SUMMARY REPORT >>













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BETWEEN OPPORTUNITY AND DISASTER RISK





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n a country that is among the most exposed to natural hazards. Vietnam's coastline often bears the brunt. Typhoons, storm surges, riverine flooding, coastal erosion, drought, or saline intrusion are all-too-familiar threats to most people living along the coast. Yet despite these risks, coastal regions host thriving economic sectors, providing livelihoods for a growing and rapidly urbanizing population. The coastal regions could be a powerful engine for Vietnam's continued socioeconomic development, but rapid urbanization, economic growth, and climate change mean that disaster risks are bound to increase in the future.

Although the government of Vietnam has made impressive progress in reducing and managing natural risks, current trends show that the work is far from complete. To guide effective action, this report provides an in-depth and multisectoral analysis of natural risks in coastal Vietnam and reviews current efforts in risk management, proposing a concrete action plan to balance the risks and opportunities of coastal development. These actions, if taken decisively, are an opportunity to strengthen the resilience of coastal communities and hence the prosperity of coming generations.

Natural risks to coastal communities are substantial and increasing.

This report offers detailed estimates of the

natural risks faced by people, towns, key economic sectors, infrastructure systems, and public services in Vietnam's coastal zone. The overall picture is clear: the threats are significant and growing. Around 11.8 million people in coastal provinces are exposed to the threat of intense flooding¹ and over 35 percent of settlements are located on eroding coastlines. And on a coastline that is already crowded - more

than one-third of it is built-up — development continues to concentrate along the coast, especially in high-risk areas. Flood risks in high-growth areas are twice as high as in low-growth areas. Key economic sectors that create the foundation for future development and prosperity are facing significant disaster risks. Each year, an average of \$852 million — or 0.5 percent of national GDP — and 316,000 jobs are at risk from riverine² and coastal flooding in the agriculture, aquaculture, tourism, and industry sectors.

Essential public services are also at risk: 26 percent of public hospitals and health care centers and 11 percent of schools are exposed to intense coastal flooding, compromising their ability to provide critical services when they are most needed. Flooding of facilities is not the only concern: every year, typhoons and floods cause about \$144 million in direct damages to public transport infrastructure.³ Average annual damages to energy infrastructure amount to \$330 million, not least because more than one-third of Vietnam's transmission grid is located in forested areas, at risk of falling trees and branches during storms.³ When infrastructure is affected by disasters, it obstructs people's access to jobs, education and health

care, and damages the competitiveness of firms. The lack of reliable and resilient infrastructure disrupts firms' operations, causing some \$280 million in utilization rate losses each year.⁴

While the risks from flooding, drought, erosion, and saline intrusion are already substantial, climate change is expected to intensify these natural hazards. In a pessimistic scenario, mean sea levels are estimated to rise 30 centimeters by 2050 and 70 centimeters by 2100.⁵ This increases exposure of urban areas to intense flooding by 7 percent, exposing an additional 4.5 million people in coastal areas. Without action, human pressures on ecosystems — for instance, due to ground water extraction and sand mining — will exacerbate these risks.

Despite much progress, current risk management measures are falling short of needs.

The government has made impressive progress in managing disaster risks in recent decades, investing in structural and non-structural risk reduction measures and adopting extensive legal, regulatory and policy frameworks to guide coastal development in safe and sustainable ways. However, these measures fall short of the country's needs.

Hazard and socioeconomic risk information is fragmented and incomplete, often drawing from global databases and relying on a single scenario in plans and project designs. A lack of guidance, enforcement, capacity and funding have led to shortcomings in implementing risk-informed spatial planning, building codes and safety standards, and systematic maintenance of infrastructure systems. Two-thirds of Vietnam's dike system, which stretches over 2,659 km, does not meet the prescribed safety standards; in many high-growth provinces, even the set standards leave substantial protection gaps.⁶ Nature-based systems have an often underappreciated role in boosting coastal resilience, and are under increasing pressure from development and over-exploitation. And although Vietnam has made tremendous progress in reducing losses from natural disasters, evolving and intensifying risks mean that the government must further improve its systems for disaster financing, relief, and response.

An action plan to balance the risks and opportunities of coastal development.

To ensure that Vietnam's coastal regions

can continue fulfilling their potential as engines of resilient socioeconomic growth and prosperity, the government must take urgent action. If the current trends of rapid economic development in high-risk areas continue, disaster losses are bound to increase unless such growth is resilient and risk-informed. Delaying action by 10 years could expose an additional \$4.3 billion of economic growth to natural shocks.

This report presents a concrete action plan to strengthen resilience in coastal areas, outlining five areas of strategic interventions:

 Strengthening data and decisionmaking tools. To manage risk effectively, decision makers need up-to-date information. Establishing systematic, detailed hazard, risk and assets management information at

national and subnational scales is essential for making evidence-based decisions on coastal area development and planning.

2. Enforcing risk-informed planning. To ensure economic growth in coastal zones does not irreversibly lock in unsafe development, risk-informed zoning and spatial planning is vital and this should be based on the best available risk information.

- 3. Strengthening the resilience of infrastructure systems and public services. To ensure that lifeline infrastructure systems can deliver their essential services, critical assets should be strengthened by integrating risk information into the planning, design, and maintenance stages of all infrastructure investments. Upgrades should start in the most exposed and under-protected areas and existing safety standards should be reviewed and updated.
- 4. Taking advantage of nature-based solutions. To harness the protective function and economic contribution of ecosystems (including mangroves and sand dunes), a systematic approach to their rehabilitation, conservation, monitoring, and management is essential. Relevant policy, regulatory and legal frameworks must be strengthened and lessons from past initiatives consolidated to inform technical guidelines and future programs.
- 5. Improve preparedness and response capacity. Disaster risk can never be

fully eliminated. To manage residual risk and prepare Vietnam for more intense natural risks, the government must further strengthen its emergency response capacity. This includes upgrading the effectiveness of its early warning system, strengthening local response capacity, adapting social safety nets, and implementing a comprehensive risk financing strategy.

The government's experience with disaster risks, and its proven long-term planning approaches, are important elements for implementing a resilient development strategy. Through decisive action, Vietnam has an opportunity to safeguard future prosperity and development in the face of climate change and disaster risks.

- 1. Intense flooding refers to flooding with a 100-year return period or a 10 percent probability of occurrence in a decade.
- 2. In this report, riverine refers to as the combination of fluvial and pluvial flooding.
- 3. World Bank DRFI Program. 2019. Vietnam Country Risk Assessment. Washington, DC
- Losses are associated with infrastructure disruptions caused by natural and non-natural shocks (Rentschler, J, Kornejew, M, Hallegatte, S, Braese, J and Obolensky, M. 2019. Underutilized Potential: The Business Costs of Unreliable Infrastructure in Developing Countries. World Bank Policy Research Working Paper no. 8899.)
- 5. MONRE. 2016. Climate Change and Sea Level Rise Scenarios for Vietnam. Hanoi, Vietnam.
- van Ledden, M, Tung, T T, Nguyen, D H and Nguyen, L T. 2020. Coastal Development in the Face of Natural Hazards: Assessment of the Coastal Protection System in Vietnam. World Bank Policy Research Working Paper.

Summary report

In November 2017, Typhoon Damrey hit Vietnam, killing 107 people and damaging or destroying more than 300,000 houses across 15 provinces. It also caused around \$1 billion in economic losses, affecting people's incomes and livelihoods (GFDRR 2018). A devastating reminder of the destructive force of nature, Damrey highlighted the need to further boost communities' resilience to safeguard the development potential of Vietnam's coastal regions.

coastal regions host thriving economic sectors, providing livelihoods for a growing and rapidly urbanizing population. Growth sectors include modern large-scale agriculture, aquaculture, tourism, manufacturing, service industries, and international maritime trade. The coastal regions could be a powerful engine for Vietnam's continued socioeconomic development, but rapid urbanization, economic growth, and climate change mean that risks are bound to increase in the future.

