Chapter 16

Advancing Climate Change Adaptation, Disaster Risk Reduction, and Resilient Growth

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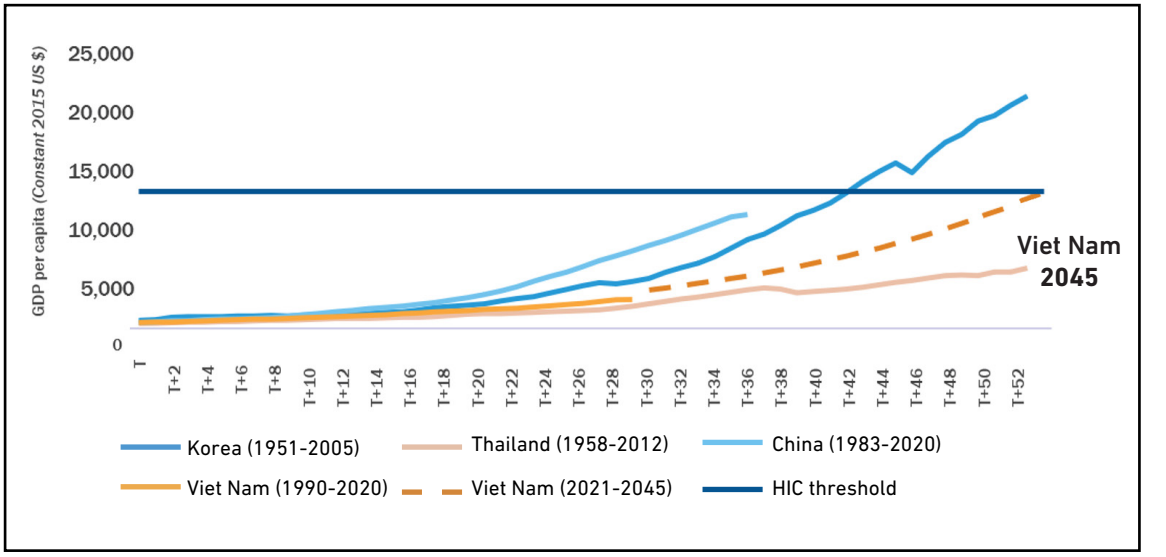
Since the Doi Moi reforms and after more than 2 decades of steady economic growth, Viet Nam has set an ambitious goal of reaching high-income country status by 2045 (Figure 16.1). To achieve this, the industrial growth achieved during 1990–2000 needs to be tripled to reach a per capita income of $12,695 from the current level of $2,785 (IMF, 2022). Viet Nam's latest Socio-Economic Development Strategic Plan 2021–30 emphasizes the need to accumulate more productive, physical, and human capital–and to use its resources more efficiently–to generate productivity and social development gains.

Figure 16.1. Viet Nam's Path to High-Income Status by 2045



HIC = household income, GDP = gross domestic product.
Source: World Bank, 2022a.

Previously, Viet Nam relied heavily on its natural resources for industrial development, using its extensive stocks of agricultural, forest, and mineral resources to drive export-led economic growth. The estimated value of Viet Nam's natural capital accounted for about 35% of its wealth during 1990–2018, compared with 10% in East Asia and 17% in other developing countries of Southeast Asia (Thanh et al., 2017). The deterioration or depletion of the existing natural capital has been further exacerbated by climate change. This chapter examines the climate risks posed to the country, compares its adaptations with Japan's and proposes areas for international cooperation for reconciling economic growth with climate change.

1. Impacts of Climate Change on Economic Growth and Social Development in Viet Nam

1.1. Changes in Temperature, Rainfall, and Weather Patterns

The Ministry of Natural Resources and the Environment study (MONRE, 2021) summarises the evolution of climate change in Viet Nam over 1958–2018 as follows:

Temperatures tended to increase nationwide from 1958–2018. On average, annual temperatures increased by about 0.89°C from 1958–86; from 1986–2001, they increased by 0.74°C, and from 2001–18, they increased by 0.32°C (Table 16.1). Assuming a similar rate of increase in average temperatures, by 2080–90, temperatures could be higher on average by 1°–3.4°C, relative to the 1986–2005 baseline for Viet Nam. The temperature rise is likely to amplify the impacts on rainfall patterns, human health, livelihoods, and natural ecosystems.

Table 16.1. Change in Average Temperature from 1958 to 2018 Across Climate Zones (°C)

Climate zone	Winter	Spring	Summer	Autumn
Northwest	1.1	0.8	0.9	1.3
Northeast	1.0	0.8	0.8	1.1
Northern Delta	0.9	0.9	0.7	1.2
North Central	0.8	0.9	0.8	1.3
South Central	0.6	0.4	0.6	0.9
Highlands	1.3	0.7	1.0	1.4
Southern	1.1	0.8	0.9	1.1

Source: MONRE, 2021.

Annual national rainfall increased by 2.1% in the period 1958–2018, mainly in the southern area (Table 16.2). Several modelling results show considerable uncertainty around two important issues for Viet Nam: future rainfall patterns and the intensity of extreme events such as floods and droughts.

Table 16.2. Change in Average Rainfall from 1958 to 2018 Across Climate Zones
(mm)

Climate zone	Winter	Spring	Summer	Autumn
Northwest	41.4	9.9	–4.3	–17.3
Northeast	34.3	-0.7	1.4	–16.0
Northern Delta	13.8	2.7	–0.9	–27.1
North Central	16.8	13.0	8.6	–12.1
South Central	82.2	23.0	8.9	11.3
Highlands	40.3	14.6	0.5	7.4
Southern	97.4	7.5	2.5	3.8

Source: MONRE, 2021.

Further, the low-lying coastal and river delta regions of Viet Nam have very high vulnerability to sea level rise. It has been observed that water levels tend to increase, with the strongest rate of over 6 mm/year at the Cua Ong, Bach Long Vy, and Con Dao hydrographic stations (Box 16.1).

Box 16.1. Summary of Sea Level Change in Viet Nam

(1) According to sea level observations at selected hydrographic stations:

- Almost every station reported increasing sea level trends.
- Cua Ong station had the largest increase (6.5 mm/ year).
- Hon Ngu and Co To station had a decreasing trend (5.7 and 0.6 mm/year).
- Con Co and Quy Nhon had no trend.
- The average water level in all stations had risen to about 2.7 mm/per year.
- From 1993 to 2018, the average sea level rise in all stations had grown to 3 mm/year.

(2) According to the satellite statistics:

- The average water level in the East Sea rose by 4.1 mm/per year.
- The average water level in the East Sea centre had the largest increase to 6–7.2 mm/year.
- The average water level in the Viet Nam Coastal Sea increased to 3.6 mm/per year.
- The coastal water level from the Mekong delta had the lowest growth of 2.2–2.5 mm/year.

Source: MONRE, 2021.

The number of storms and tropical depressions tends to be less variable but more concentrated at the end of the monsoon season, which is also when cyclones are mainly active in the South. Strong to very strong storms tend to increase over time. On average, there are 12–13 storms and tropical depressions in the East Sea every year. The activity of tropical depressions affecting Viet Nam in recent years has many irregularities and erratic patterns. The number of hot days when the temperature is more than 35°C has increased almost everywhere in the country, with the largest increase in the North Central, South Central, and Southern regions. Drought may become more severe in some regions due to increased temperature and reduced rainfall in the dry season, such as in the South Central region in spring and summer, the South in spring, and the North in winter. The number of days of intense cold and harmful cold also has tended to decrease; however, the number of cold spells has fluctuated sharply from year to year. Table 16.3 summarises the impact and forms of extreme weather events through different channels, adversely impacting the future of economic growth in Viet Nam.

Table 16.3. Types and Forms of the Impact of Extreme Weather Events on Viet Nam's Economy

Impact Factors	Type of Impact
Increase in temperature	Affecting natural ecosystems, shifting the thermal boundaries of ecosystems, and changing the structure of plant and animal species in some regions. Some species may be lost leading to biodiversity loss. For agricultural production, the structure of crops, livestock, and seasons may change in some regions, requiring changes in farming techniques. There will be increased likelihood of developing pests and diseases, leading to reduced productivity and output, and increasing risks to agriculture and food security. There will be increased pressure on the human body, especially the elderly and children, which increases disease. The increase in temperature also will affect other sectors such as energy, transportation, industry, construction, tourism, commerce, etc. related to the increased costs for cooling, information, and communication.
Rainfall change	An increase in rainfall or an increase in rainfall intensity affects the productivity of the production area over time. In particular, abnormal rainfall changes lead to unpredictable consequences of natural disasters, many mountainous areas are strongly affected by natural disasters caused by water, such as flash floods, and landslides (MONRE, 2021).
Sea level rise	Viet Nam is a sea country, with a coastline of more than 3,260 km and more than 3,000 islands, including two archipelagos of Hoang Sa and Truong Sa. There are 28 coastal provinces and cities, and the population accounts for more than 50% of those in the country, with most of the labour here working in marine economic sectors; 28 coastal provinces

Impact Factors	Type of Impact
	and cities contribute over 60% to the national GDP (Hills et al., 2022). Long coastlines and heavily populated low-lying areas also make Viet Nam one of the world's most vulnerable countries to rising sea levels (IMF, 2022). Sea-level rise makes drainage difficult, increasing coastal erosion and salinisation of water sources affecting agricultural production and domestic water, and posing great risks to the coastal areas. Coastal constructions such as sea dykes, roads, ports, factories, urban areas, and coastal residential areas. Rising sea levels and temperatures affect marine and coastal ecosystems, pose risks to coral reefs and mangroves, and have negative impacts on biodiversity, local communities, and economic activities such as fishing, marine tourism, and aquaculture.
Extreme weather phenomena	Extreme weather is a permanent, immediate, and long-term threat to all sectors, regions, and communities. Storms, floods, droughts, heavy rains, heat, storms, and hurricanes occur every year in many regions of the country, causing damage to production and life. The areas that are expected to be most affected by these extreme climate events are the Central Coast, the North and North Central Mountains, the Northern Delta, and the Mekong River Delta (MONRE, 2021).

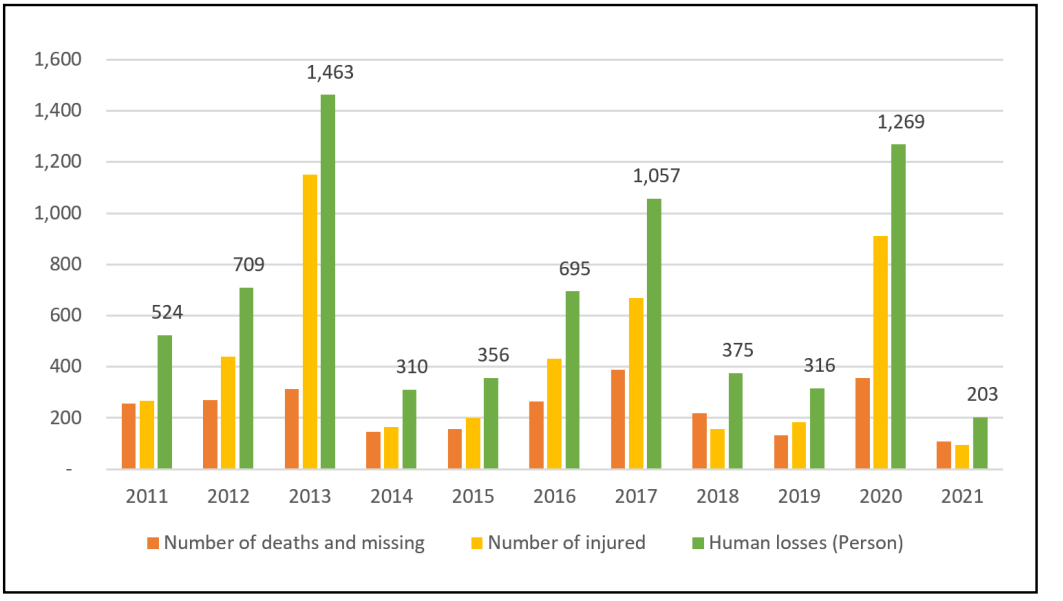
Source: Authors collected, 2022.

1.2. Impact of Climate Change Natural Disasters on Socioeconomic Development

According to the Viet Nam Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (IMHEN & UNDP, 2015), increased exposure to changing weather patterns and hazards to people and property has had a profound impact on all areas of socio-economic development and regions. According to the IMF (2022), the total costs of climate hazards already exceed $3–5 billion in case of an increase in the intensity and frequency of extreme events. Figures 16.2, 16.3, 16.4, and 16.5 describe the historical value of damages caused by natural disasters in the country in terms of people, housing assets, crop-cultivated areas, and the economic value of damages (GSO, 2022).

