



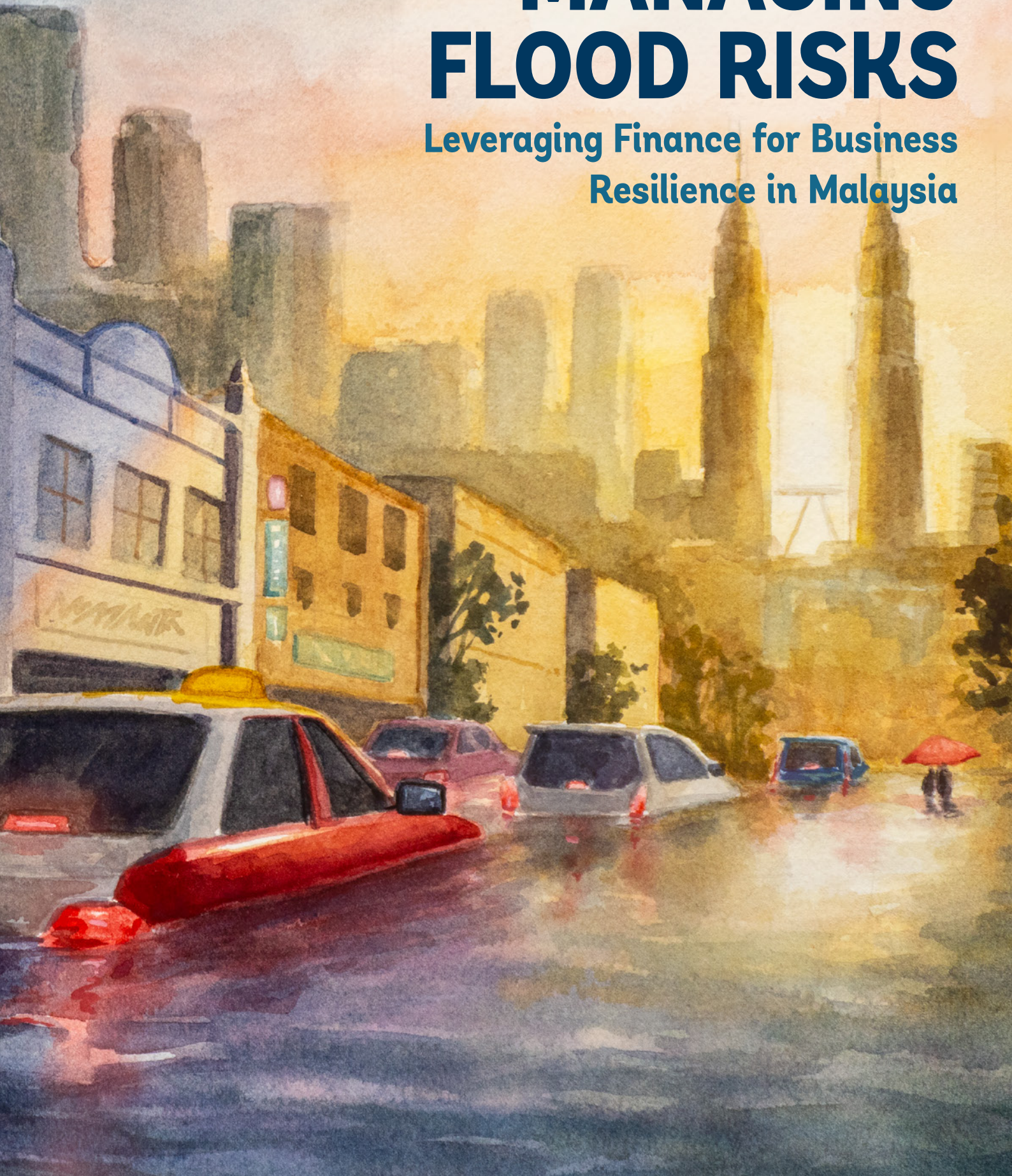
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# MANAGING FLOOD RISKS

Leveraging Finance for Business  
Resilience in Malaysia





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# **MANAGING FLOOD RISKS**

## **Leveraging Finance for Business Resilience in Malaysia**

**MARCH 2024**

**World Bank and Bank Negara Report**

Led by Tatiana Didier (World Bank) and  
Katie Lee Sheah Tsan (Bank Negara Malaysia)



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The views, thoughts, and opinions expressed in the text belong solely to the authors, and not necessarily to the authors' employer, organization, committee, or other group or individual.