Although the government of Vietnam has made impressive progress in reducing and managing natural risks, current trends show that it needs to take further action to safeguard future development in the face of disaster risks. However, designing a comprehensive coastal resilience strategy can be challenging when that coastline stretches more than 3,200 kilometers, faces a wide range of hazards, is administered by 28 provincial governments, and has a limited budget for implementing resilience measures.

particularly along its coast. Da Nang Province alone experienced 26 typhoons, 13 tropical depressions, and 46 flood incidents between 1998 and 2015. Nationally, natural shocks cause private and public asset losses worth an average of \$8.1 billion in purchasing power parity (PPP) terms each year; that is \$2.7 billion in real terms (UNISDR 2015). About 60 percent of these losses are caused by typhoons and accompanying storm surges (100 Resilient Cities 2017; World Bank DRFI Program 2019). But asset losses do not tell the full story: annual losses to people's well-being from natural disasters are estimated at around \$11 billion in PPP terms (Hallegatte et al. 2016).¹

Vietnam has long experience of natural disasters,

The estimated annual loss to people's well-being from natural disasters.

In a country that is among the most exposed to natural hazards, the coastline often bears the brunt. Typhoons, storm surges, riverine flooding, coastal erosion, or saline intrusion are all-too-familiar threats to most people living along Vietnam's coast. Yet despite these risks,

\$11B



In this context, the government must decide which areas face the highest level of risk, what measures can help mitigate these risks, and which actions to prioritize. To this end, this report provides an in-depth analysis of natural risks in coastal Vietnam and proposes a comprehensive risk management strategy to safeguard future development with a concrete action plan based on rigorous analytical evidence. It also provides in-depth risk assessments and risk reduction strategies for six coastal districts, developed in close consultation with local and national stakeholders (figure 1).

Key messages

Using a combination of a nationwide cross-sectoral risk assessment and detailed hotspot analyses for six coastal locations, this report provides a detailed picture of disaster risks in Vietnam. It arrives at three key messages:



Natural risks in coastal Vietnam are

substantial and growing. Natural disasters threaten people, economic sectors, public services, and lifeline infrastructure in Vietnam's coastal provinces. With many safe spaces occupied, new development in highrisk zones is increasing. Rapid urbanization, economic development, and climate change will exacerbate risks in the future.



FIGURE 1 >>

The six hotspot locations selected to develop tailored resilience strategies

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Despite impressive progress in recent years, current disaster risk management measures are falling short of the country's needs. While the government has made substantial progress, significant gaps compromise the coastal regions' development potential-in data and decision-making tools, risk reduction measures, and emergency preparedness and response capacity. To achieve its development goals in the face of climate change, Vietnam must address these shortcomings.



A tailored action plan is needed to balance the risks and opportunities of resilient coastal development.

Based on the risks and policy gaps identified, this report recommends concrete actions in five areas to reduce and manage disaster risks:

1. Strengthen data and decisionmaking tools; 2. Enforce risk-informed coastal planning; 3. Increase infrastructure resilience: 4. Take advantage of nature-based solutions; and 5. Improve disaster preparedness and response capacity. Together, these measures can help build a resilient and prosperous future for Vietnam's coastal communities.

FIGURE 2 >>

Diagnosis: a multi-sectoral risk assessment of Vietnam's coastal provinces

People and urban areas









People 11.8 million people are directly exposed to the threat of intense flooding

Towns Over 35% of coastal settlements are located on eroding coastlines

Key economic sectors



Aariculture \$1 billion of agricultural GDP and 1.5

million workers are directly exposed to the threat of intense flooding

PART

Diagnosis: evolving natural risks in coastal Vietnam

ietnam's coastal provinces have long played a major role in the country's socioeconomic development, and their contribution is bound to increase. Home to half the population, they have the potential to be a powerful engine of growth and prosperity. However, typhoons, storm surges, flooding, droughts, coastal erosion, and saline intrusion threaten this development. Assessing the impact of natural hazards on the people, key economic sectors, vital public services, and lifeline infrastructure (figure 2), this report considers Vietnam's extensive coastal protection infrastructure and provides spatially disaggregated and sectoral estimates of flood risk for the 28 coastal provinces.

People and urban areas

Economic opportunity vs risk in coastal towns

Vietnam's coastal regions are undergoing rapid development,



Aquaculture

1.1 million tons of aquaculture production is at risk, corresponding to \$935 million in exports



eroding beaches

Industry Half of all industrial zones are directly exposed to the threat of intense flooding





Schools

22% of schools could be directly exposed to the threat of intense flooding



26% of health care facilities are directly exposed to the threat of intense flooding

Lifeline infrastructure





roads, resulting in daily

losses of \$114-324 million

exposed to falling trees in

severe storms



Energy A typhoon with wind speeds 36% of transmission lines of up to 200 km/h can close are in forested areas,

Water

52 out of 63 provinces could depend on water-stressed river basins by 2030

attracting many people to settle there. Opportunities in tourism, aquaculture, industry, and other sectors have helped sustain prosperous livelihoods and decrease poverty rates, which are among the lowest in the country. Almost one-third of the coastline is urbanized or built-up, and the coastal provinces - home to 46.6 million people contributed 60 percent of national gross domestic product (GDP) in 2016.² Secondary cities in the North and South Central Coast Regions have experienced some of Vietnam's highest urban growth rates since 2012 (World Bank 2020).

While proximity to the coast offers economic opportunities, it also increases exposure to natural hazards, threatening lives and livelihoods. This report's assessment of nightlight satellite and flood hazard data shows that urban and economic growth is occurring disproportionately in high



Sources: Based on data from Fathom³ and World Bank 2020. Note: Low growth areas could be either not yet developed or already developed.

disproportionately occuring in highrisk areas

flooded by coastal and riverine flooding, grouped by nightlight growth 2012-2017

FIGURE 4 >>

Coastal flood exposure is concentrated in the two main river delta regions

Province	Coastal flood risk	Riverine flood risk
NORTHEAST		
Quang Ninh	32	7
RED RIVER DELTA		
Hai Phong City	62	2
Thai Binh	- 67	4
Nam Dinh	- 68	4
Ninh Binh	29	2
NORTH CENTRAL COAST		
Thanh Hoa	27	24
Nghe An	16	10
Ha Tinh	8	4
Quang Binh	1	5
Quang Tri	0	3
Thua Thien-Hue	1	10
SOUTH CENTRAL COAST		
Da Nang City	2	7
Ouang Nam	1	16
Ouang Ngai	1	17
Binh Dinh	1	17
Phu Yen	0	8
Khanh Hoa	2	11
Ninh Thuan	0	5
Binh Thuan	2	10
SOUTHEAST	-	
Ba Ria-Vung Tau	7	4
Ho Chi Minh City	54	15
MEKONG RIVER DELTA		
Tien Giang	19	4
Ben Tre	47	4
Tra Vinh	22	5
Soc Trang	15	4
Bac Lieu	19	2
Ca Mau	4	3
Kien Giang	3	6
i diang		
	0 10 20 30 40 50 60 70	0 10 20 30 40 50 60 70
Coastal Vietnam:	508	212

Average number of people exposed to flooding each year (thousands)

Sources: General Statistics Office of Vietnam (population data),² Fathom (coastal flood maps),³ Braese et al. 2020 (riverine flood maps). Note: Averages calculated using 5, 20 (riverine)/25 (coastal), 50, 100, 250 and 500-year return periods.

flood risk areas (figure 3). On average, more than half a million people are exposed to annually occurring coastal flooding (figure 4). This increases to 12 million people (12.6 percent of the population) who are exposed to rare and intense coastal flooding events (with a 10 percent probability of occurrence in a decade). In economic terms, \$852 million (0.5 percent of GDP) and about 316,000 jobs are directly exposed to coastal and riverine flooding every year. If current growth rates in coastal areas are sustained, the additional risk to economic activity could be equivalent to \$6.8 billion by 2030 if no resilience measures are taken. Delaying action by 10 years could expose \$4.3 billion of economic growth to natural shocks.