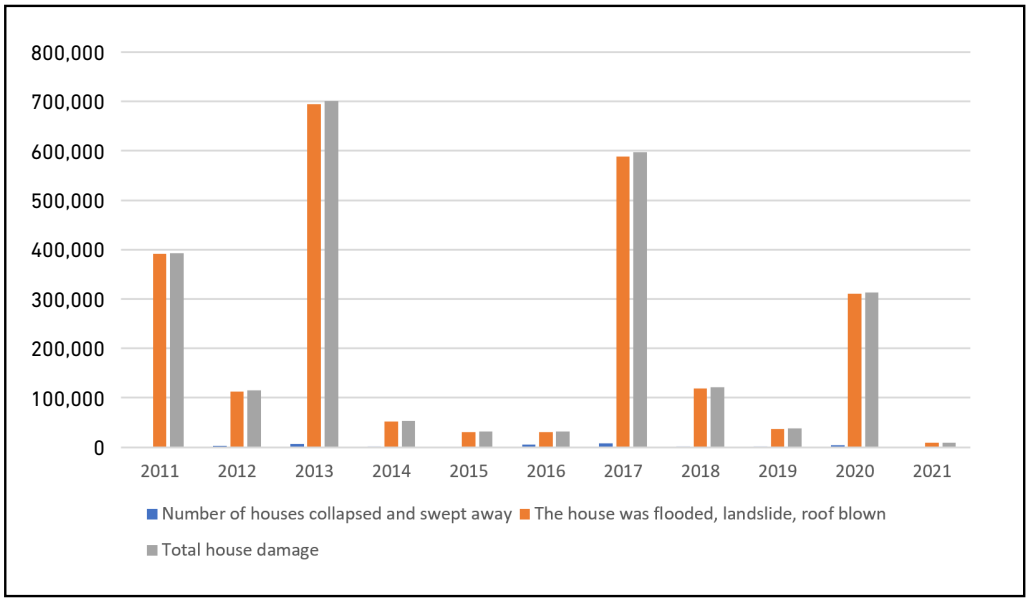
Climate change-induced natural disasters are affecting the basic elements of human life in all provinces, and access to water, food, energy, and health are becoming major challenges to achieving sustainable economic growth. It also has a profound impact on the achievement of the United Nations' Sustainable Development Goals set for 2030.

Figure 16.2. Number of Deaths and Injuries Caused by Natural Disasters in Viet Nam from 2011–21



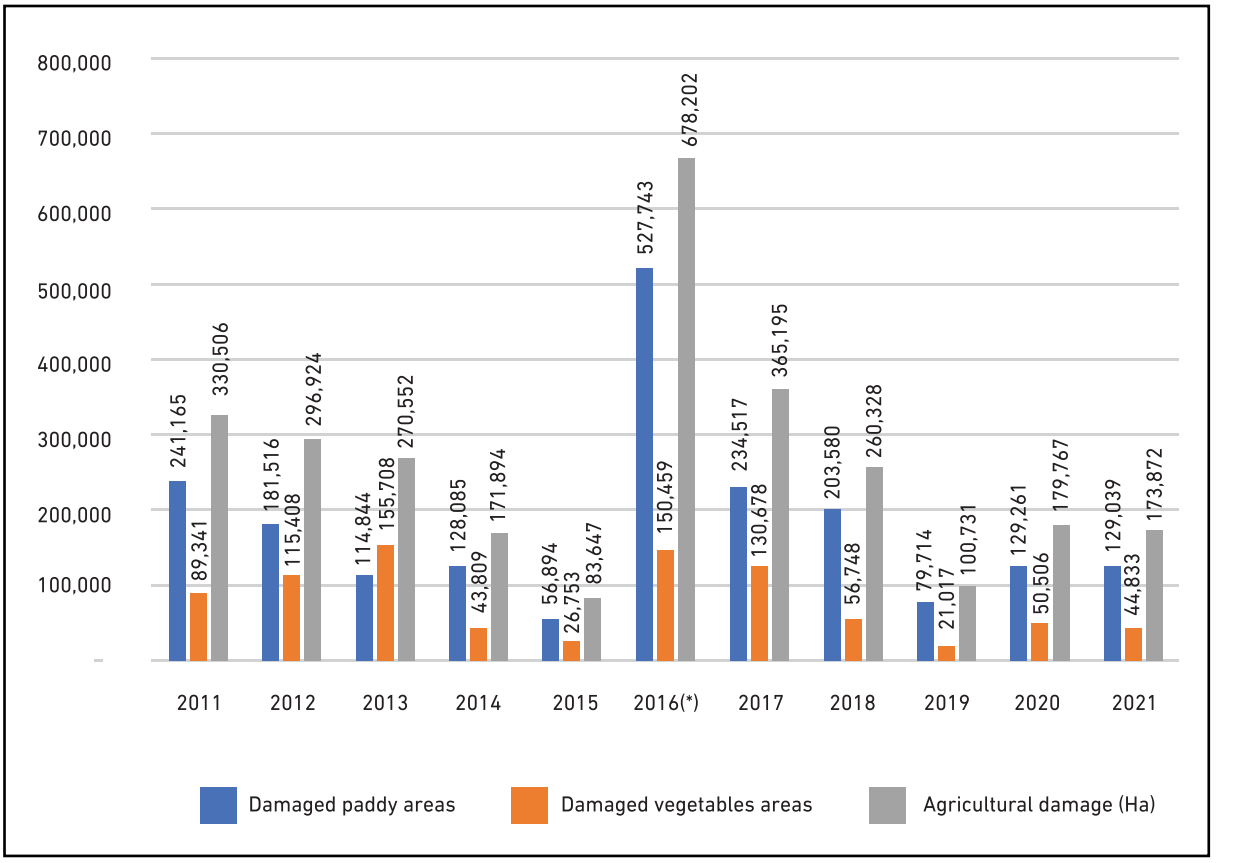
Source: GSO, 2022.

Figure 16.3. Number of Houses Damaged or Impacted Caused by Natural Disasters in Viet Nam, 2011–2021



Source: GSO, 2022.

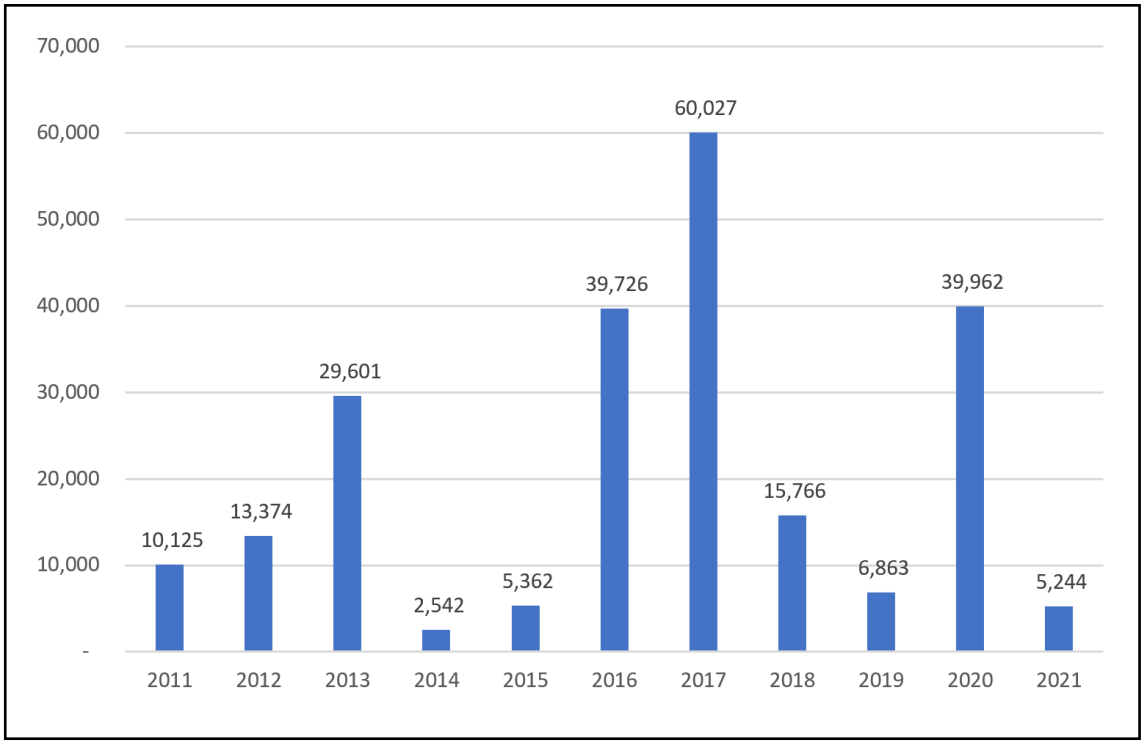
Figure 16.4. Damage to Rice and Crop Areas Caused by Natural Disasters in Viet Nam, 2011–2021



Source: GSO, 2022.

Figure 16.5. Total Economic Losses Annually Due to Natural Disasters in Viet Nam, 2011–2021

(Billion D)



Source: GSO, 2022.

1.3. Climate Risk Management and Resilient Economic Growth

According to the Climate Change Vulnerability Index (MONRE, 2021), Viet Nam is one of the 30 countries in the world categorised as 'extremely risky'. Eckstein et al.'s Climate Risk Index (2021) ranked Viet Nam as the 13th-most affected nation regarding the impact of natural disasters from 2000–19, and ranked fourth amongst the Association of Southeast Asian Nations (ASEAN) member countries affected by climate-induced natural disasters, as illustrated in Table 16.4.

Table 16.4. Climate Risk Index for 2000–2019 in the ASEAN Region

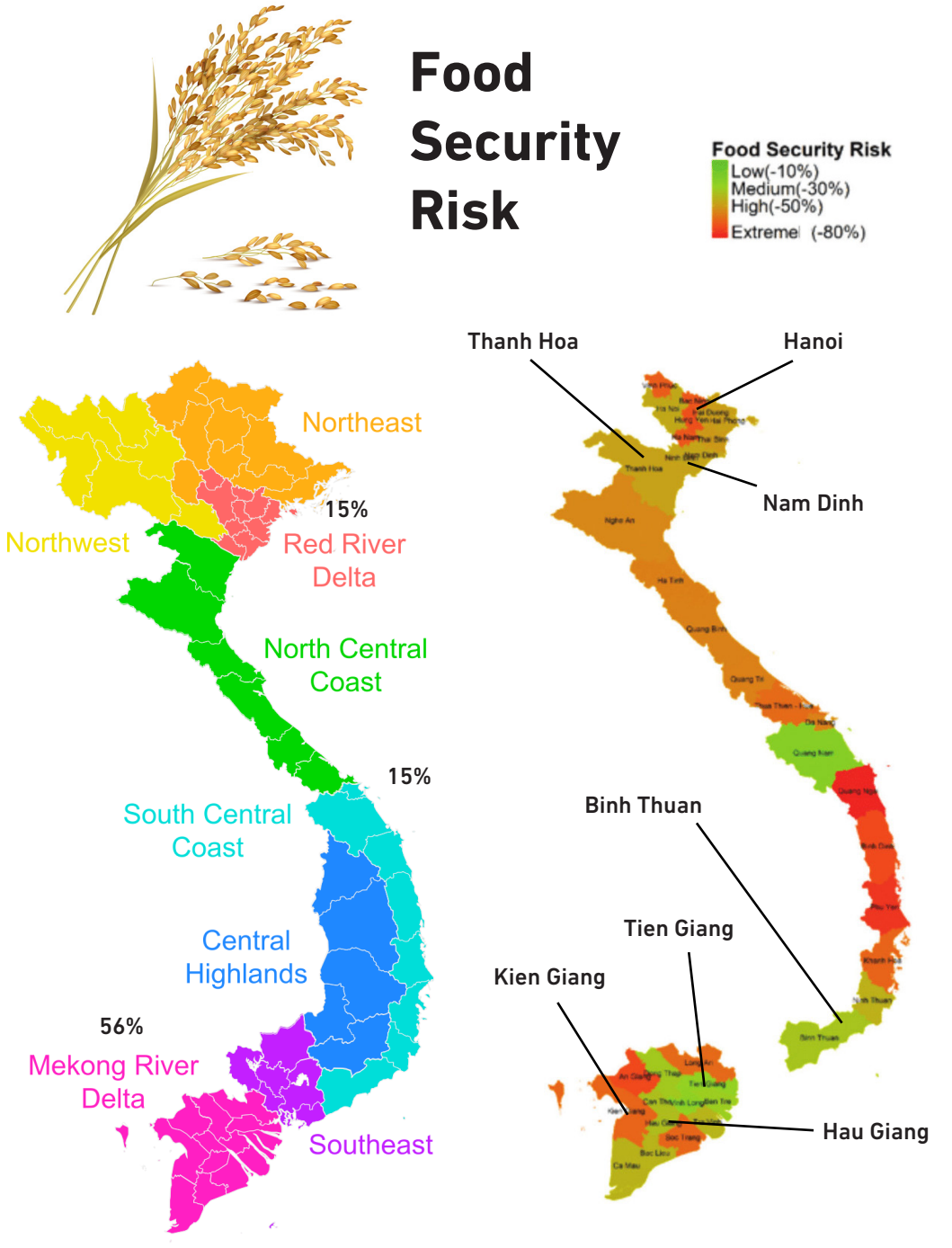
CRI rank in global	CRI Rank in ASEAN	Country in ASEAN	CRI score	Average fatalities 2000–19 (Rank)	Average Fatalities per 100,000 inhabitants, 2000–19 (Rank)	Average Losses in million $(PPP) 2000–19	Average losses per unit GDP in % 2000–19
176	9	Brunei Darussalam	167.50	167	151	178	178
14	5	Cambodia	36.17	38	35	53	28
72	7	Indonesia	143.17	93	155	120	168
52	6	Lao PDR	60.50	82	66	73	38
116	8	Malaysia	105.67	64	108	66	144
2	1	Myanmar	10.00	1	1	19	19
4	2	Philippines	18.17	7	16	8	31
179	10	Singapore	172.00	172	172	162	177
9	3	Thailand	29.83	22	60	3	17
13	4	Viet Nam	35.67	15	47	11	47

ASEAN = Association of Southeast Asian Nations, CRI = climate risk index, GDP = gross domestic product, PPP = purchasing power parity, Lao PDR = Lao People's Democratic Republic.
Source: Eckstein et al., 2021.

Without effective adaptation measures, 6–12 million people in Viet Nam could be affected by coastal flooding by 2070–2100, which could be exacerbated by the already substantial risks posed by river floods by 2035–45. Several million acres of cropland are affected by extreme floods every year; combined with droughts, almost all provinces of Viet Nam will face severe food security challenges, with extreme risks projected in the Mekong River Delta (Figure 16.6).

