Chapter 8

Enhancing Climate-Resilient Infrastructure Development in Indonesia

Fauziah Zen
Wempi Saputra

Zen, Fauziah and W. Saputra (2023), 'Enhancing Climate-Resilient Infrastructure Development in Indonesia', in Indrawati, S.M., T.Anas, C.F.Ananda and F. Zen (eds.), *Infrastructure for Inclusive Economic Development Vol.1: Lessons Learnt from Indonesia.* Jakarta: ERIA and Ministry of Finance, pp. 193- 215.

Indonesia faces significant climate-change risks, which have led to disasters, numerous fatalities, and significant economic losses. To address these threats, Indonesia has pledged to reduce its greenhouse gas (GHG) emissions by 29% from business-as-usual levels by 2030 under an unconditional mitigation scenario and by 41% under a conditional mitigation scenario. To achieve these goals, Indonesia has focussed on two sectors that contribute the most to GHG emissions: land-use change and forestry (LUCF) and energy. Due to a lack of resources, funding initiatives to meet GHG reduction targets is difficult, but the government has mobilised various financial resources, including public–private partnerships (PPPs), private financing, charitable foundations, and development partners. To develop climate-resilient infrastructure, Indonesia can establish appropriate incentives for key stakeholders, expand the financial market through regional and global cooperation, and integrate climate considerations into sub-national infrastructure. This requires comprehensive technical guidance and capacity development, emphasising critical sectors like transport, energy, and LUCF.

1. Background

Climate change is a part of global development challenges; if unmanaged, it will exacerbate confluent shocks, creating further obstacles to ending poverty and inequality. Climate change has been making a devastating impact – especially on vulnerable and less-prepared countries (World Bank and ADB, 2021). Governments are trying to balance the need to expedite development with that to become climate resilient. Studies have shown that infrastructure plays an essential role in building resilience to climate-change impacts (OECD, 2018).

In terms of economic performance, Indonesia has been managing robust economic growth over the past 2 decades, setting an ambitious target in *Rencana Pembangunan Jangka Menengah Nasional* (*National Mid-Term Development Plan*, RPJMN), 2020–2024. Recent data from Statistics Indonesia (2023) show that gross domestic product (GDP) grew by 5.3% in 2022, exceeding the forecast of 5.2%. Further, strong growth was contributed by domestic consumption (2.6% of the total growth) and robust commodity-driven exports (0.8% of the total growth). Lifted COVID-19 pandemic mobility restrictions, potential pent-up demand, rising public investment, a revival in tourism, rapid digitalisation, and lower inflation have been supporting the country's robust economic growth. Moreover, Indonesia has also relatively low debt per GDP – 39.9% at the end of 2022.[1] Growth rates are projected to stabilise at around 5% until 2027 contingent on effective reform implementation, COVID-19 control, and global headwinds.

[1] IMF, General Government Gross Debt, https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/IDN?zoom=IDN&highlight=IDN (accessed 31 August 2023)

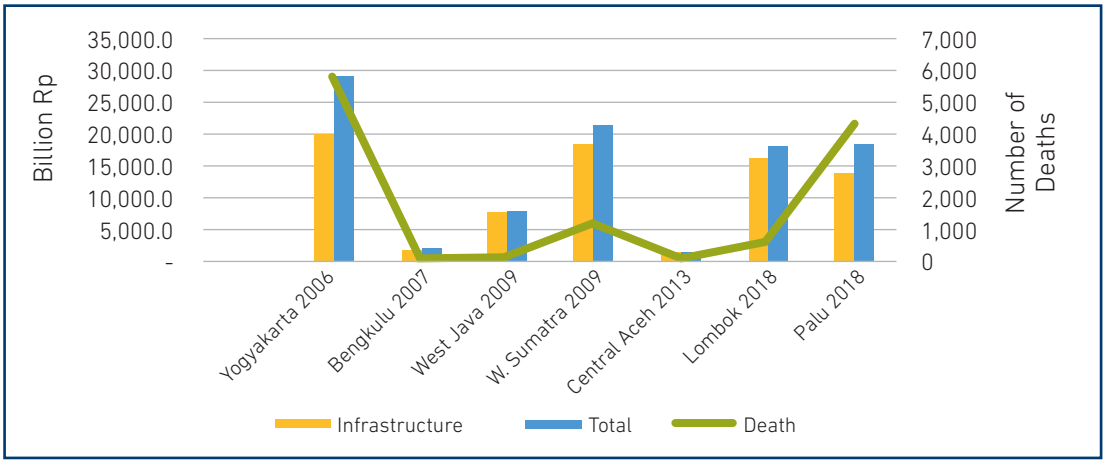
Based on this background, this chapter analyses climate risk considerations in infrastructure development in Indonesia. Guidelines are proposed for climate-resilient infrastructure and developing climate risk considerations in project preparation. Financing is also explored, focussing on the roles of public–private partnership (PPP) and blended financing schemes in developing climate-resilient infrastructure. This issue requires a multidisciplinary approach, which considers the interplay amongst climate risk, infrastructure development, and low-carbon development. By understanding and adopting a comprehensive approach, policymakers can help build infrastructure that is resilient to climate change while promoting sustainable economic growth and social development.

2. Climate Risk in Indonesia

2.1. Exposure and Risks

Indonesia is very vulnerable to climate change impacts, as it is ranked in the top one-third of countries in terms of climate risks, particularly all types of flooding and extreme heat.[2] Climate change-associated disasters have frequently occurred, leaving many social and ecological impacts. Some notable disasters were due to earthquakes, which have caused a significant number of deaths and infrastructure damage over the past 2 decades (Figure 8.1).

Figure 8.1. Economic Losses and Deaths due to Earthquakes in Indonesia, 2006–2018



Source: Pribadi et al. (2021).

[2] Climate risks in Indonesia have been comprehensively analysed for a country risk profile towards climate change. This effort is jointly managed by the World Bank and Asian Development Bank. See World Bank and ADB (2021).

Other examples of climate change-related disasters have occurred on several islands in Indonesia, such as prolonged flooding due to extreme rainfall (Kalimantan), intensive forest and land fires (Sumatra), sea-level rise on the north coast (Java), and failure of food crops in across provinces (MEF, 2023).

Moreover, Indonesia is very vulnerable to natural hazards, including tsunamis, earthquakes, epidemics, floods, cyclones, and droughts.[3] Despite this high exposure to natural hazards, Indonesia ranks moderately in terms of its coping capacity and vulnerability (Table 8.1).