As more people settle in coastal areas, natural and human-induced erosion are increasingly affecting their homes and livelihoods. Entire villages – such as Tan An in Thua Tien-Hue province and Khe Tan in Quang Ngai province – are built on dunes, vulnerable to erosion. In some places, the coastline has retreated as much as 300 meters, displacing hundreds of households and disrupting livelihoods. Analysis for this report shows that only 19 percent of coastal settlements are near stable coastlines, more than one-third experience eroding shores, and almost half experience accretion. In the Mekong Delta, 38 percent of coastal settlements face strong erosion. Case studies show that much of this erosion is human-induced, through overexploiting, poorly planned infrastructure and developing sensitive ecological zones.

A threat to sustained poverty reduction

Vietnam has achieved extraordinary success in lifting

people out of poverty and boosting shared prosperity. The poverty headcount rate decreased dramatically from 58 percent in 1990 to 9.8 percent in 2016.² However, increased exposure to natural hazards threatens these achievements and poses a challenge to further poverty reduction among vulnerable and highly exposed communities. Evidence shows that low-income households in Vietnam tend to live in districts with higher exposure to hazards, including air pollution, tree cover loss, human-induced land degradation, land slide risk, erosion, rainfall or temperature variability, and drought hazards (Narloch and Bangalore 2018). Flood hazards tend to be highest in coastal areas, which also have lower poverty rates. But local pockets of poverty persist, and the poor tend to be disproportionally exposed to floods. In Ho Chi Minh City, for example, slums are more exposed to floods than other areas, and climate change will only increase this inequality (figure 5). A 30-centimeter rise in sea level would increase flood exposure by 6 percentage points across the city as a whole, but by 15 percentage points in slum areas (Bangalore et al. 2017).

Key economic sectors

Key sectors that create the foundation for future development and prosperity are facing significant disaster risks. The analysis conducted for this report indicates that, each year, an average of \$852 million (0.5 percent of national GDP) and 316,000 jobs are at risk from riverine and coastal flooding in the agriculture, aquaculture, tourism and industry sectors (figure 6).

Agriculture and aquaculture production

Agriculture is crucial for the Vietnamese economy,



FIGURE 5 >>

Within urban areas in Ho Chi Minh City, the poor are disproportionally exposed to flood risks

Source: Adapted from Bangalore et al. 2017

accounting for 15 percent (\$25.9 billion) of national GDP in 2017, employing 40 percent of the working population (28.9 million people) and providing livelihoods for many of the country's poorest people (World Bank 2019). Similarly, in 2020 aquaculture is expected to contribute \$8–9 billion (5 percent of GDP) and 5 million jobs (MARD 2015). But most agricultural and aquaculture production is concentrated in the low-lying river deltas and coastal provinces, which together account for 83 percent of total national rice

FIGURE 6 >>

Flood exposure of key economic sectors in coastal Vietnam

Average annual production value at risk from coastal (a) and riverine (b) flooding in \$, millions

	Agricu	ulture	Aquac	culture Tourism		Industry		
Province	Coastal flood risk	Riverine flood risk						
NORTHEAST								
Quang Ninh	1.5	0.6			15.7	10.2	20.3	0.8
RED RIVER DELTA								
Hai Phong City	2.9	0.1	2.4	0.1	8.3	0.9	14.2	0.4
Thai Binh	4.9	0.3	5.5	0.3	1.1	0.1	1.1	0.1
Nam Dinh	5.6	0.3	4.1	0.2	0.8	0.0	1.4	1.4
Ninh Binh	3.0	0.1	1.5	0.1	25.3	0.9	2.4	2.0
NORTH CENTRAL COAST								
Thanh Hoa	2.7	2.2			4.0	3.3	5.9	7.7
Nghe An	2.1	1.8			3.2	2.6	3.8	9.0
Ha Tinh	1.9	0.9			1.1	1.5	6.5	11.6
Quang Binh	0.7	2.1			9.6	27.9	1.1	1.4
Quang Tri	0.2	1.8			0.7	7.3	0.2	0.1
Thua Thien-Hue	0.5	1.7			15.6	41.9	1.0	1.0
SOUTH CENTRAL COAST								
Da Nang City	0.0	0.3			7.2	22.5	4.6	2.4
Quang Nam	0.0	3.2			14.4	40.1	1.5	2.9
Quang Ngai	0.1	2.4			0.4	7.7	3.2	0.3
Binh Dinh	0.1	1.8			0.5	14.4	2.7	0.7
Phu Yen	0.0	0.9			1.1	7.8	0.3	0.0
Khanh Hoa	0.1	1.3			6.5	25.2	0.8	0.9
Ninh Thuan	0.0	0.8			0.8	5.6	0.2	0.1
Binh Thuan	0.0	2.7			12.1	41.0	0.4	0.8
SOUTHEAST								
Ba Ria-Vung Tau	0.1	0.3			14.7	25.7	2.4	0.1
Ho Chi Minh City	0.8	0.1			16.0	10.8	3.3	13.7
MEKONG RIVER DELTA								
Tien Giang	3.3	0.4	5.2	6.6	2.1	3.5	0.2	0.1
Ben Tre	5.9	0.5	24.7	11.9	2.9	2.5	0.1	0.0
Tra Vinh	5.2	0.7	7.9	4.7	1.1	0.7	0.0	0.0
Soc Trang	1.9	0.6	6.3	8.8	0.0	0.3	0.0	0.0
Bac Lieu	2.0	0.1	13.0	10.6	0.1	0.1	0.0	0.0
Ca Mau	0.6	0.1	4.6	15.5	0.2	1.1	0.0	0.1
Kien Giang	1.2	2.0	3.3	0.4	12.7	18.1	0.1	0.1
COASTAL VIETNAM	47.2	30.0	78.5	59.1	178.2	323.7	77.6	57.9

Average annual value at risk (\$, millions)

Sources: JAXA EORC 2018 (land use maps), Open Street Map (tourism data), World Bank DRFI Program, 2019 (industry data), Braese et. al. 2020 (coastal flood data); and Fathom (riverine flood data).³

Notes: For all sectors except industry, estimates are based on contribution to GDP. For industry, estimates are sourced from World Bank DRFI Program (2019). For aquaculture, geo-referenced pond data were only available for provinces in the Red River and Mekong Deltas, which account for about 86 percent of national aquaculture production.

production (figure 7a). The Mekong River and Red River Deltas also account for 70 and 16 percent of total national aquaculture output respectively.

Natural hazards cause significant damage in the sector each year. Storms and floods destroy crops, inundate ponds, damage yields, and kill livestock; droughts and storm surges cause saline intrusion, which can devastate soil fertility for years. The effects have direct consequences on jobs and incomes. In 2016, for example, drought caused severe saline intrusion in over 1.4 million hectares of farmland in the Mekong Delta. This rendered 22 percent of its rice paddies unviable (12 percent of national rice production and 8 percent of national agricultural GDP), directly affecting the livelihoods of some 3 million rice farmers.

Analyzing high-resolution land use satellite imagery, this report shows that 10 percent of national crop production which is 4 percent of agricultural GDP and accounts for \$1 billion in production and 1.5 million jobs — is exposed to intense coastal flooding.⁴ Around 62 percent of aquaculture ponds in Vietnam's coastal delta provinces also face the risk of intense flooding, exposing 1.1 million tons of aquaculture production, affecting \$935 million in exports (4 percent of agricultural GDP) and 1.5 million jobs. Eighty percent of this risk is concentrated in the Mekong Delta provinces.⁵ A province-level breakdown of agri- and aquacultural flood exposure shows that the two major river deltas are most exposed, confirming that areas with high agricultural production and economic potential are particularly exposed to natural risks (figure 7).

Tourism

An important and fast-growing source of national revenue, tourism in Vietnam's beautiful coastal areas contributes around 70 percent of national tourism GDP. Between 2007 and 2017, annual international tourism tripled to 12.9 million visitors.² While the COVID-19 pandemic has caused a severe reduction in tourist numbers in 2020, the government maintains ambitious growth targets for the coming decade. However, such rapid growth adds stress to ecosystems and threatens to overload local infrastructure. Natural risks also threaten the viability of the sector.

Coastal erosion is already decreasing the attractiveness of some of Vietnam's beaches, coastal towns and hotels. The analysis conducted for this report shows that almost onefifth of coastal hotels are near beaches that experienced more than 20 meters of erosion between 1990 and 2015, as typified by those in Nha Trang City (figure 8). If such erosion trends continue, regions that rely on beach tourism will struggle to attract tourists.