As the climate changes, it is increasingly disrupting Viet Nam's economy, and the costs are already starting to undermine the current economic growth. Recent estimates suggest that Viet Nam lost $10 billion in 2020, or 3.2% of its gross domestic product (GDP), due to climate change (World Bank, 2022a). These damages' magnitude, which is projected to increase rapidly, emphasises the increasing need for Viet Nam to adapt to the risks of a changing climate.

Figure 16.6. Climate Change and Food Security Risks in Viet Nam, 2020–2050



Source: Anbumozhi et al., 2019.

While Viet Nam's vulnerability to climate change stems from the global accumulation of greenhouse gas (GHG) emissions in the atmosphere and the slow response by the advanced and emerging economies to reduce their carbon emissions; it is exacerbated by the past practices of uncoordinated and unsustainable management of natural resources. A case in point is the Mekong Delta, where continued sand mining compounds the effect of sea level rise on the erosion of the coastline and riverbanks (Anbumozhi et al., 2019).

According to the report on the Index for Risk Management by European Commission 2017 illustrated in Table 16.5, Viet Nam ranks 98th globally on the INFORM climate change index. Compared with Japan (ranked 153), Viet Nam's index is still low, but in ASEAN, Viet Nam ranks third after Singapore (191) and Malaysia (100) in terms of INFORM index. This proves Viet Nam's efforts in natural disaster prevention and control and climate change adaptation.

Table 16.5. Index for Risk Management in Viet Nam and other ASEAN countries and Japan

Country	Natural	Human	Hazard & Exposure	Social Economic Vulnerability	Vulnerable Groups	Vulnerability	Institutional	Infrastructure	Lack of Coping Capacity	INFORM 2017	RANK	Lack of Reliability Index
Brunei Darussalam	2.3	0.1	1.3	1.0	0.6	0.8	4.7	4.2	4.5	1.7	164	4.1
Cambodia	5.4	4.2	4.8	4.1	1.7	3.0	7.0	6.0	6.5	4.5	59	2.2
Indonesia	7.8	6.6	7.2	2.3	2.3	2.3	4.5	5.1	4.8	4.3	66	1.3
Lao PDR	4.7	2.9	3.9	4.2	2.0	3.2	6.4	6.0	6.2	4.3	66	1.7
Malaysia	4.8	3.6	4.2	2.3	3.7	3.0	3.3	2.9	3.1	3.4	100	3.1
Myanmar	8.0	7.0	7.5	5.0	6.9	6.0	7.4	5.7	6.6	6.7	12	3.4
Philippines	8.4	9.0	8.7	2.6	4.1	3.4	4.6	3.6	4.1	4.9	50	1.6
Singapore	0.1	0.1	0.1	0.6	0.3	0.5	1.2	0.9	1.1	0.4	191	3.3
Thailand	6.4	4.3	5.4	2.1	3.8	3.0	5.0	2.9	4.0	4.0	80	2.2
Viet Nam	7.2	2.8	5.4	2.6	0.9	4.1	3.5	5.2	3.4	4.3	98	1.8
Japan	8.3	0.6	5.7	0.9	0.8	0.9	2.0	1.0	1.5	2.0	153	3.3

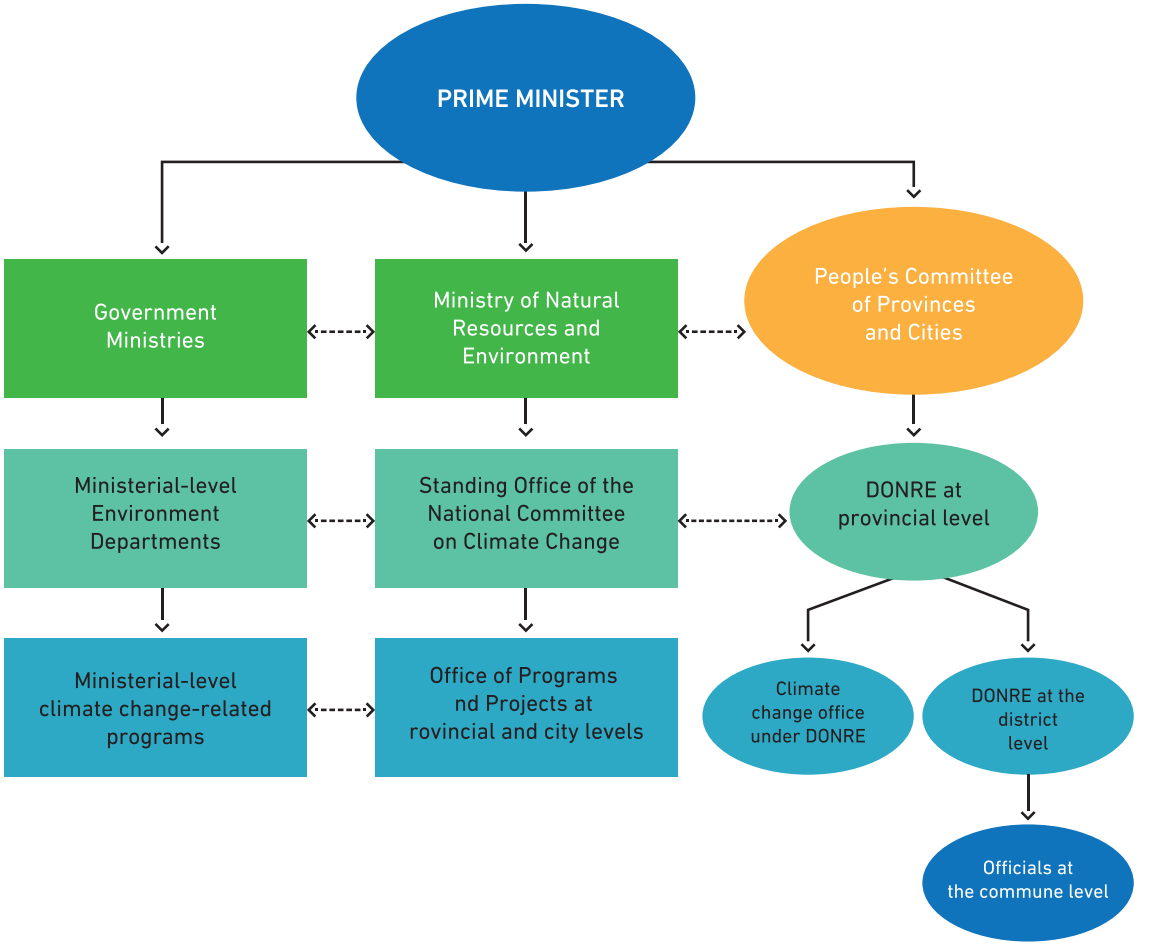
ASEAN = Association of Southeast Asian Nations, Lao PDR = Lao People's Democratic Republic.
Source: European Commission, 2017.

Climate change is not only negatively affecting strategic sectors, such as agriculture, water, transport, and fisheries, but also global supply chains and production networks, slowing labour productivity growth, increasing costs for insurance, and affecting business continuity plans, as well as health expenditures. Climate change adaptation seeks to reduce the risks posed by climate change and to benefit from any associated opportunities where possible. It is one of two main policy responses to climate change in Viet Nam, the other being mitigation, that is, reducing GHG emissions to address the root causes. While Viet Nam's climate risks are well captured in recent policy documents, academic reports, and national economic statistics, public and private budgets often fail to account for the loss of natural and physical assets.

2. Current Strategies, Policies, and Legal Frameworks in Addressing Climate Change Risks

2.1. Organisational Structure

Figure 16.7. Organisational System in Response to Climate Change in Viet Nam



DONRE = Department of Natural Resources and Environment.
Source: Authors, 2022.

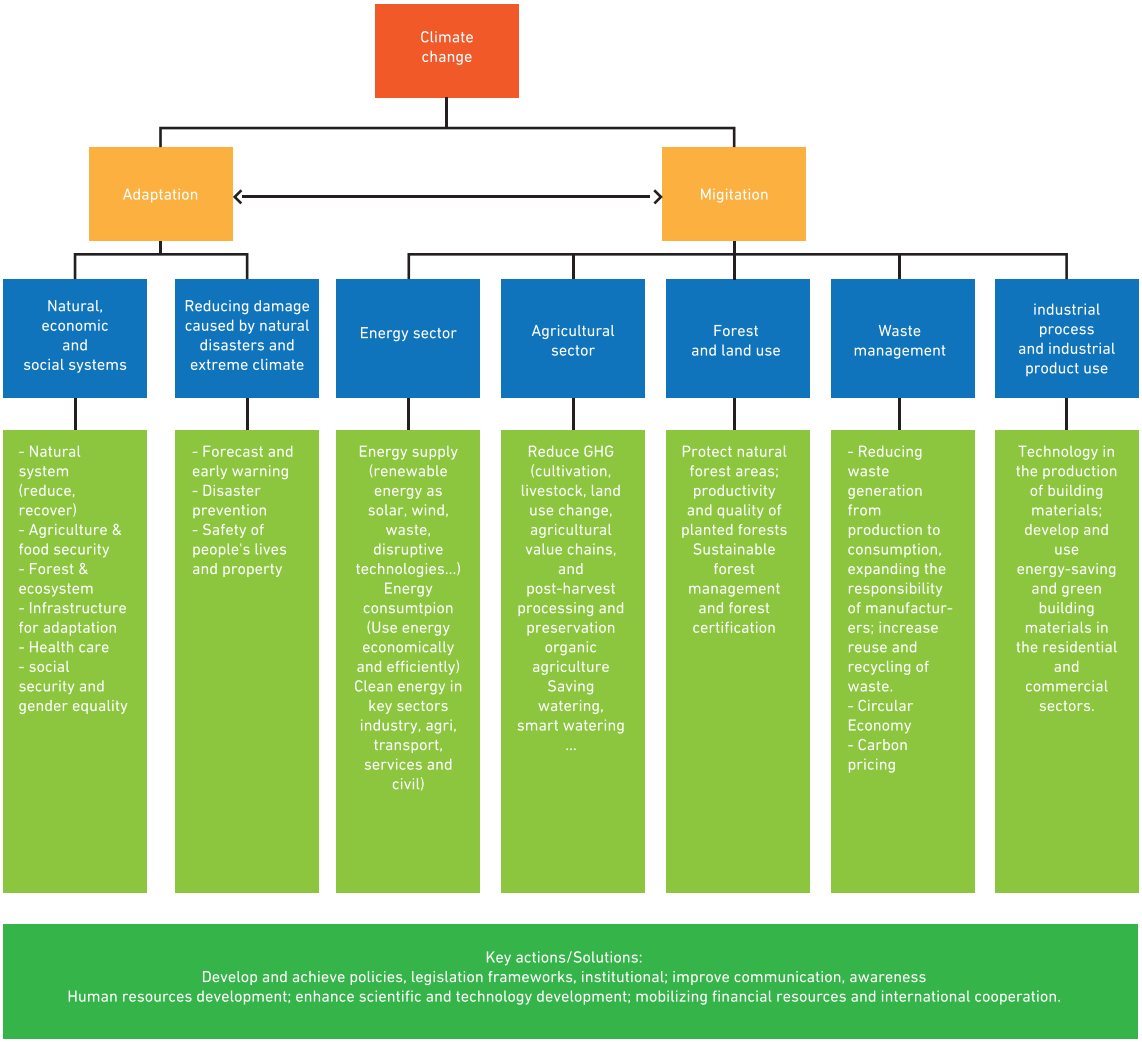
The organisational system of Viet Nam's climate change response is shown in Figure 16.7. Viet Nam has a National Committee on Climate Change, which advises and assists the government and the Prime Minister in researching, proposing, directing, regulating, coordinating, and urging the settlement of tasks, sectors, fields, programmes, and national strategies on climate change, including international cooperation programmes. The Prime Minister is the chairman of the committee; the permanent vice president is the Deputy Prime Minister, and the vice president is the Minister of Natural Resources and Environment. The members are from relevant ministries and branches.

In addition, Viet Nam has a National Steering Committee for Natural Disaster Prevention and Control established by the decision of the Prime Minister (the Ministry of Natural Sources and Environment of Viet Nam, personal communication, 20 March 2015). The Committee oversees inter-sectoral coordination, assisting the government and the Prime Minister in natural disaster prevention and control nationwide. The Committee is headed by the Prime Minister or the Deputy Prime Minister; members include ministers, heads of ministerial-level agencies, or leading representatives of several related ministries and agencies, all working on a part-time basis. The Ministry of Agriculture and Rural Development is the standing body of the Committee and has a specialised agency to advise and assist it.

2.2 Strategic Approach to Cope with Climate Risks

Viet Nam demonstrated the country's strong commitment to climate change actions at COP26 when the Prime Minister declared it would reach net-zero GHG emissions by 2050, saying that 'climate change response and the restoration of nature must become the highest priority in all development decisions and calling for fairness and justice in the global response to climate change' (Government News, 2021). Furthermore, at COP26, Viet Nam joined more than 100 countries in pledges to halt deforestation by 2030 and to slash methane emissions by 30% from 2020 levels in the same period. Viet Nam has further committed to ending all investment in new coal power generation, scaling up deployment of renewable energy, and phasing out coal power by the 2040s. These commitments go beyond those included in the nationally determined contribution (NDC) update submitted in 2020 under the United Nations Framework Convention on Climate Change. The overall framework of Viet Nam's current approach to climate actions, both adaption and mitigation, is summarised in Figure 16.8.