# Acronyms and Abbreviations

<b>AFRIP</b>	Australian Flood Risk Information Portal
<b>BNM</b>	Bank Negara Malaysia
<b>CAT DDO</b>	Catastrophe Deferred Drawdown Option
<b>CCKP</b>	Climate Change Knowledge Portal
<b>CCPT</b>	Climate Change and Principle-based Taxonomy
<b>CCTV</b>	Closed-circuit Television
<b>CDMRC</b>	Centre for Disaster Management and Relief Committee
<b>CMIP</b>	Coupled Model Inter-Comparison Projects
<b>CPI</b>	Climate Policy Initiative
<b>CRED</b>	The Centre for Research on the Epidemiology of Disasters
<b>CWC</b>	Central Water Commission
<b>DFI</b>	Development Financial Institution
<b>DID</b>	Department of Irrigation and Drainage
<b>DOSM</b>	Department of Statistics Malaysia
<b>DRF</b>	Disaster Risk Finance
<b>E&amp;E</b>	Electrical and Electronics
<b>EM-DAT</b>	Emergency Events Database
<b>EMDE</b>	Emerging Market and Developing Economy
<b>ESG</b>	Environmental, Social, and Governance
<b>FEMA</b>	Federal Emergency Management Agency
<b>GDP</b>	Gross Domestic Product
<b>GHG</b>	Greenhouse Gas
<b>GVC</b>	Global Value Chain
<b>ICT</b>	Information and Communication Technology
<b>IDFC</b>	International Development Finance Club
<b>IMD</b>	India Meteorological Department
<b>IMF</b>	International Monetary Fund
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>ITO</b>	Insurer and Takaful Operator
<b>JC3</b>	Joint Committee on Climate Change
<b>KL</b>	Kuala Lumpur
<b>KM</b>	Kilometer
<b>KOICA</b>	Korea International Cooperation Agency

<b>LT</b>	Long Term
<b>M&amp;E</b>	Monitoring and Evaluation
<b>METMALAYSIA</b>	Malaysian Meteorological Department
<b>MIDA</b>	Malaysia Investment Development Authority
<b>MINDSET</b>	Model of Innovation in Dynamic Low-Carbon Structural Economic and Employment Transformations
<b>MKN</b>	National Security Council
<b>MLIT</b>	Ministry of Land, Infrastructure, Transport and Tourism
<b>MM</b>	Millimeter
<b>MRV</b>	Measurement, Reporting, and Verification
<b>MSME</b>	Micro, Small, and Medium Enterprise
<b>MT</b>	Medium Term
<b>MyCIF</b>	Malaysia Co-Investment Fund
<b>NADMA</b>	National Disaster Management Agency
<b>NPL</b>	Non-performing Loan
<b>NRES</b>	Ministry of Natural Resources and Environmental Sustainability
<b>OECD</b>	Organization for Economic Co-operation and Development
<b>P2P</b>	Peer to Peer
<b>PCG</b>	Public Credit Guarantee
<b>PIAM</b>	Persatuan Insurans Am Malaysia
<b>PUB</b>	Public Utilities Board
<b>SC</b>	Securities Commission Malaysia
<b>SDMRC</b>	State Disaster Management and Relief Committee
<b>SEADRIF</b>	Southeast Asia Disaster Risk Insurance Facility
<b>SFHA</b>	Special Flood Hazard Area
<b>SMART</b>	Stormwater Management and Road Tunnel
<b>SME</b>	Small and Medium Enterprise
<b>SMS</b>	Short Message/Messaging Service
<b>SRI</b>	Sustainable and Responsible Investment
<b>ST</b>	Short Term
<b>TCFD</b>	Task Force on Climate-related Financial Disclosures
<b>VBIAF</b>	Value-based Intermediation Financing and Investment Impact Assessment Framework