Flooding and storm surges also pose a huge economic threat to the sector. Apart from the physical threat to hotel facilities, flooding can reduce the influx of tourists, causing losses in hotel revenue and dropping retail sales. Analysis of 3,309 hotels in coastal provinces shows that 52 percent are exposed to intense riverine flooding, potentially threatening up to \$5 billion of tourism revenue (3 percent of national GDP), and affecting 753,000 workers.

Industrial zones

Industrialization plays a central role in the government's

FIGURE 7 >>

Concentrated in the Mekong and Red River Deltas, Vietnam's agricultural sector is highly exposed to flood risks

	Return period: ■ 1-in-25 ■ 1-in-100 ■ 1-in-500				
	a) Crop production exposed to coastal flooding	1-in-500 year flood exposure	b) Aquaculture production exposed to coastal flooding		
Quang Ninh		33%			
Hai Phong City		97%			
Thai Binh		99%			
Nam Dinh		99%			
Ninh Binh		— 71%			
Thanh Hoa		24%			
Nghe An		13%			
Ha Tinh		34%			
Quang Binh		22%			
Quang Tri		9%			
Thua Thien-Hue		21%			
Da Nang City		5%			
Quang Nam		1%			
Quang Ngai					
Binh Dinh					
Phu Yen					
Khanh Hoa		2%			
Ninh Thuan		0%			
Binh Thuan		0%			
Ba Ria-Vung Tau		12%			
Ho Chi Minh City		90%			
Tien Giang		97%			
Ben Tre		88%			
Tra Vinh		89%			
Soc Trang		67%			
Bac Lieu		100%			
Ca Mau		81%			
Kien Giang		43%			

Sources: Based on data from JAXA EORC 2018 (land use data), Ottinger et al. 2018 (Red River aquaculture ponds data) Southern Institute of Water Resources Research (Mekong River Delta aquaculture ponds) and Braese et al. 2020 (coastal flood data).

FIGURE 8 >>

Coastal hotels in Vietnam are highly exposed to sediment changes

Hotel locations in Vietnam (left). Erosion poses a serious threat to hotels in Nha Trang City (right). Share of all hotels within 5 kilometers of Vietnam's coast experiencing coastal sediment changes (bottom)



Sources: Based on data from OpenStreetMap (hotel locations),⁶ Deltares et al. 2017 and the Vietnam Disaster Management Authority (erosion data). Disclaimer: The boundaries, colors, denominations, and other information shown on this map do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

plans for transforming Vietnam's coastal regions into modern economic hubs. While industrial firms are concentrated in Hanoi and Ho Chi Minh City, the whole coast is turning into a hotspot for industrial activity, with the highest growth rates observed in the North Central Coast Region (World Bank 2020). Proximity to the coast gives access to international markets, value chains and a skilled labor force.

However, this concentration of growth in coastal zones comes with risks. Annual average losses of industrial assets to flooding and typhoons amount to \$264 million, with losses concentrated in areas with large industrial activity (World Bank DRFI Program 2019). Analyzing flood exposure of 127 industrial zones in coastal provinces, this study found that around half are exposed to intense flooding. In some provinces, the risk is extremely high: a 1-in-100-year flood in Ba Ria-Vung Trau puts 9 of its 14 industrial zones — alongside some 34,000 jobs and \$280 million of infrastructure — at risk.

Critical public services

Vietnam has made impressive progress in achieving universal access to health care and education. Yet natural hazards can pose a significant threat to this progress. After a natural disaster, hospitals provide critical emergency services and their ability to do so depends on health care staff, facilities, infrastructure services and the availability of supplies and equipment. Natural shocks can impact all of these, hampering the provision of essential care to the sick and wounded. Of the 1,583 public hospitals and public health centers analyzed for this report, 26–50 percent are estimated to be at risk of intense flooding. In Hai Phong City, Thai Binh, Nam Dinh, Ninh Binh and Bac Lieu, 60–96 percent of all facilities are exposed to 1-in-100-year flooding.

Even temporary disruptions to schooling due to natural shocks can have severe and long-lasting impacts on educational attainments, reduce nutrition intake among students who rely on school feeding programs, and expose children to increased domestic violence (Rentschler 2013; Devries et al. 2013; Ellsberg et al. 2015). Many Vietnamese schools also serve as emergency shelters, so damaged facilities or disrupted access can obstruct critical evacuation activities. As no official geocoded dataset of schools is available, the impact of flooding on schools is uncertain. Using a sampled dataset of 864 schools in coastal provinces,⁷ this report found that 11–22 percent of schools are exposed to intense flooding. However, given the incompleteness of the data source, these results should be interpreted as indicative.

Lifeline infrastructure systems

Reliable water, sanitation, energy, and transport services are public services that are essential people's quality of life. They are also a central factor for supporting the productivity of firms and thus enabling socioeconomic development. When infrastructure fails, people can no longer access the goods, services, and jobs on which they depend for maintaining their livelihoods (Hallegatte et al. 2019). Strengthening the resilience of infrastructure systems will ensure a foundation for Vietnam's continued economic development and prosperity.

FIGURE 9 >>

Hazard-related direct and indirect losses affect Vietnam's transportation infrastructure

b) Annual average loss of public transport

infrastructure due to natural hazards

a) Maximum daily economic losses due to damaged transport infrastructure



Source: Based on data from a) Pant et al. 2019 and b) World Bank DRFI Program 2019. Notes: a) Natural hazards include flooding, typhoons, and earthquakes, by province. b) Color of lines indicate the road class, which depends on the volume of average daily vehicle traffic and are classified as follows: Class 1 = over 6,000 vehicles, Class 2 = 3,000–6,000 vehicles, Class 3 = 1,000–3,000 vehicles, Class 4 = 300–1,000 vehicles, Class 5 = 50–300 vehicles, and Class 6 = under 50 vehicles. *Disclaimer*: The boundaries, colors, denominations, and other information shown on this map do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Transport systems

Stretched along the length of its coastline (figure 9a), Vietnam's transport network is exposed to many natural hazards. Vietnam has the world's fifth-highest expected annual damage to transport infrastructure. On average, floods and typhoons cause about \$144 million of damage to public transport infrastructure each year, particularly to its roads (figure 9b) (World Bank DRFI Program 2019).

In addition to asset damages, natural hazards also disrupt transportation flows. A strong reliance on transport networks means that the costs of disruptions are substantial. Typhoons, with wind speeds up to 150 kilometers per hour, can cause daily economic losses of \$80–228 million as flooded roads disrupt commodity flows and create freight redistribution costs (figure 9a). When supplies are unable to reach their destinations, firms cannot operate, causing an estimated \$280 million in utilization rate losses every year (Rentschler et al. 2019a).

Energy systems

Reliable and resilient electricity in essential for modern economies, yet power outages remain common in Vietnam and come at a large cost. A recent survey found that 57 percent of Vietnam's firms report regular power outages, about 9 percent of which are due to flooding (Sagris et al. 2017). In 2014, electricity outages caused \$670 million in lost sales for Vietnamese firms, while halted production and lowered equipment utilization rates caused a further \$30 million in damages (Rentschler et al. 2019a). Companies also spend about \$72 million a year on backup generators to mitigate these outages. While not all power outages are caused by natural shocks, evidence shows that disasterresilient power systems are less prone to disruptions more generally (Hallegatte et al. 2019).

Since 1989, annual damages to energy infrastructure have amounted to \$330 million on average, primarily from floodrelated damage to transmission and distribution lines (World Bank DRFI Program 2019). This report's risk assessment of Vietnam's power sector assets in coastal provinces finds that 70 percent of power plants and 43 percent of electrical substations are exposed to intense riverine flooding. Although large power plants tend to have advanced flood protection measures, workers or fuel cannot always reach them. Electrical substations and other parts of the grid are rarely well protected from flooding.

