0% to +10%</td>
<td>0% to +10% (h)</td>
</tr>
</tbody>
</table>

Comments:
(a) except Irian Jaya, 0% to +10%
(b) except Java: 0% to -10%
(c) except Irian Jaya ad Central Kalimantan, 0% to +10%
(d) except Irian Jaya, much of Kalimantan and Sumatera, +10% to +20%
(e) except central and northern Sumatera, Kalimantan and Irian Jaya, 0% to +10%
(f) except some locations in northern Sumatera, Kalimantan and Irian, 0% to +10%
(g) except Java, Bali, Nusa Tenggara and southern Sulawesi, 0% to -10%
(h) except for much of Irian Jaya and Kalimantan