Figure 16.8. Current Framework of Viet Nam's Climate Change Policies and Actions



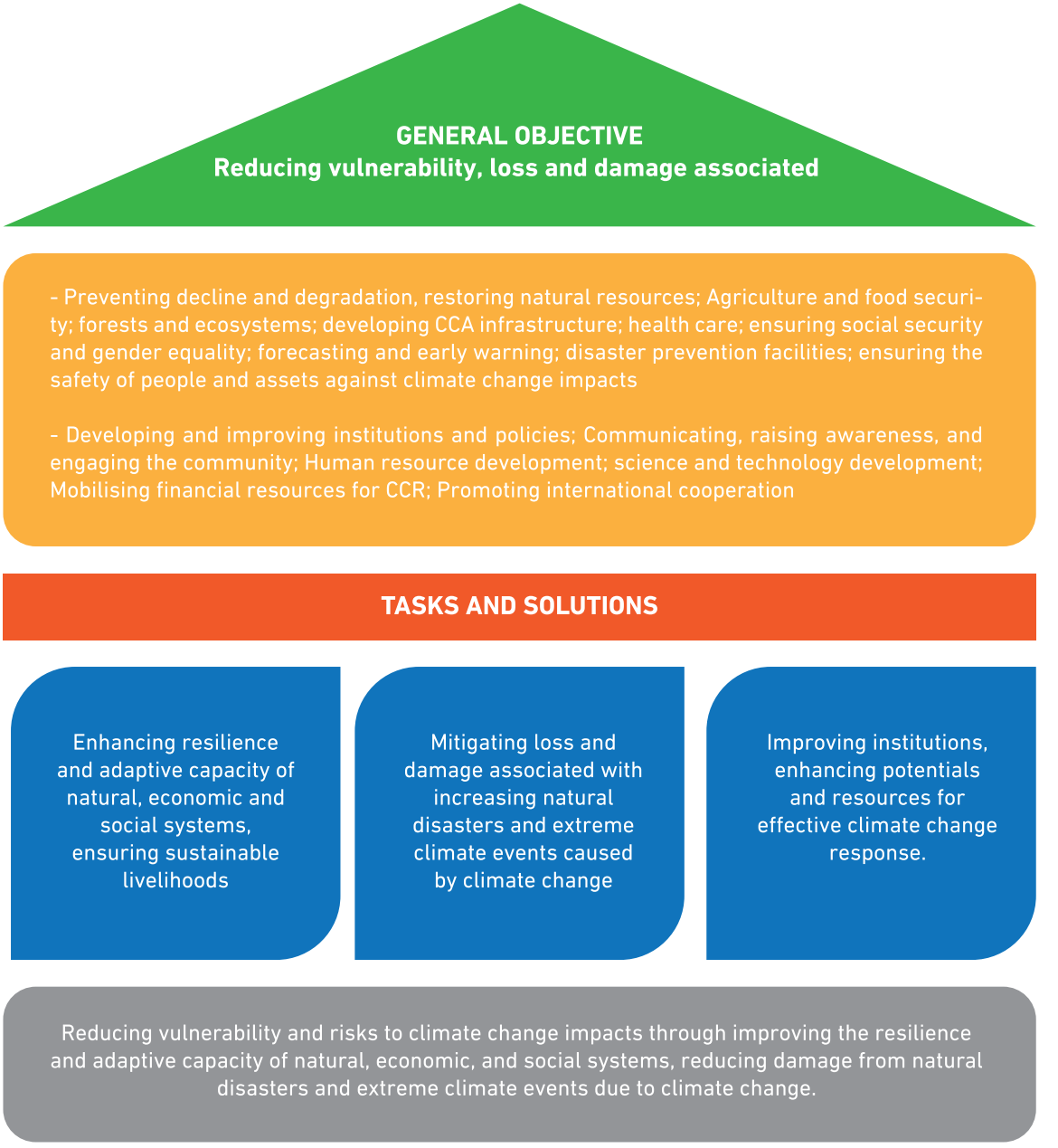
GHG = greenhouse gases.
Source: Author adapted from National Strategy on Climate Change and related policies, 2023.

Building on the recent economic development plan for 2021–30, the government has already started to revamp its implementation and develop corresponding legal framework conditions. A new Viet Nam green growth strategy prepared by the Ministry of Planning and Investment was adopted in October 2021, while an updated NDC implementation programme is being led by MONRE. In addition, the amended Law on Environmental Protection adopted in 2020 represented the most significant modernisation of Viet Nam's environmental legislation since 1993 and has climate change as its focus. The draft Power Development Plan VIII reinforces the centrality of renewable energy.

Climate change adaptation and disaster prevention were clearly shown in the orientation from the Communist Party of Viet Nam such as its Resolution on Active Response to Climate Change, Improvement of Natural Resource Management and Environmental Protection (2013); its Strategies and plans for socioeconomic development through 2010–20, and 2021–30; and other relevant resolutions on the development of specific regions, development of industries, etc. Based on these orientations, the Government has issued the National Climate Change Adaptation Plan from 2021 to 2030, with a vision to 2050, and the national strategy for climate change to 2050 with detailed viewpoints, goals and specific tasks, solutions, and mechanisms.

As illustrated in Figure 16.9, the overall objective of the national strategy for climate change is to strengthen the resilience and adaptive capacity of communities, economic sectors, and ecosystems, and to promote the integration of climate change into the strategic and planning system.

Figure 16.9. Summary of the National Strategy for Climate Change Adaptation to 2050



CCA = climate change adaptation, CCR = climate change remediation.
Source: Authors edited from Decision No. 896/QD-TTg by Prime Minister on approving the National Climate Change Strategy to 2050, and Decision No. 1055/QD-TTg by Prime Minister about promulgate the National Plan to adapt to climate change for 2021–30, with a vision to 2050.

2.3. The Legal Framework for Climate Change Adaptation

Viet Nam does not have a law on climate change. However, disaster prevention and climate change response has been integrated into the legal system. The following are some summaries of Viet Nam's legal response to climate change.

In Article 90 of the Law on Environmental Protection 2020, there are provisions for adaptation to climate change. These include (i) assessment of impacts, vulnerabilities, risks, losses, and damages for sectors, regions, and communities based on different scenarios and development forecasts; (ii) implementation of disaster risk reduction and community-based and ecosystem-based adaptation models; (iii) response to sea-level rise and urban flooding; and (iv) a monitoring and evaluation system. The Law also stipulates the responsibilities of ministries, ministerial-level agencies, and provincial-level People's Committees in implementing climate change adaptation.

Adaptation to climate change is also mentioned in specialised laws such as those related to (i) forecasting, disaster warning, and climate change monitoring (Law on Hydro-meteorology, 2015); (ii) disaster risk reduction, prevention, and control (Law on Natural Disaster Prevention and Control, 2013); (iii) flood prevention and control of river routes with dikes (Law on Dikes, 2006); (iv) improving the adaptive capacity of communities, economic sectors, and natural systems (Law on Crop Production, 2018).

2.4. Practical Efforts and Limitations in Viet Nam's Climate Change Adaptation

The system of forecasting technology and network of hydro-meteorological monitoring stations have been gradually consolidated and automated.[1] The reliability of disaster forecasts and warning systems for tropical depressions and storms have increased, while hydrometeorological forecasting technologies are gradually approaching the level of advanced countries in the region. The earthquake and tsunami warning system has begun to take shape. Hydrometeorological activities for specialised services of organisations and individuals have been enhanced with the appearance of thousands of monitoring stations across industries and fields.

Up to now, climate change and sea-level rise scenarios for Viet Nam have been updated in 2012, 2016, and 2021, with an increasing level of detail, contributing to the creation of a database on climate change. Sea-level rise has been associated with digital elevation models for socioeconomic development planning.

[1] Viet Nam has 187 surface meteorological stations, 242 hydrological stations, 20 hydrographic stations, 10 weather radar stations, six radio air-sensing stations, eight pilot stations, and 782 independent rain gauges.

Regarding the agricultural sector, transforming the structure of plant varieties and livestock and adjusting seasons and production techniques have been outlined in an action plan. Up to now, several rice varieties adapted to inundation, salt tolerance, and alum have been studied and applied, while farming methods to adapt to climate change have also been studied and implemented.

Public awareness of natural disaster prevention has been promoted and has gradually improved. Information and communication work has effectively contributed to the warning of natural disasters. Research programmes on climate change response have been implemented in recent years, especially the national programme 'Science and technology to respond to climate change, natural resource management, and environmental protection'.

According to the National Report on Sustainable Development Goals (UNDP and HSF, 2020), by 2030, Viet Nam will complete Sustainable Development Goal 13, including three specific goals: (i) strengthening resilience and adaptability to risks associated with climate change, disaster response, and other natural disasters; (ii) integrating climate change factors into development policies, strategies, master plans and plans; and (iii) education, awareness raising, capacity building and institutions in early warning, climate change response and disaster risk reduction. However, to achieve this goal, Viet Nam needs to continue making efforts to mobilise resources (especially financial resources), perfect the system of monitoring infrastructure, natural disaster warning, project hydro-meteorological reports, and improve the system of relevant institutions, policies, and laws.

There are key limitations in coping with the future climate risks in Viet Nam including the following:

i. Limitations in interdisciplinary and inter-regional thinking. The ability to withstand and recover from natural disasters is still limited; the investment in natural disaster prevention and control is still weak, fragmented, small, lacking capital, technology, techniques, and human resources;
ii. Information, data, and qualifications of officials and people in analysing and using information and data effectively are still not high; the technical infrastructure system to cope with climate change and natural disasters is still limited and outdated;
iii. Financial resources for climate change response are lacking compared to requirements; international support tends to decrease; the mobilisation of resources from private enterprises has not been achieved as expected;
iv. The application of science and technology in climate change response is generally slow, not meeting the requirements; hydrometeorological monitoring systems, climate monitoring, and climate change databases are lacking and inconsistent;
v. Lack of monitoring and evaluation system; the monitoring and supervision of the implementation has not been paid due attention; many tasks and projects in the plan were not approved (MONRE, 2022).

2.5. Capacity Building Challenges and Financial Needs for Enhanced Adaptation

There are five major challenges that need immediate attention for tackling climate change. First, Viet Nam's climate strategies need to be rebalanced to include strong policies and investments for adaptation as well as mitigation. The current strategies emphasise mitigation, but, as a highly vulnerable country, Viet Nam also needs to invest in resilience. The imbalance between mitigation and adaptation is most visible in the green growth strategy, which introduces several energy intensity targets, both nationwide and sectoral, but has no equally specific targets in terms of adaptation–even though the strategy recognises the importance of resilient agriculture, transport, and cities.

All the current strategies and Viet Nam's NDC need to be updated to reflect recent commitments, including those made at COP26. For example, the net-zero carbon emissions target has yet to be factored into any national or sectoral strategies. Greater consistency is needed across key climate policy documents. The new commitments and strategies, prepared by different ministries, set targets and priorities in inconsistent ways, complicating the vision and potentially hindering implementation. For example, the NDC defines the mitigation target as a reduction in GHG emissions relative to a business-as-usual scenario, while the green growth strategy targets the carbon intensity of GDP. These indicators are related but different; for example, whether the latter achieves absolute emissions reductions depends on the rate of GDP growth.

Second, the new strategies have yet to be translated into significant changes in Viet Nam's fiscal policy. For example, some progress has been made on the development of carbon pricing instruments, but such instruments are not yet implemented at scale. The existing carbon tax, i.e. the Environmental Protection Tax, is around $0.50 per tCO2e on coal, $77.60 per tCO2e on gasoline, and $32.90 per tCO2e on diesel, lower than most countries and too low to incentivise large-scale decarbonisation. However, the authorities have demonstrated a strong interest in using quantity-based caps in a trading system and have started to shift subsidies from petroleum to renewable sources of energy, which contributed to a private investment boom in solar energy in 2020. On the expenditure front, a recent analysis of six key ministries found climate-related spending varied annually from 2016 to 2020, but held relatively steady, ranging from 26% to 38% of the ministries' combined budgets. About 25% of public capital expenditures were fully or partially directed to adaptation, mainly in the irrigation and transport sectors. Though promising, the figures should be interpreted with caution, because there is no accepted methodology to capture them in the budget. There are also well-known inefficiencies in public investment management, and maintenance is typically underfunded in Viet Nam. Green public procurement is also just in its infancy, as existing legal and institutional frameworks need to be aligned with international best practices.

Third, the private sector will need to make substantial investments to adapt to climate change, which is already impacting many businesses. It is estimated that $300 billion of assets held by the commercial and industrial sectors are vulnerable to climate-related disasters. Many firms are already reporting climate change impacts that significantly affect their income, mainly from extreme weather events that disrupt operations, but also from reduced labour productivity and other problems.

According to VCCI Vietnam and the Asia Foundation (2020), up to 54% of enterprises surveyed in Viet Nam said that they have had their production and business activities interrupted due to climate change, up to 51% decline in labour productivity and revenue due to inclement weather. The most vulnerable sectors to climate change are extractives, manufacturing, agriculture, wholesale and retail, and hotels/accommodation. In addition, many firms have substantial long-term investments in high-emission production methods, which puts them at risk of losing competitiveness in increasingly clean export markets. Yet businesses lack the resources to adapt to climate change and to invest in cleaner technologies. This will require a greater engagement of the financial sector to ensure that private savings can be mobilised into green and more resilient investments.

Fourth, state-owned enterprise (SOE) reform will be important to encourage greater private sector investment in green technologies and business practices. In Viet Nam, SOEs still dominate many of the country's most carbon-intensive industrial sectors, particularly coal, chemicals, fertilisers, electricity, and freight transport, crowding out private investment. As part of its mitigation strategy, the government could condition its near-term support for SOEs on actions that accelerate decarbonisation, enhance climate resilience, and otherwise reduce climate-related risks. Over the medium to long term, reforming SOEs and opening the market to greater private sector participation in the economy is essential to achieving much of the climate agenda as many of the new technologies are easily accessed by private firms, including foreign ones. Putting Viet Nam on a low-carbon climate-resilient path will require mobilising massive amounts of private capital, which will not happen in sectors dominated by SOEs without fostering further competition now and in the future.