Typhoons pose a particular risk to electricity transmission infrastructure, especially when nearby vegetation is not controlled (Rentschler et al. 2019b). By analyzing transmission grid and wind speed data, this report finds that almost 7,000 kilometers of transmission lines are exposed to wind speeds over 100 kilometers per hour in the event of a 1-in-100-year typhoon. More than one-third of all transmission lines are located in forested areas (figure 10), significantly increasing the probability of damage from falling trees and branches during storms. With so much of the grid in forested areas, systematic vegetation control near power lines is a necessary and effective measure, with an estimated maintenance cost of \$4.1–16.5 million per year.⁸

Water supply and security

With its many river basins and wetlands, Vietnam has

FIGURE 10A >>

A significant fraction of Vietnam's electricity grid is at risk from high wind speed Transmission lines in Vietnam and modeled peak wind speeds



Sources: Based on data from UNDRR 2015 (typhoon wind speeds) and World Bank 2016 (transmission lines). Disclaimer: The boundaries, colors, denominations, and other information shown on this map do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.



an abundance of surface and freshwater resources. Nevertheless, industrial and agricultural pollution, unregulated ground water extraction, droughts, and saline intrusion all compromise water availability and quality. Climate change is expected to aggravate many of these challenges.

For households and most firms, reliable water supply is critical. While water infrastructure is comparably reliable in Vietnam, water pollution is a major challenge. In the Red River and Mekong River Deltas respectively, 25 and 18 percent of firms report water quality challenges. This threat – often caused by pollution and saline intrusion – is reducing firms' sales by an average of 48 percent compared to less or non-affected firms (Hyland et al. 2019). Only 46 percent of urban households are connected to modern drainage systems and over two-thirds of industrial and livestock water goes untreated, causing pollution and other adverse effects on downstream farmers (Hyland et al. 2019, Sagris et al. 2017, World Bank 2018a). By 2035, deteriorating water quality and mounting pollution is expected to cost 4.3 percent of GDP annually (World Bank 2018a). The severe drought of 2016, which affected 35 percent of the country, showed how rapidly and drastically freshwater access can be compromised. During the peak of the drought, more than 2 million people had insufficient access to drinking water. The consequences were felt most intensely in the Mekong Delta Region. With prices soaring more than tenfold, bottled water was beyond the reach of the poorest households and 60-90 percent of planted crops were damaged in affected districts (UN and Government of Vietnam 2016). Saline intrusion aggravated the impacts of the drought, causing long-term damage to soil fertility. Such events have disastrous consequences for households that rely on natural aguifers for their main water supply and agricultural producers that need to irrigate their fields.

Climate change and socioeconomic development will heighten today's risks

While the risks from flooding, drought, erosion, and saline intrusion are already substantial, climate change is expected to intensify these natural hazards. In a pessimistic scenario, mean sea levels are estimated to rise 30 centimeters by 2050 and 70 centimeters by 2100. This increases exposure to intense flooding of urban areas by 7 percent, exposing an additional 4.5 million people in coastal provinces and

increasing the flood exposure of agriculture and aquaculture areas by up to 10 percent.

Similarly, typhoon-related coastal flooding and storm surges could become significantly more destructive, intensifying their impact on people, key sectors of the economy, vital public services and lifeline infrastructure. Additional climate change-induced damages to road infrastructure are estimated at \$4–55 billion for 2010– 2050 (Chinowsky et al. 2015). Rising sea levels and droughts are also bound to aggravate saline intrusion levels, compromising freshwater availability for people and industries, affecting agriculture and aquaculture production and imposing high adaptation costs as producers acquire pumps and other equipment to maintain adequate volumes and salinity levels in their ponds and wetlands (World Bank and Ministry of Planning and Investment of Vietnam 2016).

In the coming decades, socioeconomic development and coastal urbanization are likely to add to these climatic stressors and aggravate disaster risks. The overexploitation of groundwater is already causing land in the Mekong River Delta to subside by 1–3 centimeters a year; it could sink up to 90 centimeters by 2035 in some places (World Bank 2018). Unless risk-informed spatial planning is adopted systematically, assets and economic activity are likely to continue to be concentrated in highrisk coastal regions, with significant consequences. The impacts of climate change and natural hazards could drive up to 1.2 million people into poverty by 2030 (Rozenberg and Hallegatte 2016).

30 cm

Potential sea level rise by 2050 in a worst-case climate change scenario (70 centimeters by 2100)

4.5 million

More people in coastal provinces exposed to intense flooding in a pessimistic climate change scenario

^{up}_{to}1.2 million

More people pushed into poverty by 2030 due to climate change



Expected land subsidence in the Mekong River Delta by 2035

^{Up} 10%

 \searrow

Increase in the flood exposure of aquaculture production by 2050 in the Red River and Mekong River Deltas in a worst-case climate change scenario

to \$55 billion

Total damages to road infrastructure due to changes in temperature, precipitation, and flooding between 2010 and 2050 without adaptation measures

52 of 63

Number of provinces that could depend on water-stressed river basins by 2030



More rice production areas exposed in case of a 1-in-50-year flood and worst-case climate change scenario by 2050

Stock take: a review of Vietnam's existing measures for managing natural risks

Recognizing Vietnam's vulnerability to natural hazards and the threat this poses to economic development and shared prosperity, the government has made impressive progress in managing disaster risks. It has invested in structural and non-structural risk reduction measures and adopted extensive legal, regulatory and policy frameworks to guide coastal development in safe and sustainable ways. This part of the report reviews Vietnam's risk management measures (figure 11). While much progress has been made, shortcomings in planning and implementation mean there are still significant gaps that compromise the resilience of coastal communities. As rapid coastal development continues and the pressures from climate change intensify, such shortcomings could aggravate communities' vulnerabilities.

Hazard and socioeconomic risk information is fragmented and incomplete

Reliable hazard and risk information is essential for disaster risk management, risk-informed socioeconomic planning, and resilient development in coastal areas. Complete information on the location, safety standards, and maintenance status of public infrastructure is also vital for understanding gaps and prioritizing upgrades to these assets. Many of Vietnam's strategies and policies require hazard and risk maps and the government has made efforts to develop and consolidate such data. But analysis for this report found that disaster risk management information for key institutions is fragmented, largely under-developed and often of unreliable quality. Moreover, decision-making tools used by both government and private actors tend to overlook the deep uncertainty associated with long-term hazard projections. As such, they base plans and project designs on a single future scenario, which can lead to inadequate decisions and vulnerable assets. Developing a comprehensive platform of hazard data, risk information, and robust decision-making tools that address this challenge will be indispensable to support risk-informed decision making in all sectors and regions.

Coastal zone management is not enforced

Profound transformations are already underway along Vietnam's coast, with small-scale agriculture growing into agro-industrial production, villages into towns, and fishing harbors into international trading hubs. To guide and manage such changes, the government has developed an institutional and legal framework, and set out detailed national and province-level socioeconomic plans in line with its development targets. Under the Paris Agreement, Vietnam has committed to Integrated Coastal Zone Management (ICZM) as a priority for national climate change adaptation, and authorities in two-thirds of the country's coastal provinces have begun developing and adapting



FIGURE 11 >>

Stock take: a review of Vietnam's existing measures for managing natural risks

ICZM plans. The government is using several planning tools—including integrated coastal resource management programs, marine spatial plans, land use plans, coastal setback lines and resettlement programs—to strengthen communities' resilience against natural hazards.

However, a lack of guidance and enforcement at national level and of capacity and funding at local government level means that implementing many of these instruments has been slow. The hotspot analyses confirm, for example, that many land use and socioeconomic development plans do not consider



natural risks, creating an environment of uncontrolled risks in coastal zones that will become increasingly difficult to manage. Meanwhile, rapid urban expansion and coastal development continues in sensitive seafront zones, cementing heightened risks to future development. These challenges, together with climate change, make it more important than ever that authorities update and systematically enforce such risk management programs.

Infrastructure lacks risk-informed planning and systematic maintenance

With a large share of Vietnam's population and economic activities concentrated in the low-lying coastal zone, many infrastructure assets are exposed to flooding, typhoons, and other hazards. And while the country's extensive sea dike system is vital for managing flood risk, analysis for this report suggests that two-thirds of it does not meet the prescribed safety standards (figure 12). In many provinces with high economic and population growth, the set standards are inadequate and leave substantial protection gaps. To protect communities effectively, the dike system needs updated safety standards, upgrades, and systematic maintenance. The costs of implementing these measures will be high and resources are limited. Upgrading dikes to their currently prescribed safety standards will cost around \$2.2 billion, on top of a maintenance budget that already falls short by \$10–40 million per year.