# Abstract

**Building resilience to flood risks is imperative for Malaysia's sustainable private sector development and growth.** Estimates in this report show that floods can cost Malaysia up to 4.1 percent of GDP by 2030. Yet, empirical evidence on the vulnerability of Malaysian businesses to flood risks is scarce. Little is known about which businesses are most vulnerable and the most significant challenges hindering greater adoption of risk mitigation strategies, both ex-ante preparedness and ex-post coping strategies. This makes it difficult for policy makers—namely, the Government of Malaysia, including the Ministry of Finance and relevant line ministries and their respective agencies, financial sector regulators (Bank Negara Malaysia and Securities Commission Malaysia), and development financial institutions—to identify and prioritize support policies to strengthen private sector adaptation and resilience. Financial institutions, including banks, insurers, and takaful operators, can also be an important enabler of business efforts to manage flood risks. This report is a step toward bridging this knowledge gap to shed light on how policy makers in Malaysia can support and foster private sector resilience to floods, emphasizing policies to strengthen the role of the financial sector in supporting business adaptation and resilience to flood risks.

**This report looks holistically at the challenges of adaptation to climate change for businesses, exploring the complementarity among the public sector, the financial sector, and the private sector.** To set the stage, the report starts with the profile of floods in Malaysia, benchmarking it against countries worldwide, and an estimation of the aggregate impacts of future floods for Malaysia. This macro-modeling assessment aims to highlight the importance of greater resilience by the private sector. Drawing on a novel business-level survey conducted among 1,500 Malaysian businesses, this report explores vulnerabilities to flood risks and the factors discouraging businesses from investing in adaptation and resilience. The demand-side assessment is complemented by an analysis of the challenges faced by financial institutions, namely commercial banks and insurers and takaful operators, in providing financial services to support adaptation and resilience of businesses. Finally, the report discusses the range of public sector policies that recognize and act upon the barriers preventing businesses from adopting more resilient and sustainable practices while creating an enabling environment that encourages private capital flows toward these investments. It concludes with a roadmap for policy action, with concrete recommendations for policy makers in Malaysia.



# Executive Summary

## Floods Can Cause Significant Impact on Jobs and GDP

**Malaysian businesses are increasingly vulnerable to climate change through physical risks, primarily floods, impacting business operations, and in turn, affecting their ability to grow and create jobs.**

Floods have been Malaysia's most frequent natural disaster, accounting for 85 percent of all natural disasters since 2000. Malaysia has one of the world's highest levels of exposure to flood-related disasters, ranking 12<sup>th</sup> in the world in terms of the frequency of events but 78<sup>th</sup> in terms of the average annual damages. Recurring floods mean that businesses are constantly recovering from and bracing for new events, which significantly constrain their economic prospects. Floods can directly impact businesses through losses and damages in inventories, machinery, equipment, facilities (including buildings), and assets more broadly. Businesses can also incur indirect losses due to business disruptions and supply chain interruptions, for instance, due to the

negative impacts of floods on employees, suppliers, customers, and infrastructure.

**The increasing frequency of floods can have a sizable impact on the Malaysian economy.**

The impact of floods on businesses can lead to substantial macroeconomic effects. The analysis in this report based on historical flood hazard data shows that a 1-in-20-year flood can cost Malaysia up to 4.1 percent of GDP in 2030, in the absence of adaptation efforts. The estimates also indicate a significant impact on jobs from floods that could lead to up to a 2.2 percentage point increase in Malaysia's unemployment rate. Climate change is projected to increase the frequency of precipitation, and consequently, raise the likelihood of floods in Malaysia, which could lead to even more significant impacts on output and employment.