Finally, the financial sector, which will be the key to ensuring that capital can flow to climate investments, is also vulnerable to climate change in two ways. First, there is physical risk, as extreme weather events can disrupt business operations and damage the property and infrastructure of financial institutions and their customers. Rising temperatures, rising sea levels, and precipitation changes will require additional investments and adaptation by households, firms, and governments that may increase their credit risk. Second, financial institutions may face risks through their high-emitting clients who could suffer market losses and be exposed to legal challenges. According to estimates of the World Bank (2022a), to achieve Viet Nam's net zero emissions target by

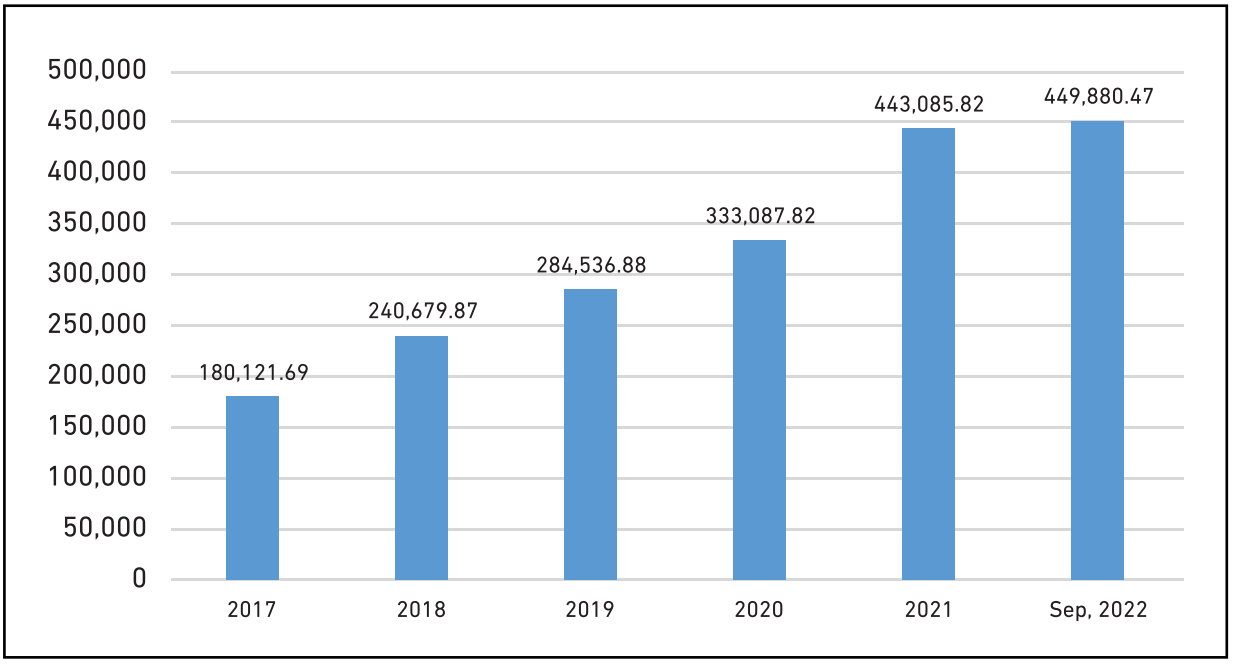
2050, Viet Nam needs about $368 billion for 2022–40, equivalent to about 6 8% of GDP per year, 65% of which will have to be mobilised from outside the public sector. There has been no systematic and comprehensive assessment of the climate risks faced by the financial sector in Viet Nam. Several indicators suggest that physical risks for many financial institutions in Viet Nam are already high and expected to grow. For example, about 55% of total loans extended by banks in Viet Nam goes to businesses and people in climate-vulnerable coastal regions. Similarly, the risks for banks have not been evaluated. The government should consider assessing climate-related risks in the government and commercial banking sector and other parts of the financial system including stress testing, as recommended by international standards. Such assessment will require quality data and robust analytics.

In addition, green financial flows, including green credits, green bonds, and green loans, are showing strong signs of development in Viet Nam due to the commitments of commercial banks, international financial institutions, etc. to accompany the government's commitments at COP26 (Figure 16.10). However, this resource is still quite small, focusing mainly on a few key areas such as renewable energy (wind power, solar power) and green agriculture projects (Figure 16.11). Therefore, Viet Nam needs to implement the following solutions: build a green taxonomy and create conditions for commercial banks and businesses to access green financial capital in climate change adaptation and resilience, and disaster reduction.

According to statistics from the State Bank, the green credit balance exceeded D180 billion in 2017 and had surged to nearly D450 billion (equivalent to US$20 billion) by September 2021. This accounted for over 4% of the country's total credit balance and approximately 5.3% of Viet Nam's GDP, as illustrated in Figure 16.10. Notably, the majority of these outstanding loans were channelled into the renewable energy sector (comprising over 47%), and green agriculture (constituting around 32%), as depicted in Figure 16.11. This pattern underscores that in Viet Nam, green credit has yet to encompass all categories of environmentally beneficial projects that could make significant contributions to environmental protection and sustainable development. Examples of such unaddressed areas include projects focused on the conservation and development of natural capital, biodiversity, technological advancement, and initiatives related to climate change adaptation.

Figure 16.10. Development of Total Green Credit in the Period 2021–2022 (unit: Billion D)

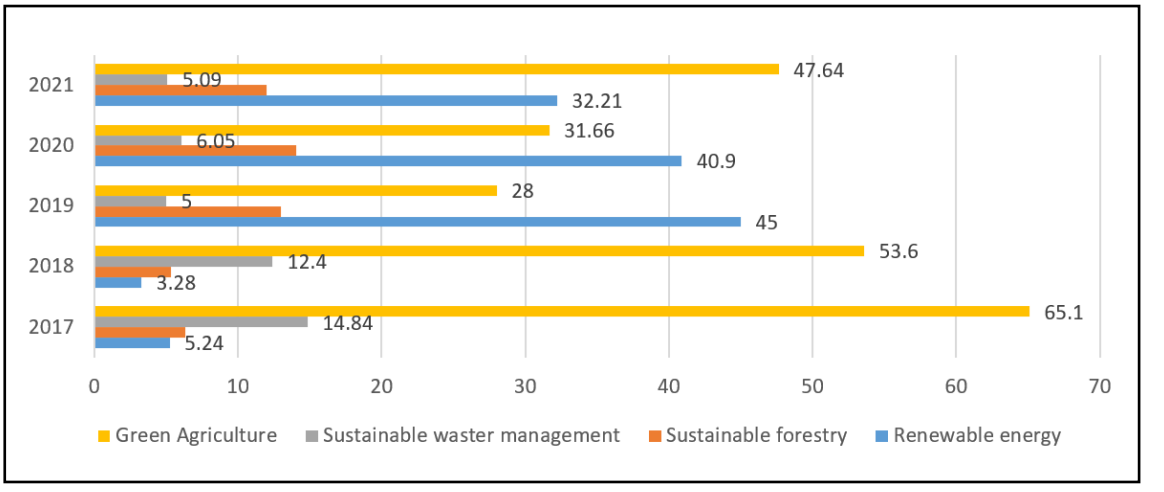
Unit: Billions D



Source: State Bank of Viet Nam, 2022.[2]

Figure 16.11. Viet Nam's Green Credit Balance from 2017 to 2021

Unit: % of total green credit balance



Source: State Bank of Viet Nam, 2022.

[2] Tran Anh Quy (2022). Materials in the Consultation workshop on the Prime Minister's Draft Decision on environmental criteria for projects granted with green credit or issuing green bonds. State Bank Vietnam (2022).

In Viet Nam, green bond market remains relatively limited. Various regions have taken steps to issue government bonds, local government bonds, and corporate bonds for environmentally sustainable objectives, programmes, and projects. According to a report by Climate Bonds Initiative (CBI) from 2021,[3] which focuses on ASEAN's sustainable finance market encompassing both green bonds and green loans, Viet Nam has experienced rapid growth. By 2021, the market had reached a value of US$1.5 billion, a nearly fivefold increase from the previous year when it stood at US$0.3 billion. Notably, Viet Nam's overall bond market expanded by more than US$5 billion in 2021, with over 80% of the bonds issued being government bonds. Similar to green credit, green bonds predominantly originate from the transportation and energy sectors (Climate Bond Initiative, 2022).

According to the State Securities Commission of Viet Nam, the concepts of green bonds, social bonds, or sustainable bonds are relatively new in the Vietnamese context. The introduction of such bonds dates back to 2016 when both Ho Chi Minh City and Ba Ria Vung Tau province initiated the issuance of green municipal bonds to secure funding for environmental protection projects as part of their respective budget mandates. Subsequently, Ho Chi Minh City issued D3,000 billion worth of 15-year municipal green bonds to raise capital for projects outlined in budget expenditure mandates, including 11 environmental protection initiatives. Similarly, Ba Ria Vung Tau province issued D500 billion in 5-year bonds, which encompassed one environmental protection project (Ministry of Finance, 2021).[4]

[3] https://www.climatebonds.net/2022/06/asean-sustainable-debt-market-hits-record-issuance-volume-2021
[4] Official Document No. 5122/BTC-TCNH on providing information and data on green bonds of the Ministry of Finance

3. Japanese Experience in Setting Priorities for Enhanced Resilience against Climate Change and Natural Disasters

3.1. Imperatives of Disaster Risk Management and Climate Change Adaptation in Japan

Japan shifted from a middle-income country to a high-income country from the 1950s to the 1970s, while confronting earthquakes, tsunamis from frequent typhoons, deadly heatwaves, and landslides (Box 16.2)

Box 16.2. Frequent Natural Disasters in Japan Often Linked to its Topography

Almost 75% of Japan's land is mountainous, which limits the amount of water that it can store.

Most of its population sits in alluvial planes or low-elevation areas where the level of floodwater is higher than the area itself. For instance, Tokyo is built on an alluvial plain, and its elevation is below sea level.

Droughts are frequent in Japan. Before its modernisation, most water shortages were due to droughts, which affect its electricity supply, hydropower generation, and industries.

Japan's battle with floods for centuries resulted in their innovative flood management systems; however, authorities warn residents, especially those in Tokyo, to remain vigilant towards disasters.

With climate change, Japan is expecting that the number of heavy rains will increase by up to 10 days in the next 100 years.

Source: Authors.

The high concentration of the population in small habitable areas has made Japan historically vulnerable to droughts.

Box 16.3. Japanese Experience in Building Climate-Resilient Water Infrastructure Systems

To understand Japan's complex relationship with water, we must first turn to its topography. Nearly three-quarters of Japan's land is mountainous, which forms the basis of its steep and short rivers. This limits the amount of rainwater that can be captured before it flows into the sea. As a nation that receives intense rainfall during specific periods of the year (rainy season from June to July and typhoon season from August to September), Japan has traditionally suffered from extreme floods.

Prior to Japan's modernisation, most of its water shortages were caused by severe droughts: 1939 Lake Biwa, 1964 Tokyo Olympics, 1967 Nagasaki, 1973 Takamatsu, and 1978 Fukuoka are some examples. According to a meta-analysis of Japan's droughts from 1902 to 2009, the most severe drought took place from 1939 to 1941, lasting for 666 days. This drought very seriously affected water supply, electricity, hydropower generation, factories, railway, and marine transportation. It was even considered the reason for the nationalisation of major industries.

A more recent example is the nationwide drought that began in spring and ended in mid-September of 1994. The continuing low rainfall had deteriorated the water quality of major rivers near Lakes Sagami, Tsukui, and Tanzawa and forced the rationing of water. Water rationing began in June in the Kiso River basin and spread to other districts. In the most extreme cases, water for irrigation and industrial use was rationed to a maximum of 65% and 35% in the case of domestic uses. Rainfall started in September, and water rationing was relaxed and finally lifted in November.

Japan has also been fighting floods for centuries, and its evolving flood management has been documented extensively. The Tokyo of today is a product of the engineering of the Tone River to the east and the Arakawa River to the west during the Tokugawa era (1603–1867). To avoid disasters in Tokyo's east lowlands, the Arakawa Channel, Edogawa Channel, and a reclamation land at Kasai were constructed. In light of the high population density in the east lowlands, it has been urged that the population remain vigilant towards natural disasters by strengthening the early warning system.

Source: Authors.

Japan has been proactive in boosting its resiliency to disasters – and continues to boost economic growth. Japan first prepared using infrastructure development and forested areas or green dams. There is a strong emphasis on the use of forest management to address water management. Japan's climate mitigation includes the use of renewable energy, forest conservation, and drainage infrastructures.

3.2. Japanese Climate Policies and Practices

The Climate Change Adaptation Act enacted in 2018 provides Japan's legal foundation for adaptation measures. It mandated Japan's Climate Change Adaptation Plan, to be monitored and updated every 5 years. It outlines the latest impacts of climate change and expands its adaptation intentions to areas such as disaster risk reduction, agriculture, and health. The comprehensive plan for climate change adaptation includes strategies for coordinating policies across relevant ministries; developing climate research, an information infrastructure, implementing localised adaptation measures; improving public awareness; promoting adaptation action in the business sector; and providing aid for climate change adaptation in developing countries.

In addition, the revised plan for 2020 includes a total of 66 key performance indicators for sectoral and fundamental measures to monitor the progress of each measure. The Plan, Do, Check, Act approach has been introduced to manage the plan, specifically by using these key performance indicators and following up the progress of short-term measures implemented by ministries and agencies. The relevant ministries collect a wide range of indicator data, while the climate change adaptation promotion council monitors the progress of medium- and long-term adaptation measures every 5 years.

In addition to national legislation, Japan has been working to implement the institutional capacity for climate change adaptation in several ways. Domestically, municipal and prefectural climate change centres support locally led adaptation. These centres provide climate information to businesses and residents and incorporate local knowledge and capacity building into their plans. As of April 2022, there are active centres in 38 out of 47 prefectures.