Shortcomings in applying and enforcing technical standards and building codes for other public and private

assets - including roads, energy networks, water supply, and buildings-also reinforce vulnerability in coastal communities. Design and safety standards have struggled to keep up with rapid infrastructure development, and while lifeline infrastructure systems have some mandated resilient construction standards, these are not systematically enforced. Similarly, infrastructure system planning does not adequately account for system-level resilience – for example, by identifying critical network links that can determine resilience and functionality in the overall network. Private developments do not have to assess risks or environmental impacts, so informal settlements have grown in disaster-prone areas, increasing exposure to natural hazards. Risk-informed infrastructure planning is essential for ensuring the resilience of assets, infrastructure systems, and the communities whose livelihoods depend on them.

Natural protection systems are under increasing pressure from development and over-exploitation

In Vietnam, a wealth of ecosystems plays a crucial – but often underappreciated – role in boosting coastal resilience. Vietnam's dunes, mangroves, and coral reefs provide an extraordinary biodiversity and key ecosystem services, reducing the impact of typhoons by absorbing wave energy and stabilizing sediments to help reduce erosion. But a range of factors – including unsustainable management, urbanization, coastal and tourism development, land use intensification, agricultural expansion, overexploitation, water pollution, and sedimentation – have degraded these ecosystems.

FIGURE 12 >>

Assessment of Vietnam's sea dike system



Source: van Ledden et al. 2020. Note: Investment needed includes costs of upgrading dike segments to meet prescribe safety standards, making allowance for future sea level rise.

By eroding their protective function and other essential services these ecosystems provide to local livelihoods, this degradation reduces communities' capacity to deal with disaster risk. Without action, the projected effects of climate change, particularly sea level rise, will further compound these impacts, increasing pressure on coastal areas. Several mangrove restoration and management projects have already demonstrated the effectiveness of such approaches, but shortcomings remain in several areas, including institutional organization and cooperation, monitoring, technical capacity, community involvement, enforcement of conservation plans, and budgets.

Disaster preparedness is advanced, though capacity constraints persist

Vietnam has made tremendous progress towards reducing losses from natural disasters. It has an effective institutional structure with a well-established legal and regulatory disaster risk management framework. Local governments play a central role in managing emergency preparedness and response. However, a lack of capacity, tools and funding poses significant obstacles – for instance, by hindering damage assessments or the implementation of emergency plans.

Vietnam's social protection system provides essential support for vulnerable and poor households, including through short-term cash transfers and in-kind benefits. For rural households experiencing loss or damage of agricultural assets, disaster relief payments provide some protection. However, these support systems struggle to keep up with the pace of development and increasing frequency of natural disasters. The rate of coverage and level of support are especially low in coastal regions, which tend to have low overall poverty rates, but high natural risks. As such, the system leaves vulnerable groups at risk of being pushed into poverty by natural shocks. The strong focus on short-term emergency management also means that gaps remain in building long-term recovery and resilience. In 2020, the government moved quickly to mobilize a \$2.6 billion social assistance program to help people cope with the COVID-19 pandemic (Gentilini et al. 2020). This has provided an opportunity to build a more inclusive and responsive system to cope with future emergencies, and prevent the trappings of recurrent disasters, poverty, and debt.

Vietnam has also established several sources of postdisaster financing, including government budget allocations and contingency funds. However, state contingency budgets-which provide immediate postdisaster relief - often fall short of the needs and can be inefficient. Government capital expenditure is rigidly planned three years ahead with little flexibility, so it can take several years for government post-disaster reconstruction funding to become available. With no strategic or systematic approach across government levels, the use of modern contingency financing instruments has been limited and inefficient. In the last decade, the government has actively explored financial and insurance solutions to mobilize necessary resources and better manage natural disaster risks – thus creating the basis for a comprehensive risk financing strategy that reflects the country's substantial disaster risk.

A way forward: safeguarding the opportunities of resilient coastal development

A lthough Vietnam has made much progress in managing the significant and growing natural risks in its coastal regions, major challenges remain. Addressing these risks will be critical to ensure that future development plans account for and minimize these risks. And taking action is urgent: if current trends of rapid economic development in high risk areas continue, disaster losses are bound to increase unless such growth is resilient and risk-informed. Delaying action by 10 years could expose an additional \$4.3 billion of economic growth to natural shocks. So, how can the government of Vietnam ensure that its coastal regions fulfill their potential as engines of resilient socioeconomic growth and prosperity?

Coastal resilience cannot be achieved solely by constructing higher sea dikes. An affordable and practical approach requires a mix of equally crucial measures. This section presents the building blocks for a comprehensive strategy to strengthen resilience in coastal areas, outlining five areas of strategic interventions with concrete actions that the government can undertake today to safeguard

ACTION IS URGENTLY NEEDED

\$4.3B

Additional hazard exposure of economic growth, if resilience action is delayed by 10 years.

the opportunities of long-term coastal development (table 1). Reflecting the complex challenges of resilient coastal development, these **recommendations for action** make the most of limited resources while striking a balance between risk and opportunity. Systematic risk assessments (as presented in Part 1) can help prioritize actions in areas where risks are most severe; especially where current measures may be falling short (as reviewed in Part 2).

Recommendation 1:

Strengthen data and decision-making tools

To manage risk effectively, decision makers need robust and up-to-date information. Ongoing socioeconomic and climatic changes in the coastal zone warrant a system of collecting, sharing, using, and updating detailed hazard and risk information. Establishing systematic, detailed hazard and risk information – for example, through flood maps – at national and subnational scales is essential for making evidence-based decisions on the design of coastal investments and development planning.

ACTION 1.1 >> Ensure availability of complete, robust hazard data and analysis tools. Robust, consistent, and disaggregated data for all of Vietnam must be developed, published, regularly updated and maintained, and made available to all relevant stakeholders. Analytical capacity must be built to ensure such data are used consistently. Long-term climate change projections require tools for making decisions under uncertainty, which will stress-test decisions against a wide range of scenarios. Without these,

FIGURE 13 >>

High resolution satellite data have enabled the first systematic risk assessment of Vietnam's aquaculture sector

Aquaculture ponds in Nam Dinh and Ninh Binh Provinces along the Day River mouth



Source: Ottinger et al. 2018 (aquaculture ponds data).

decision makers risk opting for costly projects and policies with catastrophic long-term consequences.

ACTION 1.2 >> Establish systematically updated asset management systems for gray and green infrastructure. To accurately estimate risks, the government needs complete knowledge of critical assets, including their location, type, and vulnerability. A regularly updated asset management system is essential for this. Monitoring urban expansion in coastal zones will help track people's exposure to natural hazards; a central dike management database could help assess protection levels and shortcomings; and systematically mapping and monitoring coastal ecosystems will guide the rehabilitation and conservation of mangrove forests, coral reefs, dunes, beaches, and foreshores.