## Private Sector Adaptation Efforts Can Reduce Flood-related Costs

**The impact of floods could be reduced significantly by private-sector adaptation efforts.**

Conceptually, the effect of floods on businesses depends on a combination of three factors: hazard (the probability of floods and their intensity), exposure (including both direct exposures to the hazard, such as the share of assets exposed to floods, and indirect exposures associated with business disruptions), and vulnerability (the degree to which businesses and their assets would be adversely impacted, given hazards and exposures). These three elements interact with each

other and are fundamental to understanding private sector resilience to floods. A business may be highly exposed to floods, but its vulnerability may be low if it has developed effective coping strategies. For example, estimates show that by building resilience in supply chains, thereby ensuring the continuity of production, businesses can reduce their expected losses due to floods by more than 50 percent. The estimates also show that such adaptation efforts are instrumental in mitigating the impact of frequent but less severe floods.



**However, the business case for investments in flood risk adaptation and resilience might be tenuous, especially for small and medium enterprises (SMEs).** Such investments often require significant upfront expenditures but returns tend to have longer and more uncertain payback periods when compared to conventional investments. Moreover, the benefits of these investments can be particularly complex to quantify as, in practice, they are avoided losses. They may not even be internalized by businesses due to externalities and their public good nature. This is further compounded by the high uncertainty and deficiencies in the information environment surrounding not only flood risks but also the effectiveness of adaptation and resilience strategies. All these factors hinder the willingness of both businesses and financiers to invest in flood risk adaptation and resilience. These challenges can be particularly constraining to SMEs—they often face significant barriers to access to finance for adaptation and resilience that hamper their ability to invest more broadly. Moreover, the benefits of investments in flood risk adaptation and resilience may not be material to them in the short to medium term, as they may not be operating when the risks these investments seek to address materialize.

**Adaptation efforts by businesses should not be viewed in isolation; an effective management of flood risks entails complementary roles for the public sector,**

**the private sector, and the financial sector.** The public sector has a crucial role to play as the primary provider of large-scale flood control infrastructure. It is also responsible for ensuring that critical infrastructure and service delivery are resilient to flood risks, and for strengthening urban planning and land use restrictions in flood-prone areas, among other responsibilities. In doing so, the public sector can reduce businesses' exposures and mitigate their vulnerabilities to floods. But these actions are unlikely to completely mitigate the impacts of floods on businesses in Malaysia. Residual risks would remain, and ultimately, the ability of businesses to reduce the impact of floods hinges on their capacity to adapt. Notably, private sector actions should build on and complement those of the public sector, which puts a premium on transparency about public sector policy priorities and strategies. In this context, the financial sector can be an important enabler. Access to financial products can support businesses in coping with floods by financing ex-ante adaptation efforts and enabling ex-post financial resilience. Hence, constraints in access to finance for businesses can eventually increase the fiscal burden of floods for the public sector, especially as it is compelled to step in to provide relief in the aftermath of floods. Overall, an integrated, coherent, and proactive approach by the public sector, the private sector, and the financial sector is paramount in building a flood-resilient economy.

## This Report Looks Holistically at the Management of Flood Risks for Businesses

**This report focuses on the management of flood risks for Malaysian businesses.** Building resilience to flood risks is imperative for Malaysia's sustainable private sector development and growth. Yet, empirical evidence on the vulnerability of Malaysian businesses to flood risks has been scarce. Little is known about which businesses are most vulnerable, and what are the most significant challenges hampering greater adoption of risk mitigation strategies, both ex-ante preparedness and ex-post coping strategies. This makes it difficult for policy makers to identify and prioritize support policies to strengthen private sector resilience. An evidence-driven approach to designing and implementing policy support is essential to ensure effective outreach to the most vulnerable businesses. Only then can public sector policies support private sector resilience efficiently and sustainably, improving the odds of credible impact. This report is a step toward bridging this knowledge

gap to shed light on how policy makers in Malaysia can support and foster private sector resilience to floods, with emphasis on policies to strengthen the role of the financial sector in supporting business adaptation and resilience to flood risks.