In recent years, the Ministry of Environment and the Ministry of Economy, Trade, and Industry (METI) have ramped up support for private sector investments and innovative start-ups that help to manage climate risks. METI has identified seven promising areas where Japanese companies can contribute on an international scale through climate change adaptation businesses: resilient infrastructure against natural disasters; sustainable energy supply; food security and agricultural production; health and sanitation; climate monitoring and early warning; secure resources and sustainable water supply; and climate change finance. In line with these areas, METI compiled a collection of good practices on climate change adaptation (2021).

Japan's early warning system technologies, particularly against earthquakes/tsunamis, typhoons, and heatwaves, are some of the most advanced in the world. Japan distributes user-friendly climate information nationwide to facilitate adaptation actions by all stakeholders. Its climate change Adaptation Information Platform (A-PLAT) consolidates climate risk information so that local governments can more easily apply it to formulate local adaptation plans. A-PLAT also showcases

innovative measures being carried out in prefectures across Japan. The platform acts as a nexus between national and local research and governance, collaborating on building a cohesive national ecosystem of resilience. Japan also has deep expertise in Disaster Risk Reduction, which is applied internationally through development assistance. Examples include a flood-resilient subway system in Thailand, and erosion-control dams in Indonesia that use Japanese technology. Building infrastructure that is resilient to local disaster risks can alleviate impacts on the economy and facilitate recovery and reconstruction.
Throughout its history, Japan has faced various types of natural disasters. Public financing of climate risk management also increased cumulatively and the development of a wider range of insurance schemes. Against this backdrop, the social impact of disasters has reduced.

Japan's earthquake insurance, established in 1966, provides a means of burden-sharing between the public and private sectors through a three-tiered system. The government also tailors its public budgetary schemes to various recovery and reconstruction needs, in accordance with the magnitude and characteristics of climate change events.

Thus, Japan offers a great deal of climate resilience to Viet Nam and the global community in terms of both technical and financial experiences. Expanding the domestic A-PLAT platform to Viet Nam can promote climate-resilient societies. Three main pillars of cooperation could be: (1) providing easy-to-understand, cutting-edge scientific knowledge on climate change adaptation; (2) developing tools to help co-create regional climate-related risk information infrastructure; and (3) offering capacity-building and training for adaptation policy development and project development. Japan–Viet Nam partnership could focus on sharing knowledge, which in turn informs effective national adaptation plans and policies.

Japan has also committed to doubling adaptation finance to approximately $14.8 billion from public and private sources from 2021 to 2025. The country also contributed about $6 million to the Climate Change Adaptation Fund in March 2022 towards the global goal of doubling adaptation finance. Its international development assistance agency, Japan International Cooperation Agency which is mandated to share Japanese adaptation know-how and technology in sectors such as disaster risk reduction, water resources, agriculture, and smart city strategies, could find a key role in the bilateral partnerships.

Based on its experience, Japan should now extend its examination of how to situate climate resilience within the planning and design stages, and environmental impact assessments of specific project design and express its view in this regard as an intellectual contribution to Viet

Nam. Japan should also make extensive use of its outstanding experience in developing early warning systems and raising awareness for developing local-level climate information database management systems.

There is growing interest in the potential of public involvement and public-private partnerships in climate insurance. An example is the catastrophic loss pool and climate bond issuance. There are several successful experiments in the Japanese private sector with Catastrophic Loss Bonds with weather derivatives. These and other initiatives have mostly sprung from a natural disaster area and could be experimented with in terms of their relevance for climate resilience pathways identified in the four sectors, namely agriculture, infrastructure, and industry.

Japan through its Official Development Assistance programmes and foreign direct investment could provide tailored capacity-building support to local government institutions in Viet Nam and social entrepreneurs (private sector) to manage climate risks and the investment needs for resilient growth in Viet Nam.

4. Sectoral Pathways for Building a Climate-Resilient Viet Nam by 2045

4.1. Towards Resilient Agriculture and Forestry

As discussed, rising temperatures and erratic rainfall are likely to shorten plant growth cycles in Viet Nam and severe water shortages could lead to significant reductions in annual yields of major crops. The most productive agricultural area of the country, the Mekong Delta, faces growing threats from sea-level rise and associated saltwater intrusion, which could render the production of some crops impossible. Agricultural losses due to climate change in Viet Nam are projected to reach 5.6%–6.2% by 2030 and 7.6%–10.6% by 2050, depending on the climate scenario. Based on an analysis by the International Food Policy Research Institute, losses are estimated to be from 5.6% to 10.6% under different scenarios (World Bank, 2022b). Notably, without climate change, Viet Nam's overall agricultural output would be projected to increase 25% from 2010 to 2030, and 36% by 2050.

Despite great economic progress and decreasing deforestation, the forest sector in Viet Nam faces challenges from competing land uses, overexploitation of resources, and insufficient capacity for forest governance and management. Although the forest cover continues to increase, that is mostly due to the expansion of plantations and to how 'forests' are officially defined, which includes palm and bamboo plantations, for instance. Meanwhile, the quality of natural forests continues to deteriorate.

Since 2008, the Forest Ecosystem Services Programme has paid out nearly $400 million to farmers helping to prevent deforestation in Viet Nam. Besides employment and timber and non-timber products, forests provide a range of environmental services involving water resources, biodiversity, and climate protection. Forests are a means for delivering adaptation measures, and well-planned and protected coastal forests can deliver adaptation and economic benefits. Conversely, when forests are burned, their climate adaptation benefits are lost, with substantial amounts of carbon released into the atmosphere.

Key adaptation strategies for resilient agriculture and forestry sectors include:

- Repurpose agricultural subsidies on inputs, such as the use of water and fertilisers, to support the adoption of resilient agriculture production practices. Expenditure realignment is required to increase public spending on research and development of drought-resistant and salt-tolerant crop varieties and other innovations to boost productivity.

Subsidies can be redirected from water and fertilisers into training, local infrastructure, and services to help farmers switch to improved seeds/breeds and adopt practices that bring climate benefits while maintaining or increasing productivity. Increasing the share of public expenditure for operations and maintenance of irrigation and flood control infrastructure can ensure their durability and reduce the frequency and cost of rehabilitation. The focus of these adaptation measures should be on the most productive agricultural landscapes, particularly coastal low-lying areas such as the Mekong Delta, which are particularly vulnerable to the effects of climate change.

- Rehabilitate and upgrade irrigation infrastructure and make it more resilient to climate change to reduce system losses. Expand irrigation infrastructure in selected areas. Rain-fed agriculture is highly vulnerable to droughts and increasingly unreliable precipitation, and floods and salinisation can create problems for irrigation systems. Along with making irrigation systems more climate-resilient, it is important to establish last-mile connections between irrigation infrastructure and low-income farmers' land and to provide irrigation for vulnerable rain-fed smallholders.

- Adopt new fiscal policies and incentives to curb the expansion of agriculture into forested areas. Agricultural expansion continues to be the main direct cause of forest loss in Viet Nam, with the construction of rural infrastructure, in particular roads, also contributing. Agricultural expansion at the expense of forests is often the result of poor planning or fiscal policy privileging food production over the protection of ecosystem services. More protection and sustainable management of forests is needed. Japan has successfully developed its system of biomass town wherein a new resource management and local development approach is formulated that contributes to the reversing of ecological degradation and biodiversity loss, as well as to climate change mitigation and adaptation.

- Support large-scale investments in agriculture by strengthening cooperative farm models and facilitating the entry of big operators. In Viet Nam, small farms remain an important part of the sector, but many are constrained in their capacity to invest in climate adaptation. Capacity-building of farmers is needed so they can be more commercially oriented and transact effectively with large entities. This is also an opportunity to promote climate-smart digital agriculture practices amongst farmers through agriculture cooperatives, as in Japan. Small farmers would also benefit from the adoption of institutional frameworks to promote the digital transformation of the sector and efficiencies in payments and logistics. This is an area in which Viet Nam currently lags many of its peers. Improved weather risk forecasting and early warning systems are also crucial.

- Improve access to finance for smallholder agriculture by removing caps on bank lending and allowing warehouse receipts and crops as collateral. Providers of financial services for the agriculture sector are subject to significant public policy intervention. For example, commercial banks cannot lend to agricultural activities at a rate higher than the cap imposed by the State Bank of Viet Nam. Allowing small farms to use warehouse receipts and crops as collateral would allow them to secure loans to upgrade their operations.

4.2. Towards Resilient Infrastructure Design and Development

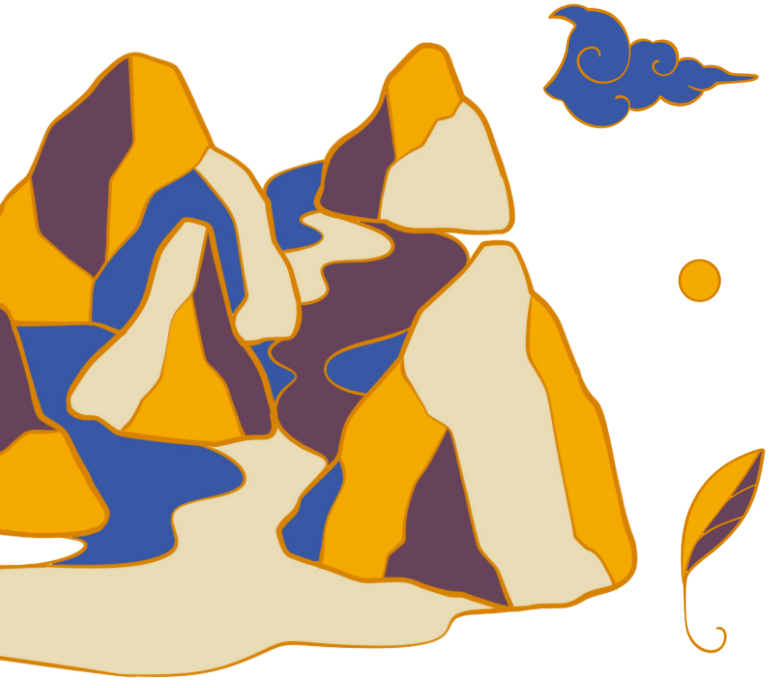
Flooding and subsequent landslides are the main hazards threatening Viet Nam's transport, water, and energy infrastructure and services. Although regional vulnerability varies depending on the type of hazard, the risk is particularly high in disaster hotspots that include vulnerable regions along the coast, in the Northern mountains, and in the Mekong Delta. Under a high-emission scenario, events that used to occur once in 1,000 years could start occurring in 5-year cycles.

Repairing damage to the power grid from extreme weather events, meanwhile, already takes up to 2% of the power sector's capital expenditures, and those costs are only expected to rise. At the same time, extreme heat will increase cooling needs and thus electricity demand, which translates into higher peak power generation needs. Weather extremes around the world can also impact global fossil fuel markets, with implications for Viet Nam's energy security, as it relies heavily on imported fossil fuels. Damage to physical infrastructure has negative local impacts as well as cascading national macroeconomic impacts. Damage to the interconnected power grid can generate prolonged outages and reduced system reliability that can affect manufacturing and trade. Mountainous regions, where many poor ethnic minority communities are concentrated, rely on a few critical road links and power lines, so the loss of infrastructure connectivity due to climate events could leave them isolated for months. Damage to national-level networks could have major macroeconomic impacts.

Recommended adaptive capacity for the infrastructure sector includes upgrading road and power assets to climate-resilient design standards. Upgrading a typical national highway on flat terrain to very high standards may cost more in the short run but would yield several long-term benefits. In addition, integrating different transport networks, i.e. roads, maritime, inland waterways, and railways, would enable the overall network to function better and to be more resilient to disasters. Shifting just 10% of road freight to other modes could reduce the economic impacts of extreme climate events by 20%–25%. Different networks are often exposed to different hazards; for instance, waterway and domestic

maritime transport is known to be much less affected by flooding than road transport. It also has little exposure to landslide risks. On the other hand, ports are exposed to climate risks and, if poorly planned, may themselves aggravate climate change-linked damages, in particular coastal erosion.

Introducing the life-cycle asset management approach for new infrastructure development as practiced in Japan would contribute to resilient growth. Viet Nam currently allocates well below 20% of its transport expenditure to maintenance, far less than peer countries such as Indonesia and Malaysia. The high-quality infrastructure approach is recognised good practice to sustain the level of service while minimising the overall budget. The approach is especially critical for Viet Nam, which has major network expansion needs and faces significant climate risks. A substantial proportion of the needed finance can be mobilised from the private sector via management contracts or public-private partnerships in which the government retains control over the assets but transfers the day-to-day management and business operations to the private sector. More detailed guidance on Decree 35 (2021) and the Law on Investment in the Form of Public-Private Partnership (2020) can increase private investment in contestable sectors, including transport, as well as electricity transmission connectivity and infrastructure. Updating the technical and operating standards of transport and energy sectors to adapt to climate risks and improve resilience, including designing the assets to better withstand extreme weather events and adding redundancy, where possible, will be crucial. A systematic climate risk review is necessary, followed by the incorporation of such standards into sectoral plans for road, energy, and water infrastructure investments.



4.3. Resilient Industry and Manufacturing Sector

Viet Nam's competitiveness in global supply chains is at risk from climate change. Two of Viet Nam's largest export sectors, i.e. manufacturing and agriculture, are concentrated in coastal lowlands and deltas that are extremely vulnerable to the impacts of climate change.

The vulnerability of global supply chains is particularly apparent in cases of critical industrial parks. A recent Asian Development Bank (2019) report showed that 34% of the country's industrial zones are in coastal provinces at risk of disasters like flooding. In coastal cities like Binh Duong and Dong Nai, where many industrial zones are concentrated, flood-prone areas within the city may increase from 23% to 35% by 2050.