Recommendation 2:

Enforce risk-informed coastal planning

The government must ensure that growth is risk-informed and resilient and does not irreversibly lock risks into longterm development. In the short term, it may appear attractive to protect flood zones to enable urban growth and economic activities or to build long-lived infrastructure developments, such as energy plants or transport routes close to the coastline. But these investments tend to attract further investments and settlements, so allowing such growth in high-risk areas can impose high and ever-increasing costs on future generations for upgrading protection measures. Risk-informed zoning and spatial planning encourages development in safe areas and discourages it in the riskiest

TABLE P3.1 >> Recommended actions to strengthen the resilience of Vietnam's coastal provinces

Recommendation		ndation	Action	Lead role	Cost of a five- year action plan
Ľ	1.	Strengthen data and decision-making tools	 1.1. Ensure availability of complete and robust hazard data and analysis tools 1.2. Establish systematically updated asset management systems for gray and green infrastructure 	Ministry of Agriculture and Rural Development (MARD), Ministry of Natural Resources and Environment (MONRE) and relevant central ministries and provincial governments	\$8–10 million plus ongoing operating costs
	2.	Enforce risk-informed coastal planning	2.1. Ensure systematic planning to protect high-risk and high-growth areas2.2. Implement ICZM to balance risks and opportunities	MONRE, MARD, Ministry of Planning and Investment, and provincial authorities	\$10 million for priority provinces
R	3.	Strengthen the resilience of infrastructure systems and pubic services	 3.1. Strengthen the resilience of critical assets and services 3.2. Ensure systematic infrastructure maintenance, especially in high-risk areas 3.3. Upgrade dikes, starting with the most exposed and under-protected regions 3.4. Update and enforce safety standards and technical guidelines for infrastructure systems 	MARD, in close coordination with the Ministry of Transport and the Ministry of Industry and Trade	\$300–500 million for priority investments
**	4.	Take advantage of nature-based solutions	4.1. Ensure management and protection of the sandy coastline4.2. Develop a plan for restoring and protecting mangroves and coral reefs	MONRE and MARD	\$70–100 million for two priority provinces
(((!)))	5.	Improve preparedness, response, and recovery capacity	 5.1. Improve early warning systems and communication channels 5.2. Strengthen emergency planning and civil protection capacity 5.3. Establish a national financial protection strategy 	MONRE MARD Ministry of Finance	\$45 million

Note: The costs of a five-year action plan are tentative estimates based on past activities in Vietnam and comparable World Bank projects. They are indicative of the orders of magnitude but cannot replace detailed project design and costing.

or ecologically sensitive ones. And while this approach can be challenging in the short term, it is more sustainable and cost-effective in the long term.

ACTION 2.1 >> Ensure systematic planning to protect high-risk and high-growth areas. To ensure that any new development and investment in coastal zones does not increase the risk of disaster, regulators and authorities should require systematic risk assessments. Large infrastructure investments with long lifetimes or in sensitive seafront zones should be subject to systematic and robust screening, accounting for the deep uncertainty associated with hazard and exposure projections. Local authorities at the frontline of implementing riskinformed socioeconomic development plans need access to assessment tools and adequate budgets. The complex interactions and trade-offs between risks and opportunities in coastal zones require robust yet practical spatial planning approaches, based on the best available risk information (Recommendation 1). This is particularly important in secondary cities, where urban planning frameworks are not keeping up with growth rates.

ACTION 2.2 >> Implement ICZM to balance risks and

opportunities. Spatial planning in sensitive coastal zones is not limited to new developments in urban or economically active areas. As a comprehensive spatial planning strategy, ICZM must balance environmental, social, economic, cultural, and recreational objectives within the limits of natural dynamics. To fully formalize and institutionalize ICZM, the government must create a consistent legal basis for its implementation through an amendment to the Law on Natural Disaster Prevention and Control and the Marine Law. Successful ICZM will depend on the local authorities in charge of implementing it on the ground. Coordinating the complex demands of ICZM requires technical and administrative capacity, clear guidance from central authorities, and adequate resources.

Recommendation 3:

Strengthen the resilience of infrastructure systems and public services

Transport, energy, and water systems are crucial lifelines for supporting livelihoods and prosperity in coastal areas, while disaster protection infrastructure, health care and education facilities provide critical public services. Ensuring these systems can deliver their essential



services is crucial for continued resilient development. Decision makers must therefore strengthen critical assets by integrating risk information into the planning, design, and maintenance stages of all infrastructure investments. Although Vietnam's dike system protects many people and assets along the coast, several coastal regions are already high-risk hotspots where many people face the threat of disasters. Dike upgrades should focus on the highest-risk areas, include systematic maintenance, and follow safety standards that are better aligned with hazard levels, population size and asset patterns.

ACTION 3.1 >> Strengthen the resilience of critical infrastructure assets and services. To guide new developments into safe areas, infrastructure developments should be aligned with risk-informed spatial master plans (Recommendation 2). High-risk critical infrastructure segments should be strengthened, and adequate back-up capacity established so critical infrastructure users such as health care providers can continue operations even when infrastructure is disrupted by natural shocks. Incentivizing firms to develop business continuity plans for managing disasters and infrastructure disruptions will allow them to continue operations and contribute to a faster recovery.

ACTION 3.2 >> Ensure systematic infrastructure maintenance. Common management and maintenance principles and regular upkeep can significantly increase the resilience of infrastructure assets, extend their lifetime and avoid costly repairs. Prioritizing funding for lifeline infrastructure asset maintenance and developing a longterm funding strategy can further strengthen the quality



KON TUM >> A girl drinks from a well tap.

and reliability of infrastructure services. Infrastructure maintenance should be incorporated in a comprehensive risk financing strategy (Recommendation 5).

ACTION 3.3 >> Upgrade dikes, starting with the most exposed and under-protected areas. The dike system will play a central role in safeguarding livelihoods over coming years, especially where large and growing populations are concentrated in high-risk areas with limited natural defense systems. Getting the system up to standard for the challenges to come will require prioritizing coastal protection investments, particularly in the densely populated Red River Delta. Upgrade costs will be around \$1 billion for this region alone. Areas in the central regions that are experiencing rapid growth should consider complementary measures — in particular natural

solutions – to mitigate risks while maintaining flexibility by avoiding gray construction.

ACTION 3.4 >> Update and enforce safety standards and technical guidelines for infrastructure systems. Safety standards and building codes for lifeline infrastructure systems, buildings, and dikes should be reviewed and updated, ensuring consistency across sectors, accounting for socioeconomic, demographic and climatic change, and ensuring adequate financing for their enforcement. The scope of technical guidelines should include the entire design and planning process, and safety standards should reflect hazard levels and population or asset value at risk, while considering practical implementation constraints such as available funding, material and maintenance capacity.

Recommendation 4

Take advantage of nature-based solutions

From sand dunes to coral reefs and mangrove forests, natural systems are often highly effective at safeguarding coastal livelihoods. Protecting them can contribute to reducing flood risk and eliminate or reduce the need for costly gray infrastructures, such as sea dikes. If managed sustainably, they can also provide tangible economic value, supporting tourism or fisheries. However, overexploitation and a preference for gray infrastructure has led to significant degradation over the past decades.

ACTION 4.1 >> Ensure management and protection of the sandy coastline. Developing a knowledge base on coastal sediment budgets and trends is essential to address the diverse causes of dune degradation. A thorough understanding of coastal dynamics must be acquired through regular monitoring programs, modeling exercises and analysis of historical observations. Acknowledging the dune system's importance and contribution to coastal resilience is a vital first step, including through awareness raising in communities. Next, the policy, regulatory and legal framework for managing coastal dunes and sandy foreshores should be strengthened, accompanied by technical guidelines and zoning schemes that define areas with different protection and use requirements. Conservation, restoration, and management measures must be tailored to local needs and enforcement capacities.

ACTION 4.2 >> Develop a plan for restoring and protecting mangroves and coral reefs. To consolidate past mangrove reforestation successes and expand the reach of current programs, formalizing long-term and sustainable co-management contracts will help strengthen mangrove co-management. Lessons from past restoration programs should be consolidated in technical guidelines to inform future programs. Government funding for mangrove restoration can be complemented by payment for ecosystem service models. For coral reefs, the government should conduct an inventory of lessons learned from restoration initiatives around the world and develop a national database capturing the location and state of all reef systems (Recommendation 1). It should then establish a policy and legal framework to formalize coral reef restoration and enable provinces to develop, implement and scale up conservation and restoration plans.

Recommendation 5:

Improve preparedness, response, and recovery capacity

While risk-informed development strategies are key to reducing risks, they cannot fully eliminate future disasters. To prepare coastal Vietnam for more intense storms, heavier rainfall, and higher coastal floods, the government must establish effective emergency response and recovery capacity for future shocks — for instance, by predefining evacuation routes and logistics, ensuring adequate shelters and clearly defining roles and responsibilities for national and local authorities. While the government has much expertise and experience in these areas, there is significant scope for improvement, especially by adopting a comprehensive risk financing strategy to raise and channel funds effectively.