**This report is the first of its kind to look holistically at the challenges of adaptation to climate change for businesses, exploring the complementarity among the public sector, the financial sector, and the private sector.** Drawn from a novel business-level survey conducted on 1,500 Malaysian businesses, this report explores vulnerabilities to flood risks among Malaysian businesses and the factors discouraging them from investing in adaptation and resilience. The demand-side assessment is complemented by an analysis of the challenges faced by financial institutions, namely commercial banks and insurers and takaful operators (ITOs), in providing financial services to support

adaptation and resilience of businesses. Finally, the report discusses the range of public sector policies that recognize and act upon the barriers preventing businesses from effectively adopting more resilient and sustainable practices while creating an enabling

environment that encourages private capital flows toward these investments. The report concludes with a roadmap for policy action, with concrete recommendations for policy makers in Malaysia.

## Which are the Most Vulnerable Businesses in Malaysia and Why?

**The business-level analysis reveals three key findings. First, SMEs are particularly vulnerable to floods in Malaysia, through both direct and indirect impacts.<sup>1</sup>**

The survey analysis shows that although flood impacts over the past three years were more prevalent among large businesses, SMEs were more likely to experience damages and disruptions associated with floods. For example, SMEs were 50 percent more likely to report asset damages than large businesses. SMEs were also more likely to cite indirect losses due to the impact of floods on their customers and employees. While supply chain disruptions affected more than half of all surveyed businesses, smaller businesses were more likely to be affected. About 75 percent of small businesses, comprising those with up to 30 employees, stated that supply chain bottlenecks were the main cause for delays in return to operations. SMEs typically took about a month to fully resume operations after being affected by floods. The evidence suggests that SMEs tend to have less developed coping mechanisms. SMEs are less likely to have disaster preparedness strategies; they are also less likely to have insurance than large businesses, even after considering differences in risk exposure and risk perceptions.<sup>2,3</sup>

**Second, flood risk awareness is a crucial factor underlying the extent of preparedness among businesses, but there are marked awareness gaps for SMEs.** The survey results show that businesses that perceive flood risks as recurrent risks are more likely to have disaster preparedness strategies and to purchase flood insurance. Consistently, 33 percent of businesses that consider floods a recurring risk mentioned the lack of risk awareness and knowledge among their top-3 barriers hindering the adoption of flood resilience practices. This is higher than all other potential barriers but access to finance for adaptation and resilience,

as discussed below. The results also indicate a risk awareness gap between large businesses and SMEs. For example, SMEs are less likely to have sufficient information about future flood risks. While 80 percent of large businesses stated that they had sufficient information about their future flood risk exposures, only 69 percent of SMEs (and within SMEs, 40 percent of small businesses) stated so. The survey results also show marked differences between large businesses and SMEs in awareness that vulnerability to flood risks can impact their competitiveness, including in foreign markets.

**Third, limited access to finance for adaptation and resilience and insurance is a significant barrier for Malaysian businesses, especially SMEs, hampering their ability to manage flood risks.** Among businesses that consider floods a recurring risk for their business, 43 percent of SMEs (and 34 percent of large businesses) cited limited access to finance for adaptation and resilience as a primary barrier for the implementation of flood risk preparedness, 10 percentage points more than the second-most cited barrier (namely, lack of awareness and knowledge). Notably, businesses with limited access to financial resources for flood preparedness had three times greater revenue losses associated with floods than businesses that did not mention it. Limited access to insurance can also thwart recovery efforts as insurance payouts represent an important source of funding for such expenditures, especially for SMEs. For example, 37 percent of SMEs mentioned insurance payouts as their primary source of funding for recovery and reconstruction, compared to 24 percent of large businesses.

<sup>1</sup> Large businesses are defined as those with revenues above RM50 million (\$11 million), and those with smaller revenues are classified as SMEs.

<sup>2</sup> Disaster preparedness strategies range from simply monitoring weather forecasts and disaster risk news to buying pumps and power generators to more complex ones involving investments in resilient inputs and acquisition of better vehicles, retrofitting buildings and relocating production to premises in less flood-prone areas.

<sup>3</sup> For simplicity, this report adopts the term insurance to refer to both insurance and takaful protection.