Table 8.1. Selected Country Risk Profiles towards Climate Change

	Selected Country								
	Indonesia	India	China	Thailand	Malaysia	Mexico	South Africa	Brazil	Philippines
Dimension									
Hazardous exposure	Natural (droughts, cyclones, earthquakes, floods, tsunamis, epidemics) Human (projected conflict risks, current highly violent conflict intensity)								
Natural	7.7	7.7	7.5	6.1	4.9	6.8	5.1	4.0	8.4
Human	5.3	7.0	0.8	5.0	0.4	7.0	8.0	7.0	7.0
Vulnerability	Socio-economic (aid dependency, development and deprivation, inequality) Vulnerable groups (uprooted people, other vulnerable groups)								
Socio-economic	3.2	4.6	2.6	2.1	1.8	3.3	4.2	3.3	3.8
Vulnerable groups	3.3	4.9	3.3	3.8	4.1	5.1	6.4	4.3	4.9
Lack of coping capacity	Institutional (governance, disaster risk reduction) Infrastructure (physical infrastructure, access to health care, communications)								
Institutional	4.3	3.5	3.6	5.1	3.4	5.6	4.5	5.2	4.7
Infrastructure	4.4	4.8	3.0	2.5	2.6	3.0	3.4	3.2	3.4
Overall rank (InformRisk)	**48 (medium)**	**31 (high)**	**87 (medium)**	**75 (medium)**	**119 (low)**	**35 (high)**	**31 (high)**	**55 (medium)**	**34 (high)**

Source: EC, DKMKC, Country Risk Profile, https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

The goal of climate-resilient infrastructure is to lessen the risk of climate-related disruptions. The severity of the risks is determined by the combination of changing climate hazards with exposure (i.e. asset location) and vulnerability (i.e. propensity to be adversely affected) (Agard et al., 2014). To reduce risks, infrastructure should be in low-risk locations, and the design and construction of facilities should fulfil the technical capacity to deal with potential catastrophic threats. Infrastructure development should evaluate the effects on risks elsewhere, such as flood risks from increased paved surfaces.

[3] EC, DKMKC, Country Risk Profile, https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

Badan Perencanaan Pembangunan Nasional (Ministry of National Development Planning, BAPPENAS) (2021) estimated that Indonesia will suffer a loss of approximately Rp544 trillion during 2020–2024 from climate-change effects without adaptation efforts (Table 8.2). It also demonstrated that spontaneous adaptation measures – relating to sector-specific adaptation initiatives – can reduce the losses up to Rp95.7 trillion or 15%. If planned climate-resilience development initiatives are implemented, the losses could be reduced to Rp58.3 trillion or almost 50%.

Table 8.2. Economic Losses due to Disasters in Indonesia, 2020–2024
(Rp trillion)

Sector	2020	2021	2022	2023	2024
Ocean and coastal	81.3	81.4	81.6	81.7	81.8
Water	3.8	4.7	5.6	6.5	7.3
Agriculture	11.2	13.4	15.6	17.8	19.9
Health	6.0	6.2	6.3	6.4	6.5
Total	**102.4**	**105.7**	**109.0**	**112.3**	**115.5**

Source: BAPPENAS (2021).

2.2. Climate Risk Considerations in Infrastructure Development

Efforts to respond to climate change can be divided into two categories: adaptation and mitigation. Adaptation refers to efforts to adjust to current or anticipated future climate circumstances, reduce negative impacts, and capitalise on potential advantages. Mitigation refers to efforts to slow the rate of climate change, such as by reducing carbon emissions. Mitigation also tries to reduce the impact of human intervention on the climate system.[4]

Creating climate-resilient infrastructure aims to reduce vulnerability to climatic change and unpredictability, limiting their detrimental effects. The net benefit of adaptation is harm reduction at the expense of climate resilience. As additional upfront expenses for more resilient assets become necessary, the costs associated with adaptation grow more complex. However, additional expenses for enhancing resilience are projected to account for only 3% of total investment needs (Hallegatte, Rentschler, Rozenberg, 2019). In addition, these costs may be offset by reduced spending on upkeep and repairs.

[4] www.eea.europa.eu/help/faq/what-is-the-difference-between (accessed on August 20, 2023)

The types of infrastructure adaptation can be divided into two groups (EUFIWACC, 2016):

(i) **Structural adaptation measures**. This first type distinguishes climate-resilient infrastructure from ordinary infrastructure by changing its structure (e.g. changing the composition of road surfaces so that they do not warp in high temperatures).

(ii) **Management adaptation measures**. This type of adaptation does not require any structural changes to the infrastructure being built. The difference is in the way it is managed (e.g. enhancing the monitoring of existing infrastructure to reduce the risk of failure as climate conditions change).

While structural adaptation measures may be costly due to increased technological adoption, management adaptation measures may be less costly while offering protection and safety. Climate-resilient infrastructure management may be adopted earlier and more efficiently as long as core climate-adjustment infrastructure is constructed. In infrastructure construction and operation, the economic advantages of technology that enhances analytical functionality, data management, connection, and automation are substantial. The same is true for management adaptability.

In its nationally determined contribution (Enhanced NDC), Indonesia aims to reduce greenhouse gas (GHG) emissions from business-as-usual (BAU) levels by 2030, with an unconditional target of 31.89% and a conditional target (i.e. with international assistance) of up to 43.20% . Indonesia considered four types of mitigation measures as part of its efforts to meet its NDC: fuel switching, clean coal technology, renewable energy, and energy-efficiency measures (Table 8.3). Under the unconditional and conditional targets, 11% or 14%, respectively, of all GHG emissions are attributable to the energy industry. Land-use change and forestry (LUCF) are responsible for 24% and 28%, respectively, under the unconditional and conditional targets of all GHG emissions (MEF, 2021). Indonesia's mitigation efforts are therefore focussed on LUCF and energy to have a substantial impact on lowering GHG emissions

Table 8.3. Mitigation Technology Needs of Indonesia's Energy Sector

Sub-sector	Technology
Transport	Improvement of public transport, compressed natural gas, intelligent transport system
Power Generation	Photovoltaic and pump storage, geothermal power plant, advanced coal power plant, landfill gas power plant, biomass-fuelled power plant, wind power, biofuel, biogas palm oil mill effluent
Industry	Efficient electric motors, combined heat and power, pump and fan system, waste heat boiler, alternative fuel, green boiler, green chiller, advanced furnace
Buildings (Residential and Commercial)	Combined heat and power, waste heat boiler, efficient lighting, green building, green boiler, green chiller, efficient electric motors, gas pipeline network, solar photovoltaic

Source: MEF (2021).

So far, there are few climate-adaptive projects listed on the *Proyek Strategis Nasional* (PSN). One, however, is the construction of green energy-producing facilities in South Sumatra, West Java, and Central Java. The Hydropower Mentarang Induk Project, located in North Kalimantan Province and operated jointly by Indonesia and Malaysia, and the Karian Water Supply Project, which reduces reliance on groundwater extraction as a supply of domestic and industrial water and mitigates land subsidence in the Jakarta suburbs, are others.