Trade and global supply chains could further be negatively affected by climate change's impacts on physical infrastructure. Maritime shipping, which accounts for about 80% of global trade by volume, could be disrupted by climate change (Box 16.4). More frequent and severe storms, heavy precipitation, and sea-level rise could cause more frequent port closures, affect the speed of passage, necessitate the use of alternative shipping routes or other safety measures, and increase the maintenance costs for ships and ports.

Box 16.4. Assessing Supply Chain Resilience against Flooding or Tropical Storms

Using the balance sheet data collected from 700 firms in Viet Nam, ERIA conducted a survey on supply chain resilience in 2017. The methodology employed a microeconomic and corporate finance approach to analyse the impact of exogenous shocks on the firms' key financial indicators, including liquidity, capital structure, profitability, and the (un)availability of cash buffers to withstand external shocks. This approach made it possible to quantify the firms' debt at risk, from which a relationship could be established to understand employment at risk and government tax revenue at risk. Manufacturing and agriculture – the two main exported products – were amongst the most financially vulnerable sectors. The main risk for manufacturing was from the impact on jobs and insufficient liquidity to sustain a big shock. For the agriculture sector, the main challenge was the number of farms affected, rather than the financial risks to individual establishments. Amongst non-tradable sectors, real estate, construction, and education emerged as the most vulnerable.

Source: Anbumozhi et al. (2020).

The recommended adaptive capacity measures for the industry sector include strengthening and enforcing policies and regulations for industry resilience, including in industrial parks. This should include guidelines on (i) infrastructure solutions that minimise physical damage and disruption of services critical to industries; (ii) financial mechanisms available before, during, and after disasters to secure financial protection of firms and channel investment in resilient infrastructure; and (iii) measures that encourage investment in and implementation of digital technologies to improve data quality, offer predictive analytics, enhance monitoring and communication, and provide real-time information. New investment plans should consider alternative locations and trading channels for the most climate-vulnerable areas and sectors. Companies should systematically assess the vulnerability of their trading environments to floods, droughts, and storms, paying particular attention to areas that have a limited ability to anticipate and adapt to climate change. For example, the most vulnerable will be places where there is limited capacity to build business continuity plans and where local ecosystems are fragile.

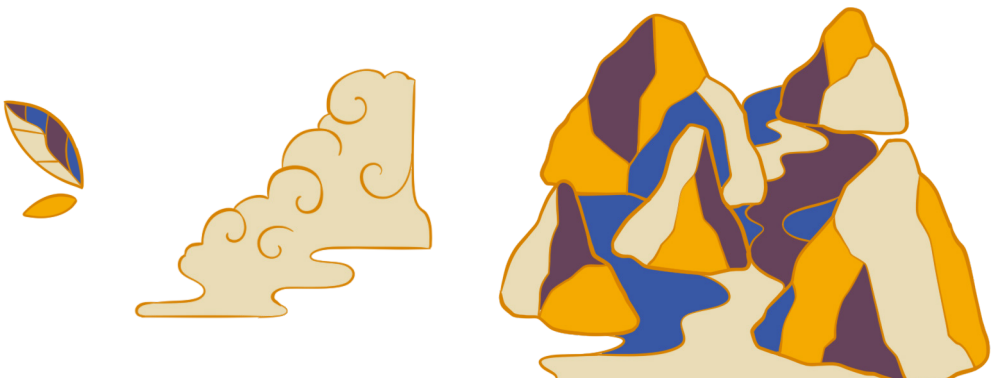
4.4. Resilient Coastal Areas and Smart Cities

Viet Nam's 300 coastal cities are low-lying and frequently affected by climate-induced natural disasters, as discussed. Tourism is also at high risk, with 42% of hotels located near eroding coastal areas. Viet Nam's large industrial sector has developed in high-risk areas, with half of the industrial zones directly exposed to intense flood risks.

The costs of climate-induced disasters are climbing rapidly, taking an increasing toll on human life, assets, and livelihoods, as well as on valuable ecological systems. The expansion of urban areas to accommodate growing populations has reduced green space and increased the extent of impermeable surfaces, which are prone to flooding and put high pressure on water resource management in Viet Nam's cities. Secondary cities in the North and South-Central coast regions have experienced some of Viet Nam's highest urban growth rates since 2012. An approach to urban development that incorporates low-carbon climate-resilient measures through incorporating smart technologies in infrastructure systems and public services will provide a safe and healthy environment for economic development and enhance residents' resilience (Anbumozhi, 2022). However, land markets often fail to fully internalise the cost of smart climate change and natural hazards. As a result, development often occurs in risky coastal areas, especially when developers do not carry the cost of future climate change impacts.

The recommended measure for enhanced adaptive capacity of coastal zones and cities includes developing an integrated coastal resilience investment programme for the main urban centres and connecting infrastructure. Risk-informed zoning and spatial planning is vital to ensure that economic growth in coastal zones does not irreversibly lock in unsafe development. This should be based on the best available risk information. To ensure that lifeline infrastructure systems can deliver their essential services, an integrated coastal resilience investment programme should be developed by integrating risk information into the planning, design, and maintenance stages of all infrastructure investments. Relevant policy, regulatory, and legal frameworks must be strengthened, and lessons from past initiatives should be consolidated to inform technical guidelines and future programmes.

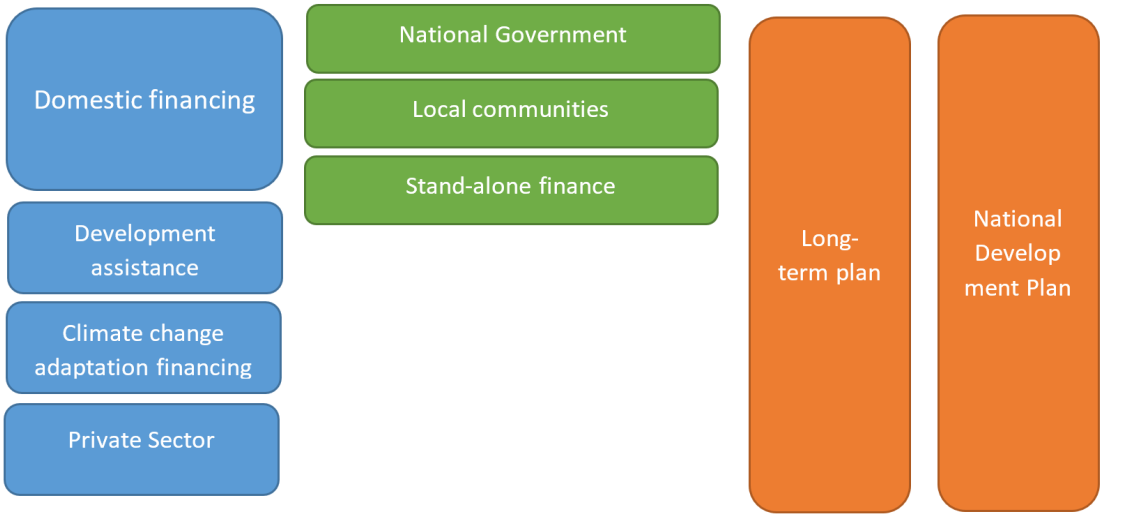
Restricting new developments, including in buffer zones, by strengthening and enforcing land-use regulations are also needed. Regulations are also needed to avoid unchecked urban development. Risk-sensitive land use and urbanisation plans must be enforced through construction norms and building regulations. The quality of construction and the role played by building regulations are key determinants of climate resilience.



5. Conclusions and Recommendations for Climate-Resilient Economic Growth

Despite substantial progress in analysing the climate risks, identifying efficient strategies, and devising sectoral capacity building, most of the current efforts are not enough to adapt to the predicted damages caused by climate change. While devising the strategies for achieving high-income countries by 2040, policies need to recognise climate and disaster risks and the availability of new technologies and finance. Hence, an integrated policy framework for international cooperation, as illustrated in Figure 16.12, is proposed. Future Viet Nam–Japan technical and financial assistance programmes could provide capacity support tailored for national, provincial, and local actors.

Figure 16.12. Climate and Disaster Risk Technology Risk Financing Cooperation Mechanisms



Source: Authors.

To achieve its climate change goals, Viet Nam needs to focus on restructuring the economy towards promoting sustainable growth models. The following are the main specific actions and opportunities for strengthening cooperation between Viet Nam and Japan:

First, integrating the goals of natural disaster prevention and climate change adaptation into regional and local development master plans and plans.

- To carry out a census and inventory to assess and classify the characteristics of natural, financial, infrastructure, human and cultural capital sources in each region and region to provide management and exploitation orientations, use, conserve, and develop those capital resources.
- To improve methods and procedures for forecasting and warning of natural disasters, earthquakes, and tsunamis, monitoring and monitoring of marine environment, climate change, and sea level rise for sustainable socio-economic development. Complete the data information system and inter-sectoral and inter-local sharing mechanism.
- To implement functional zoning based on the advantages and values of each region as a basis for localities to determine priorities in management, allocation, exploitation, and sustainable use of the values of natural capital for green economic development.
- To integrate disaster prevention and climate change adaptation into the goals and contents of restructuring the economy.
- To promote digital transformation in the economy as a key solution to improve added value, resilience, and resilience of production and business sectors and fields in the economy.
- To integrate goals and contents of disaster prevention and adaptation to climate change into the system of development planning at national, sectoral, regional, and local levels based on functional zoning based on advantages of geopolitics, resources, and functions of natural ecosystems according to the characteristics of each region or province.

Second, enhancing economic instruments and financial mechanisms to promote disaster prevention and adaptation to climate change.

- To promote restructuring of industries to reduce those that are heavily dependent on the exploitation of natural resources, especially non-renewable resources, with low added value and economic efficiency; outdated technologies, using a lot of energy and consuming resources, and having low competitiveness in the market also need to be considered and gradually eliminated.
- To give priority to industries with high technology, deep processing, efficient exploitation and use of natural resources, and competitiveness in the region and the world.
- To effectively implement preferential policies on taxes, fees, charges, and land for enterprises participating in the network of enterprises for green development, green production, and provision of environmentally friendly products and services. Provide financial support, apply tax, and market support policies to production facilities and localities to improve technology, and import modern technologies to transform into a green economy.
- To develop financial strategies to respond to natural disaster risks. Complete legal frameworks and guiding documents related to disaster risk management to facilitate the implementation of policies. Diversify investment capital sources for environmental protection and climate change response. Arrange separate expenditures from the state budget for climate change response using a variety of financial sources in disaster risk management; at the same time, it is necessary to determine the order of priority when using financial resources for each type of disaster risk.
- To create conditions for localities and businesses to access green financial capital sources such as green credit, and green bonds. Strengthen public-private partnerships to mobilise resources from the private sector in disaster prevention and climate change adaptation.
- To experiment with new economic instruments and financial mechanisms to create related

resources for disaster prevention and response to climate change such as payment for ecosystem services, biodiversity compensation, and disaster risk insurance.

Third, improving the resilience capacity of economic sectors and priority areas in response to natural disasters and climate change.

- To develop climate-smart agriculture to ensure sustainable productivity growth, resilience, adaptation to climate change, and reduction/elimination of greenhouse gas reduction (mitigation) to ensure national food security and achieve development goals. To solve this problem, it is necessary to promote shifting to climate-smart agriculture. Specific contents to be implemented in building smart agriculture to adapt to climate change include land management and improvement of nutrient content in soil; efficient water storage and use; pest assessment and disease control; building and developing smart farming systems; enhancing ecosystem resilience; and conservation of genetic resources.
- To replicate and develop green economic models to adapt to climate change through measures that improve adaptation and recovery capacity of production in business industries, in non-agricultural sectors, and industries such as transportation, and construction. To replicate and develop climate change adaptation models in vulnerable areas through (for instance) water-saving rice irrigation, changing farming methods and diversifying livelihoods to adapt to climate change, developing smart cities; watershed management model with the participation of the community, strengthening coastal ecosystem management and development community livelihoods to respond to climate change; building coastal and island cities to adapt to climate change.
- To ensure energy security in the context of climate change. In the context of climate change, the negative impacts of climate change on energy are mentioned in three aspects: renewable energy, the raw material extraction industry, and energy supply–demand. The key solutions to focus on include: (i) energy saving and efficiency through the implementation of communication activities to mobilise people to be conscious of saving and using energy efficiently; (ii) strengthening the survey and exploration of energy resources to improve the potential and storage is a regular solution, to enhance the ability to exploit and produce primary energy sources, reduce the external dependencies; (iii) diversification of energy sources are solutions to diversify exploitation and use of different types of energy sources; (iv) strengthening domestic capacity in supplying energy products, attention should be paid to building processing facilities, energy storage; (v) applying incentive policies to promote the development of renewable energy including solar energy, wind energy; and (vi) formation and development of a competitive electricity market through price mechanisms within the government orientation.
- Conservation of biodiversity: to increase the area of natural ecosystems that are protected and restored and ensure their integrity and connectivity. Biodiversity is conserved and used sustainably to contribute to a green economy. It is carried out by promoting the National Strategy on Biodiversity through (i) improving the efficiency of management of the system of natural heritage, nature reserves,

and biodiversity corridors; (ii) consolidating and expanding natural areas of national and international importance; (iii) restoring degraded important natural ecosystems; (iv) conserving and restoring endangered wild species, especially endangered, precious, and rare animals prioritised for protection, and migratory species.

Fourth, developing science and technology for natural disaster prevention and response to climate change.