ACTION 5.1 >> Improve early warning systems and communication channels. To further strengthen Vietnam's early warning capacity, it needs a strategic communication system that translates weather forecast data into actionable non-technical information for different user groups. Developing a concept of operations will guide usage and management of an integrated hydromet system to lower the risk of technical or financial failure and adapt early warning systems to better account for slow-onset disasters such as droughts. It should also strengthen capacity to monitor and forecast this type of disaster and disseminate actionable warnings, increasing authorities' mandate and funding to reflect the need for medium and long-term forecasts. ACTION 5.2 >> Strengthen emergency planning and civil protection capacity. Establishing a National Emergency Command Center at the Vietnam Disaster Management Authority will help ensure a consistent emergency response capacity along the entire coast, providing oversight and facilities to enhance preparedness and response at all levels. Capacity for locally led and inclusive emergency response should be strengthened further, with emergency plans disseminated at community, village and household levels. The needs of the most vulnerable must be actively accounted for through clear communication and support mechanisms. To effectively respond to slow-onset hazards, emergency plans and relocation strategies must also be developed, protecting lower-income households' livelihoods.

ACTION 5.3. >> Establish a national financial protection strategy. A comprehensive and layered risk financing strategy will strengthen institutional arrangements for disaster risk finance and ensure rapid and cost-effective post-disaster resource mobilization. Multi-year reserves, contingent credit, sovereign insurance, and catastrophe bonds are all relevant instruments with a proven track record. The strategy should also strengthen post-disaster finance delivery mechanisms to make 'last mile' resource delivery more effective by improving financial inclusion, maintaining social registries, and improving the effectiveness of fiscal transfer mechanisms. Institutional coordination between social protection programs and integrated disaster response mechanisms should be strengthened. Social protection support in coastal regions should be updated to increase its coverage, flexibility, scalability, and linkage with contingency budgets and risk financing instruments.

Next steps: implementing the recommendations

To guide implementation of these recommendations, this report offers concrete next steps and items for five-year action plans (box 3.2.1) that suggest locations for priority interventions, propose agencies to lead efforts and offer estimated costs of delivery.

BOX P3.1 >>

Five-year action plans for implementation



Recommendation 1: Strengthen data and decision-making tools (\$8-10 million)

- » Establish a government policy for sharing and managing hazard and risk data
- » Develop an integrated central platform for hazard and risk data
- » Select three or four priority provinces for location-specific hazard and risk assessments



Recommendation 2: Enforce risk-informed coastal planning (\$10 million)

- » Formulate and refine nationwide ICZM guidance to support coastal planning efforts
- » Ensure technical and administrative capacity to integrate natural risk information in coastal planning processes
- » Select two to three priority provinces to implement integrated development plans in line with ICZM, with a focus on high-risk and high-growth areas



Recommendation 3: Strengthen the resilience of infrastructure systems and public services (\$300-500 million)

- » Integrate risk information into maintenance practices for electricity, transport, dike, and other infrastructure systems
- » Strengthen the resilience of critical public assets, such as transport links and hospital access
- » Target dike upgrades in high-risk areas, such as Hai Phong, Thai Binh and Nam Dinh
- » Review and align safety standards of all infrastructure assets, including dikes



Recommendation 4: Take advantage of nature-based solutions (\$70-100 million)

- » Implement nature-based solutions in priority locations, such as Phan Thiet and Quynh Luu, and mitigate erosion through strategic beach nourishment, dunes restauration, and mangrove rehabilitation
- » Complement nature-based solutions by enforcing coastal setback lines and protection corridors
- » Prepare technical guidelines and action plans for mangrove rehabilitation in the Red River and Mekong Deltas

Recommendation 5: Improve preparedness and response capacity (\$45 million)

- » Strengthen communication channels for actionable early warning to different end users
- » Establish the National Emergency Command Center, with close coordination and oversight functions at the province level
- » Develop and adopt a national financial protection strategy, building on ongoing engagement with the World Bank's DRFI Program

Note: These costs are tentative estimates based on past activities in Vietnam and comparable World Bank projects.

An opportunity to recover sustainably from the COVID-19 crisis

The COVID-19 pandemic has left no country unaffected. Although Vietnam is considered to have contained the spread of the virus more effectively than other countries, quarantine measures and the global economic crisis mean that the consequences are nevertheless severe. However, the scale of the crisis also offers a window of opportunity to rapidly build back a fairer and stronger economy (Hallegatte and Hammer 2020). For this, it is important to consider both short and long-term needs in economic stimuli—immediate job creation is important, but so is investing in skills, resilience, and sustainability.

Several of the measures proposed in this report could play an important role in stimulating Vietnam's recovery from the economic repercussions of the COVID-19 crisis. The World Bank's Sustainability Checklist (Hammer and Hallegatte 2020) identifies actions that offer short-term stimuli and contribute to a sustainable long-term recovery. Two intervention areas stand out from this screening:

- 1. Investments in infrastructure upgrades and maintenance (actions 3.1–3.3) can boost short-term employment and target economic hubs that have been strongly affected by quarantine measures.
- Investing in nature-based solutions such as community-level initiatives to restore and protect the sandy coastline and mangroves forests (actions 4.1 and 4.2) can boost local employment while also contributing to coastal protection and the recovery of sustainable tourism sector.

Other actions — such as creating hazard and risk data (actions 1.1 and 1.2) — may not have large short-term benefits but are crucial for achieving long-term resilience objectives.

A window of opportunity

Vietnam is at a crossroads and its government has an opportunity to take decisive action to safeguard its future development in the face of disaster risks. Its experience and expertise of disaster risks, and its proven longterm planning approaches, are important elements for formulating and implementing a resilient development strategy. Vietnam's international partners, including the World Bank, are committed to continue their support for the government's important efforts in this area. While the expertise of other countries can help inform Vietnam's decisions, they too can learn from Vietnam's experience in taking action at the forefront of natural risks and climate change. If taken decisively, these actions are an opportunity to strengthen the resilience of coastal communities and the prosperity of coming generations.

Endnotes

- 1. Real and PPP asset and well-being losses are denominated in \$2015. Well-being losses take households' capacity to cope and recover into account. By this metric, annual expected losses in Vietnam increase from 1.5 to 2.07 percent of GDP (Hallegatte et al. 2016). In other words, the social cost of disasters in Vietnam (PPP\$11 billion) is 35 percent higher than direct asset losses.
- 2. Based on data retrieved from General Statistics Office of Vietnam, https://tinyurl.com/tq3s66s
- 3. Information from Fathom Global, https://tinyurl.com/sfzgo7z
- 4. Intense flooding refers to rare and intense flooding with a 100-year return period or a 10 percent probability of occurrence in a decade.
- 5. These estimates are based on 2017 data, assume an unchanged economy, and do not consider smaller losses, incurred by every-year returning flood events.

- Information retrieved from OpenStreetMap on November 19, 2019.
- 7. Representing 6.5 percent of all schools in coastal provinces documented by the General Statistics Office of Vietnam
- 8. This is based on a total transmission and distribution line length of 23,608 kilometers, of which 3 percent is in forested areas, and vegetation control costs ranging between \$500 and \$2,000 per kilometer of transmission line.

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VIETNAM'S COASTAL DEVELOPMENT BETWEEN OPPORTUNITY AND DISASTER RISK In a country that is among the most exposed to natural hazards, Vietnam's coastline often bears the brunt. Typhoons, storm surges, riverine flooding, coastal erosion, droughts, or saline intrusion are all-too-familiar threats to most people living along the coast. Yet despite these risks, coastal regions host thriving economic sectors, providing livelihoods for a growing and rapidly urbanizing population. The coastal regions could be a powerful engine for Vietnam's continued socioeconomic development, but rapid urbanization, economic growth, and climate change mean that disaster risks are bound to increase in the future.

Although the government of Vietnam has made impressive progress in reducing and managing natural risks, current trends show that the work is far from complete. To guide effective action, this report provides an indepth and multi-sectoral analysis of natural risks in coastal Vietnam and reviews current efforts in risk management, proposing a concrete action plan to balance the risks and opportunities of coastal development. These actions, if taken decisively, are an opportunity to strengthen the resilience of coastal communities and hence the prosperity of coming generations.