Table 8.4 outlines infrastructure projects around the globe that have incorporated climate considerations. Various climate issues are considered, such as protecting communities from potential disasters, enhancing current climate phenomena, transforming black infrastructure into green, and meeting human needs through climate-friendly compliance. Depending on the objectives and circumstances, technology options are also diverse.

Table 8.4. Climate-Resilience Considerations in Selected Infrastructure Projects

No.	Sub-sector	Technology
1	Australia (Eyre Peninsula Project)	High-voltage electricity transmission project **Climate-resilience focus**: Address climate impacts, including increasingly frequent inundation of coastal infrastructure. Adapt to increasing risk, participatory decision-making with management involvement and structural measures was developed, involving community surveys, engaging with many fora across the Eyre Peninsula.
2.	Japan (Japanese Railway)	Railway project **Climate-resilience focus:** Maintain maximum performance temperature of railroads from 60°C to 65°C, and achieve no accidents due to track buckling. **Major risk:** Extreme heat. Standards for estimated maximum performance have been raised, and a plan for maintenance vehicles that detect potential joint openings has been developed.
3	Hong Kong, China (Sponge City)	Modern stormwater management project **Climate-resilience focus:** Implement a nature-based drainage system to build up flood resilience and improve public spaces instead of constructing flood-resistant infrastructure. **Major risk:** Tropical cyclones and severe rainfall.
4	United States (Hurricane Sandy Rebuilding Strategy)	Hurricane recovery project **Climate-resilience focus:** Build back smarter and stronger infrastructure by aligning federal funding with local rebuilding visions; reduce excessive regulation; coordinate efforts of federal, state, and local governments, with a region-wide approach to rebuilding; and ensure the region's climate-change and disaster-resilient rebuilding. **Major risk:** Storms and sea-level rise.
5.	South Africa (Komati Coal-Fired Power Plant)	Decommission and repurpose a coal-fired power plant using renewables and batteries. **Climate-resilience focus:** Manage the social challenges of the transition by partnering with the government, civil society, and unions to create economic opportunities for affected workers and communities. **Major risks:** Consistency of energy policy, stranded assets, and societal impacts.

No.	Sub-sector	Technology
6.	Indonesia (Karian Water Supply)	Water supply project **Climate-resilience focus:** Provide reliable access to safe drinking water, reduce reliance on groundwater extraction as a source of domestic and industrial water, and mitigate land subsidence in one of the world's fastest-sinking cities.

Sources: OECD (2014, 2018); World Bank (2022b, 2023); South Australia Government, Eyre Peninsula Link, https://www.rdaep.org.au/eyre-peninsula-link/; Government of Hong Kong, Drainage Services Department Sponge City: Adapting to Climate Change, https://www.dsd.gov.hk/Documents/SustainabilityReports/1617/en/sponge_city.html; and IFC, Karian Water Supply Project, IFC Project Information and Data Portal, https://disclosures.ifc.org/project-detail/SII/44588/karian-water-supply-project

3. Requirements for Developing Climate-Resilient Infrastructure

3.1. Policy and Institutional Setting

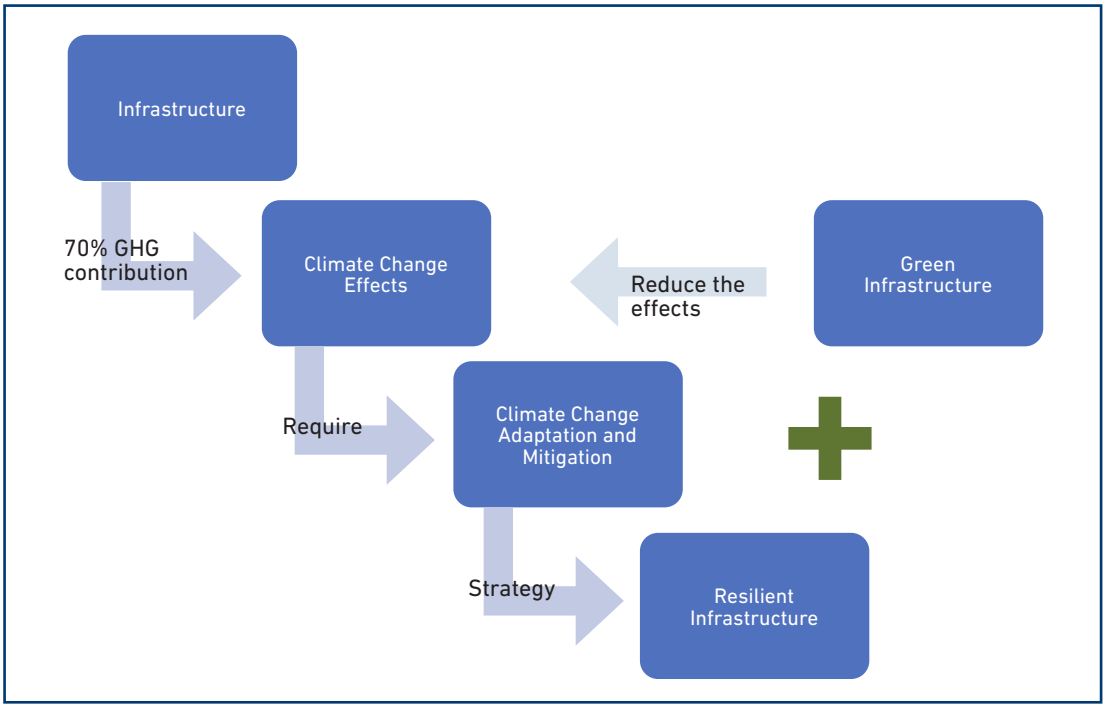
Disasters and the COVID-19 pandemic have demonstrated the fragility of global ecosystems. Resilient and sustainable infrastructure – climate-resilient infrastructure – is thus vital for mitigating impacts and supporting adaptation. Climate-resilient infrastructure is infrastructure that anticipates, prepares for, and adapts to changing climate conditions (OECD, 2018). It is also expected to withstand, adapt to, and recover rapidly from disruptions caused by climate change.

Climate-resilient infrastructure begins with the definition of objectives, targets, suitable technology, budget, system strategies, and execution. While most climate-resilient infrastructure may necessitate more expensive construction techniques, others – such as the re-naturalisation of riverbeds and banks to minimise erosion and to restore biodiversity – may not (NWRM, 2013).

Infrastructure accounts for more than 79% of global GHG emissions (Thacker et al., 2021). Therefore, not just climate-resilient infrastructure – but also green infrastructure – is required to lessen its environmental impact (Figure 8.2). Green infrastructure is a network of (semi-) natural areas that are protected and enhanced to deliver ecosystem services while also benefiting biodiversity and society more widely (EC, 2020). Examples include mangroves, wetlands, oyster reefs, and sand dunes; permeable pavement and driveways; green roofs; forests and parks; and natural areas incorporated into city designs. Such interventions can be deployed at different scales, such as at a site (e.g. green facades or roofs on a building), city-wide (e.g. parks), or landscape (e.g. green hubs and corridors).[4]

[4] Green infrastructure is not discussed in detail in this chapter, as it is not yet included in infrastructure projects in Indonesia. This issue is, however, noted, as it increases the positive impacts of climate-resilient infrastructure through structural and management adaptation measures.