- To improve methods and procedures for forecasting and warning of natural disasters, earthquakes, tsunamis, monitoring and monitoring of marine environment, climate change, and sea-level rise for sustainable socio-economic development, sustainability, disaster prevention, and response to climate change with multiple goals and fields.
- To strengthen linkages amongst the state, scientists, businesses, and people, aiming at scientific products. Green technology learning should be transferred to people and businesses at a reasonable price.
- To continue implementing programmes and projects on science and technology for environmental protection and prevention of natural disasters. Effective use and management of natural resources, protect the environment, and respond to climate change. To prioritise several research topics and programmes in terms of models of integrated regional management towards sustainability. To accelerate the renovation of production and construction technologies towards the application of production and construction technologies that consume fewer raw materials, fuel, and energy. To strengthen the development of modern technologies in exploitation to minimise resource loss.
- To encourage the development of cooperation and transfer of new and advanced technologies that strive for the sustainable use of natural resources, maintenance, conservation, and development of biodiversity associated with regions.
- To prioritise research and investigation of environmental geology and urban geology in service of development planning and prevention of the risks of geological hazards in the context of climate change.

Fifth, investing in high-quality infrastructure to strengthen natural disaster prevention and response to climate change.

- To strengthen the construction and improvement of infrastructure in urban and rural areas towards sustainability, environmental protection, and response to climate change. Focusing on effective adaptation and resilience solutions to climate change impacts in regional integrated management that includes water supply, transportation, energy supply, lighting, collection, and treatment systems of wastewater, solid waste, and cemeteries.
- To increase investment in synchronous infrastructure, create favourable conditions for green technology development, give priority to renewable energy technology, contribute to achieving NDC goals, and transition to an economy based on low-carbon energy sources.
- To invest in infrastructure and human resources for community health care. The health infrastructure has not yet met the standards of medical examination and treatment in the context of epidemics caused by climate change and environmental degradation. The infrastructure for

community health care in the context of climate change for vulnerable social groups such as ethnic minorities and the poor in rural, remote, mountainous areas and islands has not been developed like other regions.

- The state prioritises capital from the budget or public-private partnership mechanisms to mobilise capital in line with the green economic development orientation, adapted to the climate change of each region (e.g., green agriculture, eco-tourism).
- Natural infrastructure is an integral part of natural capital, bringing sustainable economic, environmental, landscape, and social effects. Natural infrastructure needs to be identified, evaluated, and prioritised for protection, use, and development, and replaced only with the use of man-made infrastructure when necessary. Therefore, ministries, branches, and provincial People's Committees integrate the value of natural capital in development strategies, master plans, programmes, and projects; organisations and individuals whose activities are accountable for causing pollution or degradation of natural capital; or those who benefit from investment activities in the restoration and enhancement of the value of natural capital are responsible for making financial contributions as prescribed by law.
- To invest in supporting equipment and strengthening facilities for local management agencies (district and commune levels) to carry out the work of monitoring and inspecting the implementation of regulations on environmental protection in the business establishments and households.

Sixth, mobilising private capital to leverage public financing of climate-resilient growth.

a) Natural capital:

- To integrate the exploitation, use, and development of natural capital resources into strategies, programmes, and planning.
- To develop the detailed criteria, roadmap, action plan, incentive mechanism, and priority for investment in the development of natural capital suitable to the country's socio-economic conditions in each period. Guide the inventory, assessment, and accounting of the value of natural capital to serve as a basis for the formulation and organisation of implementation of development strategies, plannings, and projects.
- To prioritise investment resources and encourage organisations and individuals to invest in the conservation, development, and effective use of natural capital sources, promote natural advantages and develop sustainable economic growth models.
- Revenues from natural capital must be prioritised to create concentrated resources for reinvestment, recovery, development, and enhancement of the functions and value of natural capital.

b) Financial capital

- To promulgate policies to support and create favourable conditions for people and businesses to easily access preferential loans to develop production and business projects oriented towards green economic development, circulation, and adaptation to climate change.
- To create conditions for localities and businesses to access green financial capital to implement investment projects in climate change adaptation projects, such as green credit sources, and green bonds; and develop green taxonomy to support for assessing new financial products.
- To prioritise allocation of the state budget to green development projects and programmes; projects to renovate, restore and develop natural capital resources in different regions.

Continue to mobilise and effectively use foreign capital to support the goal of responding to climate change.

c) Human capital and social capital

- To carry out investigation, assessment, and classification of traditional knowledge, indigenous knowledge, and cultural values of each locality and ethnic group to propose a solution for a harmonious combination of available green technologies. To replicate and develop good models and good practices on disaster prevention and response to climate change.
- To assess and identify the values of social capital in each region in terms of disaster prevention and adaptation to climate change; to integrate those values into development strategies and master plans at the national and regional levels. To combine the value of social capital with other capital sources to find models and solutions for harmonious development.
- To create favourable conditions to promote the organisation of social networks, rules, and standards of the community in building a green economy in each region and locality. Therefore, it is necessary to improve the legal framework to encourage socio-political organisations, unions, associations, and groups to participate in environmental protection and response to climate change; mobilise resources for green economic development.
- To organise communication activities, provide information and documents on social capital, factors related to social capital, and ways to use social capital for officials and people to bring social capital to become a resource for sustainable green economic development in each locality under the region.

Seventh, promoting communication, education, and training to disseminate knowledge to improve people's capacity to access knowledge and techniques to develop climate-resilient economic models in the Mekong River basin.

- To develop communication programmes, capacity building in research, and implementation of content related to climate change response. To focus on developing communication materials and integrating education on disaster prevention and climate change adaptation into school curricula and communities.
- To develop guiding documents for officials at all levels, sectors, businesses, and people on how to identify, deploy, and evaluate models for disaster prevention and adaptation to climate change. suitable to the characteristics of each region or region.
- To diversify communication channels on mass media to introduce and promote good models and good practices.
- To raise awareness of development models that are resistant to natural disasters and climate change.
- To mobilise the participation of mass organisations using various methods of propagating and disseminating knowledge about nature, the environment, and the regional green economy to union members, members, and people.
- To organise staff training, especially grassroots level, on green economy in general and regional green economic models (in particular). To focus on improving the capacity of grassroots officials to identify green economic activities and models suitable to the characteristics of each locality in the region, i.e. building, implementing, evaluating, and replicating the green economic model in the locality.

References

Anbumozhi, V. (2022), 'Realising Smart Cities', in ERIA (ed.), *The Comprehensive Asia Development Plan 3.0 (CADP 3.0): Towards an Integrated, Innovative, Inclusive, and Sustainable Economy.* Jakarta: ERIA, pp.322–52. https://www.eria.org/uploads/media/Books/2022-CADP-3/15_ch.11-Smart-Cities.pdf (accessed 15 May 2023).

Anbumozhi, V., M. Beiling, and V. Reddy (eds.) (2019), *Towards a Resilient ASEAN. Volume 1. Disasters, Climate Change, And Food Security: Supporting ASEAN Resilience, volume 1.* Jakarta: ERIA. https://www.eria.org/uploads/media/Books/2019-Towards-a-Resilient-ASEAN-Vol1/Towards-a-Resilient-ASEAN-Vol-1.pdf (accessed 15 May 2023).

Anbumozhi, V., F. Kimura, and S.M. Thangavelu (eds.) (2020), *Supply Chain Resilience: Reducing Vulnerability to Economic Shocks, Financial Crises, and Natural Disasters.* Jakarta: ERIA-Springer. Supply Chain Resilience: Reducing Vulnerability to Economic Shocks, Financial Crises, and Natural Disasters | SpringerLink (accessed 18 May 2023).

Asian Development Bank (ADB) (2019), *Asian Development Outlook 2019: Strengthening Disaster Resilience.* Manila: ADB. https://www.adb.org/sites/default/files/publication/492711/ado2019.pdf (accessed 22 May 2023).

Climate Bond Initiative (CBI) (2022), *ASEAN Sustainable Finance: State of the Market 2021*. https://www.climatebonds.net/files/reports/cbi_asean_sotm2022_final.pdf (accessed 22 May 2023).

Communist Party of Vietnam (2013), *Resolution on Active Response to Climate Change, Improvement Of Natural Resource Management And Environmental Protection, 7th Congress, 11th Central Executive Committee,* https://cdn.climatepolicyradar.org/navigator/VNM/2013/resolution-active-in-response-to-climate-change-improvement-of-natural-resource-management-and-environmental-protection_ae728a22630dfa863c9f9f2c38a43d4f.pdf (accessed 22 May 2023).

Decree 35 (2021), *Decree No. 35/2021/ND-CP,* https://frasersvn.com/wp-content/uploads/2021/06/Legal-Update-PPP-Law-June-2021.pdf (accessed 23 May 2023).

Eckstein, D., V. Künzel, and L. Schäfer (2021), *Global Climate Risk Index 2021: Who Suffers Most From Extreme Weather Events? Weather-Related Loss Events in 2019 and 2000–2019.* Germanwatch. https://www.germanwatch.org/sites/default/files/Global Climate Risk Index 2021_2.pdf (accessed 23 May 2023).

European Commission, Joint Research Centre, M. Marin-Ferrer, K. Poljanšek, and L. Vernaccini (2017), *Index For Risk Management - INFORM – Concept and Methodology,* Version 2017, Publications Office. https://data.europa.eu/doi/10.2760/094023 (accessed 23 May 2023).

General Statistic Office (GSO) (2022), *Niên giám thống: Statistical Yearbook of Viet Nam.* Hanoi: Statistic Publishing House.

Hills, J. et al. (2022), *Blue Economy Scenarios for Viet Nam. Ha Noi: UNDP Viet Nam*. https://www.undp.org/vietnam/publications/blue-economy-scenarios-viet-nam (accessed 23 May 2023).

International Monetary Fund (IMF) (2022), *IMF Country Report No.22/209: Vietnam, 2022 article IV consultation–press release; staff report; and statement by the executive director for Vietnam.* https://www.elibrary.imf.org/view/journals/002/2022/209/article-A000-en.xml?ArticleTabs=fulltext (accessed 23 May 2023).

Institute for Meteorology, Hydrology, and Climate Change (IMHEN) & United Nations and Development Programme (UNDP) (2015), *Summary for Policy Makers: Viet Nam Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* Hanoi: Viet Nam Natural Resources and Environment Publishing House.

Law on Crop Production, No 31/2018/QH14 (2018), https://www.climate-laws.org/documents/law-no-31-2018-qh14-on-crop-production_63f9 (accessed 24 May 2023).

Law on Dikes, No: 79/2006/QH11 (2006), https://thuvienphapluat.vn/van-ban/EN/Xay-dung-Do-thi/Law-No-79-2006-QH11-on-dikes/116843/tieng-anh.aspx (accessed 24 May 2023).

Law on Hydro-meteorology, No. 90/2015/QH13 (2015), https://leap.unep.org/countries/vn/national-legislation/law-hydro-meteorology-no-902015qh13 (accessed 24 May 2023).

Law on Investment in the Form of Public-Private Partnership, No.64/2020/QH14. https://english.luatvietnam.vn/law-on-investment-in-the-form-of-public-private-partnership-no-64-2020-qh14-dated-june-18-2020-of-the-national-assembly-186267-doc1.html (accessed 24 May 2023).

Law on Natural Disaster Prevention and Control, No. 33/2013/QH13 (2013), https://cdn.climatepolicyradar.org/navigator/VNM/2013/law-on-natural-disaster-prevention-and-control_3730fbb046133fbc6dfe90b7dfea0f51.pdf (accessed 24 May 2023).

Ministry of Economy, Trade, and Industry (METI) (2021), *Climate Change Adaptation Good Practices by Japanese Private Sector.* https://www.meti.go.jp/policy/energy_environment/global_warming/adaptation_goodpractice_FY2020ENG.pdf (accessed 25 May 2023).

Ministry of Natural Resources and the Environment (MONRE) (2021), *Climate change scenario.* Hanoi: Viet Nam Publishing House of Natural Resources, Environment and Cartography.

Ministry of Natural Resources and the Environment (MONRE) (2022), *Technical Report for the development of the National Action Plan on Climate Change*. Hanoi: Ministry of Natural Resources and Environment.

Socialist Republic of Viet Nam (2021), *Full remarks by PM Pham Minh Chinh at COP26.* https://en.baochinhphu.vn/full-remarks-by-pm-pham-minh-chinh-at-cop26-11142627.htm (accessed 25 May 2023).

Thanh, M.V., T.D. Vien, S.J. Leisz, and G.P. Shivakoti (eds.) (2017), *Redefining Diversity & Dynamics of Natural Resources Management in Asia, Volume 2: Upland Natural Resources and Social Ecological Systems in Northern Vietnam.* New York: Elsevier. https://doi.org/10.1016/C2015-0-04335-0. pp.257–63.

United Nations Development Programme (UNDP) & the Hanns Seidel Stiftung Foundation (HSF)-Germany (2020), *National Report 2020: Progress of Five-Year Implementation of Sustainable Development Goals.* https://www.undp.org/sites/g/files/zskgke326/files/migration/vn/Summary-national-SDG-report_ENG.pdf (accessed 26 May 2023).

VCCI Vietnam & The Asia Foundation (2020), *Adapting to Succeed: Assessing the Impact of Climate Change on Vietnamese Businesses.* https://asiafoundation.org/wp-content/uploads/2020/10/Adapting-to-Succeed_Assessing-the-Impact-of-Climate-Change-on-Vietnamese-Businesses_EN_2020.pdf (accessed 26 May 2023).

World Bank (2022a), *Viet Nam: Country Climate and Development Report.* Washington, DC: International Bank for Reconstruction and Development / World Bank Group. https://openknowledge.worldbank.org/server/api/core/bitstreams/a27f1b05-910d-59ab-ba2c-84206bf107c2/content (accessed 2 June 2023).

World Bank (2022b), *Accelerating Clean, Green, and Climate-Resilient Growth in Viet Nam: A Country Environmental Analysis.* Washington, DC: World Bank. http://hdl.handle.net/10986/37704 License: CC BY 3.0 IGO (accessed 3 June 2023).