Figure 8.2. Interaction between Infrastructure and Climate Change



GHG = greenhouse gas.

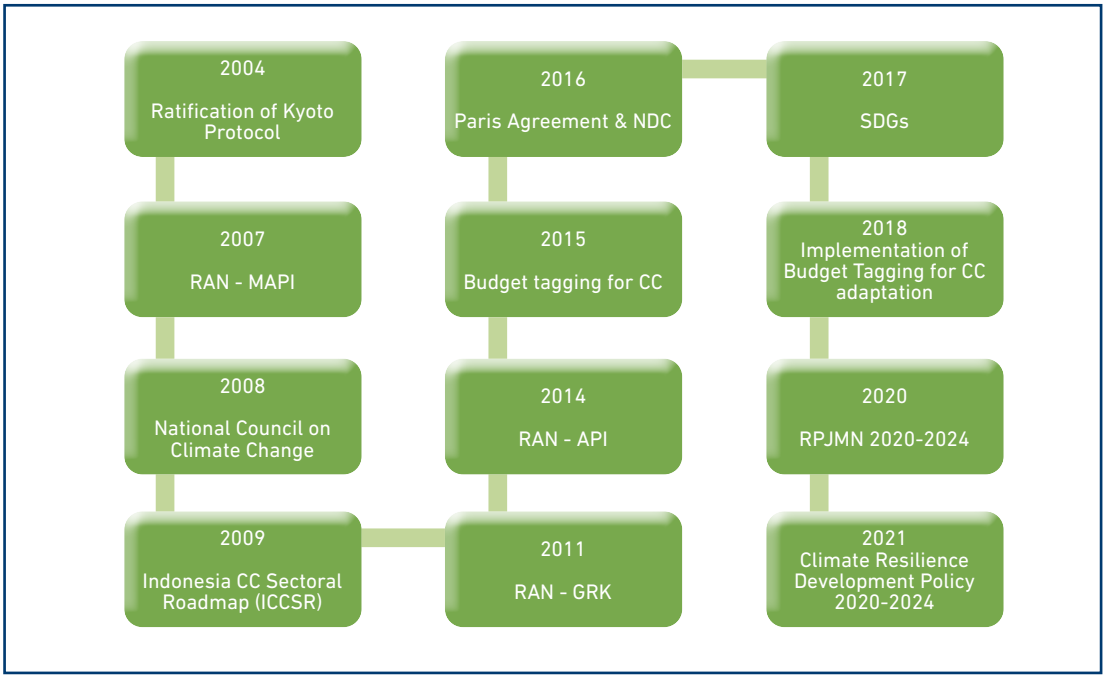
Source: Authors.

Considering that 96% of cases have a cost–benefit ratio larger than 1, 77% have a cost–benefit ratio larger than 2, and 25% have a cost–benefit ratio greater than 6, strengthening infrastructure assets susceptible to disasters is beneficial (Hallegatte, Rentschler, Rozenberg, 2019). When infrastructure is robust as well as environmentally friendly, fewer GHG emissions must be accounted for, reducing environmental expenses. However, transforming these benefits into real project finance is challenging. Obstacles include the quantification of these intangible benefits and the different domains of costs and benefits. Although communities reap the benefits of investments, investors still bear the costs. These 'unrealised benefits' for investors and mismatched cost–benefit implications must be addressed to demonstrate the significance of green and resilient infrastructure.

3.2. Financing

Indonesia has established national-level guidance for climate-change adaptation, which includes climate-resilient infrastructure development (Figure 8.3). Important guidance includes the 2014 *Rencana Aksi National – Perubahan Iklim* (*National Action Plan for Climate Change Adaption*, RAN-API); 2012 *Rencana Aksi Nasional Mitigasi dan Adaptasi Perubahan Iklim* (*National Action Plan for Climate Change Mitigation and Adaptation*, RAN-MAPI); *Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca* (*National Action Plan for Greenhouse Gas Emission Reduction*, RAN-GRK); one of the priorities of RPJMN, 2020–2024, and the *Climate Resilience Development Policy*, 2020–2045 prepared by BAPPENAS. RAN-MAPI directs the Ministry of Public Works and Housing to develop infrastructure, including roads, bridges, and water and sewerage systems throughout Indonesia.

Figure 8.3. Regulatory Milestones for Climate-Resilient Infrastructure in Indonesia



CC = climate change, NDC = nationally determined contribution, RAN-API = *National Action Plan for Climate Change Adaption*, RAN-GRK = *National Action Plan for Greenhouse Gas Emission Reduction*, RAN-MAPI = *National Action Plan for Climate Change Mitigation and Adaptation*, SDG = Sustainable Development Goal.

Source: Authors.

Additional guidance is the *Kebijakan dan Strategi Penanggulangan Bencana* (*Policy and Strategy for Disaster Management*, JAKSTRA PB), a reference for disaster management from 2015 to 2019, prepared based on the RPJMN; Rencana *Nasional Penanggulangan Bencana* (*National Action Plan for Disaster Management*, RENAS PB); and the Sendai Framework.

The funds required to meet Indonesia's emissions reduction objective is roughly Rp4,002 trillion (MEF, 2021); this is equivalent to roughly 20% of Indonesia's GDP in 2022 or 130% of its State Budget in 2022. The allocation is mostly consumed by the energy and transport sectors. To track such financing, the Ministry of Finance created climate budget tags. The environment budget was Rp126.4 trillion in 2018, Rp83.5 trillion in 2019, and Rp77.8 trillion in 2020, always falling short of the annual finance requirement of about Rp300.0 trillion.

Table 8.5. Estimated Financing to Achieve the Nationally Determined Contribution Target in 2030

Sector	Policies and Programmes	Financing Needs (Rp trillion)
Forest and land use	Forest conservation and protection programme, forest fire prevention	307
Energy and transport	Construction of renewable energy power plants, clean technology investments	3,500
Agriculture	Low-emission rice varieties, improving irrigation, biogas use, and feed additives	7
Industrial processes and product use	Mostly for cement and steel industries	925
Waste	Solid and liquid waste management at household and industrial levels	185
Total		4,002

CO_2 = carbon dioxide.

Note: Based on the business-as-usual scenario.

Source: MEF (2021).

Most of the funding has historically come from the public sector. Foreign financial assistance was negligible (Table 8.6). During 2017–2019, only $16.15 million (0.4%) of the $3.7 billion (composed of $3.16 billion in loans and $0.58 billion in grants) pledged by development partners was realised, a significant decrease from the previous period (2015–2016), which totalled $1.8 billion and consisted primarily of concessional loans from bilateral sources such as Japan International Cooperation Agency (48.0%), Asian Development Bank (22.0%), Government of Germany (12.0%), and Government of France (6.7%) (MEF, 2018).

Table 8.6. Financial Support Received for Climate Mitigation Actions, 2017–2019
($ million)

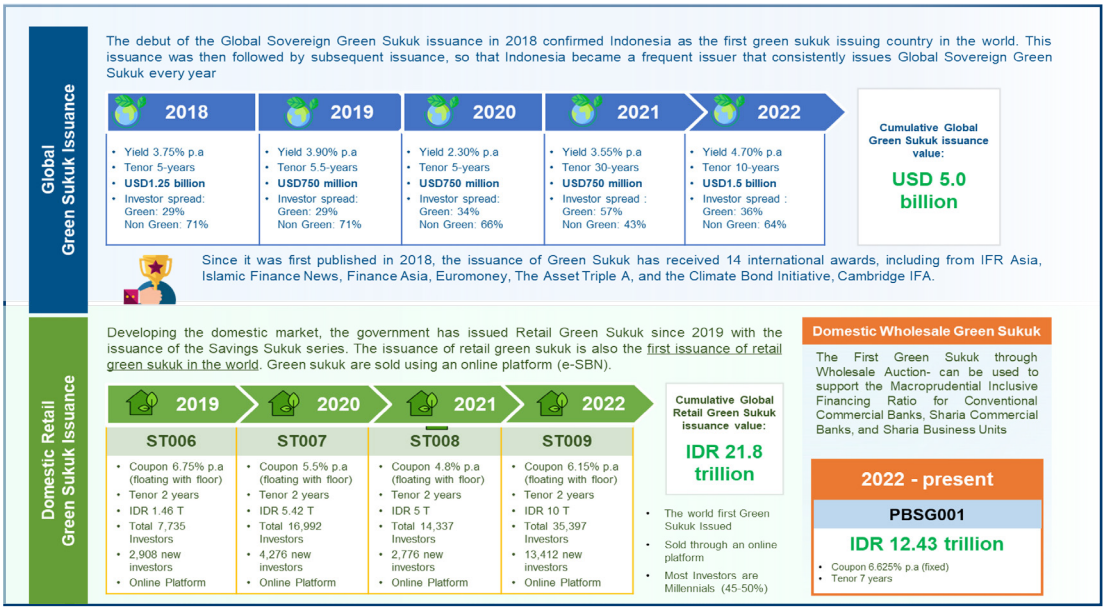
Financial Instrument	Sector	Bilateral	Multilateral	Total Received	Total Agreement
Concessional Loan	Energy				1,482.21
	Transport				1,528.56
	Waste				147.80
Sub-total					3,158.57
Grant	Agriculture				
	Multisector	2.40	10.88	13.27	395.62
	Energy				35.06
	Forestry		2.88	2.88	137.15
	Transport				1.3
	Waste				4.13
Sub-total		2.40	13.75	16.15	573.26
Total		**2.40**	**13.75**	**16.15**	**3,731.83**

Note: Total received based on funding track by Ministry of Environment and Forests.
Source: MEF (2021).

To finance climate-adaptive infrastructure, Indonesia also issued green *sukuk*, part of sustainable bonds issued by the government. In March 2018, the government issued its first global green *sukuk*,[5] which amounted to $1.25 billion (MOF, 2020). This offering was 2.5 times oversubscribed. Subsequently, Indonesia issued other green *sukuk*, dominated by the government as the issuer. It issued both global (US dollar-denominated) and domestic retail (rupiah-denominated) green *sukuk* (Figure 8.4).

[5] *Sukuk* is an equity or asset-based instrument that complies with Sharia.

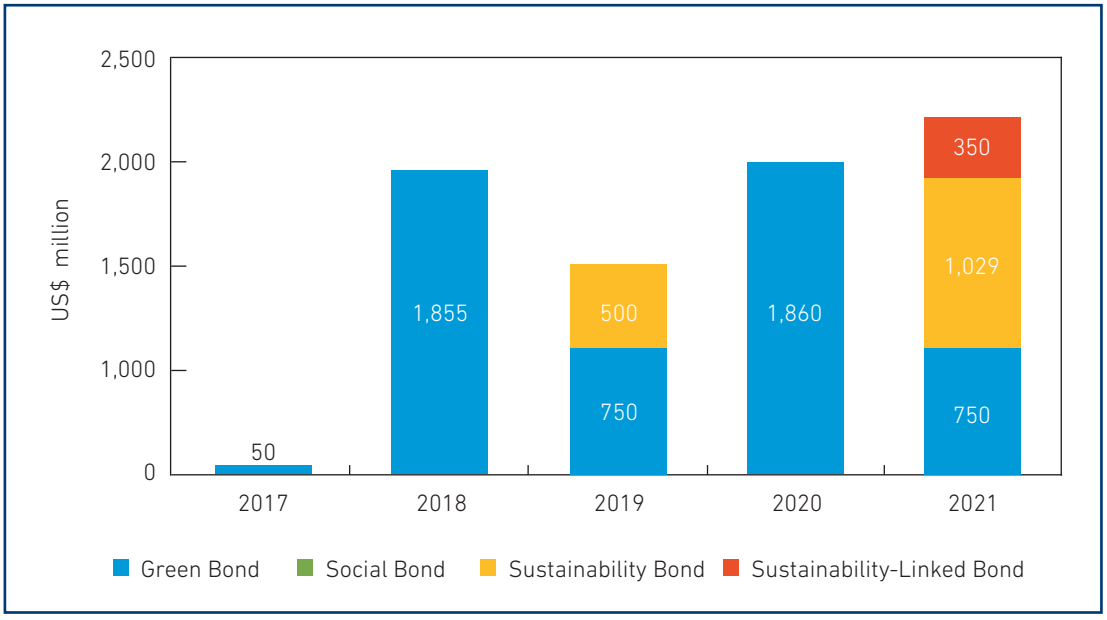
Figure 8.4. Sovereign Green *Sukuk* Issued by the Government of Indonesia, 2018–2022



Source: MOF (2022).

Besides the government, other issuers contributed green bonds. The government owned $3.1 billion out of the total $5.0 billion in green bonds outstanding by the end of 2020. Meanwhile, green bonds continue to dominate sustainable bonds in Indonesia (Figure 8.5).

Figure 8.5. Annual Issuance of Sustainable Bonds in Indonesia, 2017–2021



Note: All data as of 26 July 2022.
Source: ADB (2022).

Indonesia is the second-largest issuer of green bonds in the Association of Southeast Asian Nations (ASEAN) region after Singapore, with $6,417 million outstanding as of March 2023. There are nonetheless only four issuers in Indonesia: the government, PT Sarana Multi Infrastruktur (PT SMI), Star Energy Geothermal, and TLFF I. Meanwhile, Malaysia has 13 green bond issuers, and the Philippines has 8. The small number of issuers in Indonesia may indicate a lack of interest from stakeholders on both the supply and demand sides or that the issuing of green bonds in Indonesia faces obstacles.

The lack of funding incentives for the green industry for financial services is the primary barrier. Additionally, extra methods are necessary to evaluate whether a sector has the foundation for the green sector. In the meantime, the verification process incurs additional expenses for the payment of the independent verifier's fee to examine a sector's eligibility for sustainable finance. As a country with a developing but immature financial industry, Indonesia has great capacity for growth but lacks several supplementary instruments as enablers. One of these is insurance involvement to decrease the financial exposure of high-risk populations to disasters to participate in long-term climate-resilient investment and to provide incentives. Cooperation with other nations, particularly those in East Asia, can strengthen the national and regional markets.

3.3. Role of Public–Private Partnerships and Blended Finance

There are four categories of infrastructure finance sources: public (taxes and loans), private, development partners, and charitable organisations. Since infrastructure is owned by the government – and the government has a solid justification for building infrastructure – the most common source of funding is the public sector. Yet most infrastructure projects necessitate enormous investments, and the limited State Budget must meet a variety of spending requirements. Competition amongst programmes and policies in the State Budget is intense, and some politicians may want to avoid infrastructure spending that necessitates multiyear budgeting and whose operational phases will not be completed before the next election cycle.

There are usually one or more market failures present with infrastructure as well, making it challenging to rely solely on private investment. For example, public roads are non-excludable goods, which means that the operator cannot prevent people from using them for free. Water, electricity, schools, and general hospitals also contain some market failures because, in developing economies, they are used to address inequality and poverty. Government action is therefore required, and PPPs can be used to achieve this. Furthermore, PPPs provide the advantage of utilising private sector technology and innovation.

PPPs have been evolving; recently, because of the pandemic and various disasters, they have shifted their emphasis from value for money to a more ecologically friendly strategy. Despite this, efforts are fragmented and intermittent due to the terrain's complexity – particularly variable costs, estimates, standards and conformity, and technology – and disparities in government capacities. Fortunately, global collaboration is underway to investigate methods for incorporating resilience, sustainability, and adaptation themes into PPPs. In conjunction with the World Bank and other multi-lateral development banks, the Global Center on Adaption has made significant efforts to develop best practices for the sustainability, mitigation, and adaptation of PPPs. It produced *The Climate-Resilient Infrastructure Officer Handbook*, a knowledge module on PPPs for climate-resilient infrastructure, as a cooperative technical study in September 2021.

Infrastructure resilience requires PPPs that incorporate strategic innovation and new intelligent technology. Despite intense efforts to construct a PPP framework in developing economies such as that of Indonesia, project implementation has stalled. Public financing is often between 2% and 10% of GDP, whereas that for PPPs is typically less than 1% of GDP. Key variables impacting the adoption of PPP include consistent policy, public sector capability to handle PPPs appropriately, public sector commitment to developing cooperative relationships with private partners, and leadership (Zen et al., 2019).

PPPs in Indonesia are discussed in further depth in Chapter 6, including policy formulation, scale, plans, and responsibilities in the country's infrastructure development. It illustrates that procuring land and coordinating and harmonising the activity of all public parties (particularly governmental organisations) continue to be significant PPP issues. Because there are over 500 autonomous municipalities in 34 provinces in Indonesia, it is not surprising that sub-national governments have various capacities and interests towards infrastructure development and employing PPPs.

Four areas must be improved to promote more private involvement in infrastructure development (APEC Policy Support Unit, 2019). First, bureaucratic and regulatory effectiveness must be improved. The government's lack of understanding of PPPs should be remedied by fostering capacity-building initiatives, particularly in value for money. The second is to strengthen government assistance and facilities by instituting hybrid or blended financing. The third objective is to enhance the efficacy of land acquisition support and techniques. Fourth, PPP contracts must be strengthened to withstand unanticipated risks resulting from political and regulatory shifts.

The promotion of PPPs for climate-resilient infrastructure necessitates certain conditions. First, there should be a clear allocation of climate risks between the public and private sectors. This facilitates estimations and anticipation, including the duties of each contributing party if necessary. Second, all parties must concur on the norms and methodology for risk assessment. Although the government has published general guidelines for risk assessment, an independent assessor may be required. Third, there may be risk variances at different phases of project execution, such as during the construction phase against the operational phase, or the mitigation versus the respond versus the recovery management phases. Consequently, different responses to the same risk may come from various parties. These situations should be managed correctly.

3.4. Fiscal Capacity

PPPs require a significant commitment from the public sector. Even if most investment is provided by private partners, the public roles – in selecting projects; preparing, directing, and managing the entire process; as well as providing fiscal and non-fiscal support – need significant public sector resources. The scope of financial help varies from project to project, however. Highly commercial projects – such as telecommunications for densely populated areas, large airports, and heavily travelled toll roads – may require minimal government funding. In contrast, projects with a significant proportion of public goods may need substantial financial backing. Indonesia provides a variety of government guarantees and direct fiscal assistance to enhance the creditworthiness of such projects and to maintain their functionality. The supplied fiscal supports include guarantees; the Project Development Facility (PDF) to prepare the project; tax incentives; viable gap funding (VGF) to reduce construction costs borne by the special purpose vehicle; and availability payments, in which the government pays instalments to the special purpose vehicle during operation.

Additionally, the facilitation of the entire process – including the preparation of business cases for possible PPP projects – consumes public resources. The PPP procedure is intricate and lengthy; therefore, it is not advisable for the government to pursue many PPP projects without thoroughly preparing for and anticipating fiscal implications.

Currently, the government has a narrow fiscal space[6] for non-mandatory spending, including infrastructure. Many sub-national governments are also experiencing this. The fiscal sufficiency indices for all sub-national governments have been reviewed by the Audit Board of the Republic of Indonesia in its yearly audit report of the central government's financial statements (BPK, 2020; 2021). One of the issues is the significant disparities in fiscal adequacy amongst areas; more than 90% of municipalities are fiscally insufficient, while just eight provinces and two cities (for fiscal years 2018 and 2019) are fiscally sufficient. Just one city is classified as being highly sufficient.

3.5. Institutional Arrangements

Institutional procedures for BAU PPPs are already complex, requiring authorised line ministries, BAPPENAS, Ministry of Finance, and sub-national governments (if the government contracting agency is a local government) to define, approve, implement, and monitor the project. Adopting sustainable and resilient concepts in PPP projects may provide additional challenges, but the initial obstacles will be more formidable. In the future, adaptation of sustainable and resilient ideas will be a necessary and critical element. Incorporating the ideas of climate-change mitigation and adaptation into infrastructure projects involving PPPs must be codified. Indonesia has recently established and reinvigorated the *Komite Percepatan Penyediaan Infrastruktur Prioritas* (Committee for the Acceleration of Priority Infrastructure, KPPIP) to intervene in coordination issues and to find solutions for delayed projects.

In addition to public and private finance sources, as described at the beginning of this section, there are also development partners and charitable organisations. The role of development partners is well known, although the participation of charitable organisations in infrastructure development is relatively recent.

[6] Fiscal space is defined as room in a government´s budget that allows it to provide resources for a desired purpose without jeopardising the sustainability of its financial position or the stability of the economy (Heller, 2005).

3.6. Collective Responsibility for Green and Resilient Infrastructure

There are two essential factors regarding responsibility for green and climate-resilient infrastructure. First, because the effects of climate change transcend administrative jurisdictions, the costs of green and resilient infrastructure should be borne by governments that span international boundaries. Second, not only do the causes and effects of climate change transcend jurisdictions, but they also occur across economic and social groups, genders, and sectors; therefore, it is the responsibility of all stakeholders, not just the government. Private entities – including households and individuals – must be held accountable for their conduct, including compliance with public sector environmental standards. These facts provide the rationale for increased global action and commitment.

It is possible to develop blended finance to improve PPPs while also mobilising additional financial resources. Blended finance combines funds from international organisations, development agencies, the private sector, charitable foundations, and other sources. In blended finance, various actors supply a range of complementary services based on their unique qualities. Typically, charitable foundations, public contributions, and development organisations have a higher tolerance for risk than the private sector. The funds from these parties can thus be utilised to reduce a project's risk and make it more attractive to private investors. Indirect investments can also be made through technical grants, the demonstration of initial initiatives, and the acceptance of subordinate positions.

There are two possible fund structures: equal risk and return allocations for all investors, or different risk and return allocations for different investors. The *2020 OECD Blended Funds and Facilities Survey* found that pension funds and insurance companies invested a total of $2.5 billion in these blended finance vehicles, representing 4% of the total capital in blended finance (Dembele et al., 2022). Institutional investors are the primary capital providers for funds. This may be explained by the fact that blended finance funds, due to their structure and mandate, attract a significantly more diverse group of investors (Basile and Dutra, 2019). Still, 69% of blended finance funds and facilities' total capital continue to come from the government, while multi-lateral development banks are the second largest source.

Despite the obstacles and steady progress, blended finance provides options for mobilising financial resources for climate-resilient infrastructure. Academic and research institutions can help capture the intangible benefits of infrastructure projects, while other investors can leverage environmental benefits as a return on investment in a blended financing scheme with varying characteristics (i.e. objectives and risk tolerance). The utilisation of environmental advantages varies according to the needs of stakeholders. If it is neither immoral nor exploitative, it can be advantageous to many people in various ways.

There are other green financing choices, like international funds and carbon pricing. Indonesia published a regulation on a carbon tax (No. 7/2021) in 2021 that will apply to coal-based power producers starting in April 2022. The tariff is determined based on cap and trade, as well as cap and tax, which allow emitters to exchange their surplus carbon emissions for permits to emit those gases or to pay taxes. However, the government has delayed the implementation date. In terms of international funding, the Green Climate Fund, Global Green Growth Institute, and Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) initiative are the most used funds for emerging economies. Indonesia has access to Green Climate Fund financing and REDD+ through the Fiscal Agency of the Ministry of Finance; $476.9 million has been allocated to Indonesia, including $103.8 million for REDD+ results during 2014–2016.[7]

4. Conclusion and Moving Forward

Humans must be aware that the frequency and severity of disasters can be influenced by their actions. The Intergovernmental Panel on Climate Change found in its 2021 report that human activities are a major contributor to global surface temperature changes (IPCC, 2021). Mitigation and adaptation are two important types of efforts for reducing the effects of disasters. As a country with a high-risk profile, Indonesia cannot ignore the threats and must take responsibility.

Indonesia's infrastructure remains inadequate. Although public spending on infrastructure has increased significantly, infrastructure demand still exceeds supply. The government has made efforts to mobilise a range of financial resources, including those from the private sector, state-owned enterprises, and development partners. Recently, the number of PPP projects has been on the rise, and many delayed strategic and priority projects have been de-bottlenecked.

Despite this progress and accomplishments, Indonesia is cognizant of the lack of infrastructure and the growing threats posed by climate change. Indonesia has pledged to reduce its GHG emissions by 29% below BAU levels by 2030 under an unconditional mitigation scenario and by 41% under a conditional mitigation scenario. To achieve the goals, Indonesia has focussed on the two sectors that contribute the most to GHG emissions: LUCF and energy. Related to resilient/adaptive infrastructure, energy and transport sectors dominate the financing requirement at approximately 87% of total needs.

[7] GCF, Republic of Indonesia, https://www.greenclimate.fund/countries/indonesia and GCF, FP130, https://www.greenclimate.fund/project/fp130

The total estimated annual financing requirements are Rp300 trillion, which cannot be met by public funds alone. International community grants and loans fall short of the commitment. Green bonds and green *sukuk* are additional sources of financing that have been issued since 2018, with global green *sukuk* totalling $5 billion by the end of 2022. Private financing, charitable foundations, and other development partners can contribute to the mobilisation of various financial sources. PPPs have been contributing more to infrastructure development, including climate-resilient projects, but the demands continue to rise. Blended finance is the most recent scheme for financing climate-resilient infrastructure. There is potential and stakeholder interest, but implementation is still slow. Like PPPs, this collective financing requires a healthy ecosystem, especially for mitigation and adaptation measures. In addition, the market must grow to a sufficient size. Additional sources of financing include the Green Climate Fund and REDD+, but their funds are quite small.

Some actions can advance the development of infrastructure that is more climate-resilient:

(i) **Establish the appropriate incentives for each key stakeholder to partake in collective finance.** Given that the interests and risk-reward profiles of the stakeholders vary, it is essential to design the appropriate incentives.

(ii) **Expand the financial market by enhancing regional and global cooperation.** Clearly, a moderately expanding market will be more desirable. In addition to participating actively in international communities, Indonesia can also initiate global cooperation and financing.

(iii) **Integrate climate considerations into sub-national infrastructure, and provide innovative local governments with incentives.** This requires comprehensive technical guidance and capacity development, with an initial emphasis on critical sectors such as transport, energy, and LUCF, so that local governments can participate actively.

References

Agard, J. et al. (eds.) (2014), 'Annex II: Glossary", in IPCC, *Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Geneva, https://www.ipcc.ch/pdf/assessmentreport/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf

Archer, D. and D. Dodman (2015), 'Making Capacity Building Critical: Power and Justice in Building Urban Climate Resilience in Indonesia and Thailand', *Urban Climate*, 14(1), pp.68–78.

Asia-Pacific Economic Cooperation (APEC) Policy Support Unit (2019), *Peer Review and Capacity Building on APEC Infrastructure Development and Investment: Indonesia*, Singapore, https://www.apec.org/publications/2019/11/peer-review-and-capacity-building-on-apec-infrastructure-development-and-investment-indonesia

Asian Development Bank (ADB) (2022), *Green Bond Market Survey for Indonesia: Insights on the Perspectives of Institutional Investors and Underwriters*, Manila.

Badan Pemeriksa Keuangan (BPK) (2020), *Laporan Hasil Pemeriksaan Atas Laporan Keuangan Pemerintah Pusat Tahun 2019*, Jakarta, https://www.bpk.go.id/assets/files/lkpp/2019/lkpp_2019_1594713274.pdf

––––– (2021), *Laporan Hasil Pemeriksaan Atas Laporan Keuangan Pemerintah Pusat Tahun 2020*, Jakarta, https://www.bpk.go.id/assets/files/lkpp/2020/lkpp_2020_1624341245.pdf

Badan Perencanaan Pembangunan Nasional (BAPPENAS) (2021), *Climate Resilience Development Policy 2020–2045*, Jakarta.

Basile, I. and J. Dutra (2019), 'Blended Finance Funds and Facilities: 2018 Survey Results', *Organisation for Economic Co-operation and Development (OECD) Development Co-operation Working Papers*, No. 59, Paris: OECD.

Biodiversity (2020), 'Green Infrastructure', 19 October, https://biodiversity.europa.eu/green-infrastructure

Dembele, F., T. Randall, D. Vilalta, and V. Bangun (2022), 'Blended Finance Funds and Facilities: 2020 Survey Results', *OECD Development Co-operation Working Papers*, No. 107, Paris: OECD.

European Commission (EC), Disaster Risk Management Knowledge Centre (DKMKC), Country Risk Profile, https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

European Financing Institutions Working Group on Adaptation to Climate Change (EUFIWACC) (2016), *Integrating Climate Change Information and Adaptation in Project Development: Emerging Experience from Practitioners*, https://econadapt.eu/sites/default/files/2016-11/EUFIWACC_Adaptation_Note_Version_1.0_ENGLISH_FINAL_20160601%5B1%5D.pdf

Government of Hong Kong, Drainage Services Department Sponge City: Adapting to Climate Change, https://www.dsd.gov.hk/Documents/SustainabilityReports/1617/en/sponge_city.html

Government of Indonesia, Ministry of Environment and Forestry (MEF) (2018), *Indonesia: Second Biennial Update Report (BUR 2): Under the United Nations Framework Convention on Climate Change*, Jakarta.

––––– (2021), *Indonesia: Third Biennial Update Report (BUR 3): Under the United Nations Framework Convention on Climate Change*, Jakarta.

––––– (2022), Indonesia: Enhanced Nationally Determined Contribution, Jakarta. https://unfccc.int/sites/default/files/NDC/2022-09/ENDC%20Indonesia.pdf accessed 20 October 2023.

––––– (2023), *FOLU Net Sink: Indonesia's Climate Actions Toward 2030*, Jakarta, https://www.menlhk.go.id/uploads/site/post/1681109460.pdf

Green Climate Fund (GCF), FP130, https://www.greenclimate.fund/project/fp130

–––––, Republic of Indonesia, https://www.greenclimate.fund/countries/indonesia

Gultom, Y. et al. (2022), 'Policy Brief: Promoting Resilient Infrastructure and Public–Private Partnership', *https://www.t20indonesia.org/wp-content/uploads/2022/08/PROMOTING-RESILIENT-INFRASTRUCTURE-AND-PUBLIC-PRIVATE-PARTNERSHIPS.pdf*

Hallegatte, S., J. Rentschler, and J. Rozenberg (2019), *Lifelines: The Resilient Infrastructure Opportunity*, Washington, DC: World Bank.

Hecht, J.E. (2016), *Indonesia: Cost of Climate Change 2050*, Washington, DC: Chemonics.

Heller, P. (2005), 'Back to Basics – Fiscal Space: What It Is and How to Get It', Finance and Development, 42(2), https://www.imf.org/external/pubs/ft/fandd/2005/06/basics.htm,

Intergovernmental Panel on Climate Change (IPCC) (2021), 'Summary for Policymakers,' in V. Masson-Delmotte et al. (eds.), Climate Change 2021: *The Physical Science Basis – Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press.

International Finance Corporation (IFC), Karian Water Supply Project, IFC Project Information and Data Portal, https://disclosures.ifc.org/project-detail/SII/44588/karian-water-supply-project

International Monetary Fund (IMF), General Government Gross Debt, https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/IDN?zoom=IDN&highlight=IDN (accessed 31 August 2023)

Kennedy, C. and J. Corfee-Morlot (2013), 'Past Performance and Future Needs for Low Carbon Climate Resilient Infrastructure – An Investment Perspective', *Energy Policy*, 59(C), pp.773–83.

Natural Water Retention Measures (NWRM) Project (2013), *Individual NWRM: Stream Bed Re-Naturalization*, Luxembourg: European Union.

O'Neill, B. et al. (2022), 'Chapter 16: Key Risks across Sectors and Regions', in IPCC, Climate Change 2022: *Impacts, Adaptation and Vulnerability – Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, UK: Cambridge University Press, pp.2411–2538.

Organisation for Economic Co-operation and Development (OECD) (2018), 'Climate-Resilient Infrastructure', *OECD Environment Policy Papers*, No. 14, Paris.

Pribadi, K.S. et al. (2021), 'Learning from Past Earthquake Disasters: The Need for Knowledge Management System to Enhance Infrastructure Resilience in Indonesia', *International Journal of Disaster Risk Reduction*, 64, 102424.

South Australia Government, Eyre Peninsula Link, https://www.rdaep.org.au/eyre-peninsula-link/

Statistics Indonesia (2023), *Official Statistic News, No. 15/02/Th. XXVI, 6 February 2023*

Thacker, S. et al. (2021), *Infrastructure for Climate Action*, Copenhagen: UNOPS.

World Bank (2022a), *Achieving Climate and Development Goals: The Financing Question,* Washington, DC.

––––– (2022b), 'World Bank Approves $497 Million in Financing to Lower South Africa's Greenhouse Gas Emissions and Support a Just Transition', press release, 4 November, https://www.worldbank.org/en/news/press-release/2022/11/04/world-bank-approves-497-million-in-financing-to-lower-south-africa-s-greenhouse-gas-emissions-and-support-a-just-transit

––––– (2023), *Indonesia Country Climate and Development Report*, Washington, DC.

World Bank and ADB (2021), *Climate Risk Profile: Indonesia*, Washington, DC: World Bank.

Zen, F. (2019), 'Public–Private Partnerships in Southeast Asia', in A. Deep, J. Kim, and M. Lee (eds.), *Realizing the Potential of Public–Private Partnerships to Advance Asia's Infrastructure Development*, Manila: ADB.