## What Constrains Access to Finance and Insurance for Vulnerable Businesses?

**Evidence from a survey of financial institutions in Malaysia reveals that banks and ITOs indeed have limited engagement in supporting businesses' adaptation and resilience.** Financing for flood risk adaptation and resilience, especially ex-post emergency financing, remains relatively small, with a limited range of financial products available to businesses.<sup>4</sup> About 40 percent of banks stated that they do not provide any emergency support to businesses,<sup>5</sup> and about 20 percent of banks stated that they have no products related to adaptation financing. Consistent with the results of the business-level survey, financial institutions also believe that insurance coverage is skewed toward larger businesses, with the uptake of flood insurance among smaller businesses being less widespread. In fact, over half of the ITOs and 75 percent of banks stated that micro-business coverage is "poor." At the same time, there is a perception among financial institutions of limited demand from businesses for financial products to manage flood risks, consequently reducing the incentives for greater engagement by these financial institutions. In the case of insurance, the expectation of ex-post compensation by the government can explain, at least in part, a limited demand for insurance coverage. The low penetration of flood insurance among businesses puts pressure on the government for ex-post compensation, which arguably places Malaysia in a so-called "disaster syndrome."

**At the core of the constraints on financing and insurance for businesses to manage flood risks are significant gaps in flood-related information that hinder effective measurement of flood risks.** There is limited reporting on exposures and vulnerabilities to flood risks from businesses themselves, and the availability and accessibility of information from public sources are also limited. In addition, access to proprietary data from private sources, when available, can be costly. The information available to financial institutions in Malaysia has partial coverage of certain floods (e.g., flash floods are not tracked by the public sector), limited temporal relevance (e.g., short historical information and lack of projections), lack of spatial granularity (e.g., information only available at the postal code level which is too aggregate for an accurate assessment of flood risks), and

restrictive data gatekeeping (e.g., tight constraints in access to information). The underdevelopment of financial infrastructure for climate-related adaptation investments further complicates this already intricate informational environment. Policies such as taxonomies and disclosure and reporting requirements have focused primarily on climate change mitigation efforts rather than adaptation. In Malaysia, there is a lack of clarity around the standards and definitions for adaptation investments, including standardized reporting frameworks with well-defined metrics that would allow financial institutions to better monitor and report flood risks. In addition, limited capabilities to assess and manage flood risks seem to compound these challenges.

**This lack of information exacerbates the already high uncertainty surrounding private investments in flood risk adaptation and resilience.** Flood risks are inherently difficult to measure. There is a high degree of uncertainty in quantifying complex climatic and other natural processes (including hydrological and meteorological factors, among others) and the effectiveness of risk mitigating factors (including the capacity of drainage systems and flood protection infrastructure, among others). The impacts of climate change add an important additional layer of uncertainty to these assessments. In addition, investments in preparedness and adaptation to flood risks are marked by high uncertainty stemming from limited information related to: (i) technologies (e.g., uncertainty about the technical feasibility and effectiveness of new, sometimes untested, technologies); (ii) markets (e.g., augmented uncertainty about evolving demand and competitiveness in the marketplace due to the growing impact of floods); and (iii) policies and regulations (e.g., lack of clarity, predictability, or even consistency in government policies). In Malaysia, the latter is an important source of uncertainty. There is limited information on the government's capital investments in flood adaptation projects (actual or planned) and public sector interventions are marked by a fragmentation of responsibilities, lack of coordination, and insufficient implementation capacity. Together, these factors limit the effectiveness of the disaster risk management framework at the country level, especially during large-scale disasters, and compound uncertainties faced by

4 Throughout this report, "emergency financing" refers to financing for unplanned and unexpected expenses incurred due to the negative impact of floods.

5 Financial institutions can provide emergency support to businesses through a range of temporary measures, such as, deferment of loan repayment, minimum payment waiver or reduction, interest rate reduction, and waive of fees and penalties on early withdrawals, among others.

the private sector, thus limiting efficient coordination between private and public sectors' efforts. All these factors make adaptation investments riskier than more conventional investments for both businesses and financiers.

**Partly due to the data gaps and an inability to adequately quantify flood risks, financial institutions in Malaysia face challenges in adequately pricing, monitoring, managing, and diversifying flood risks.**

Risk management practices related to floods are not yet widespread, especially among banks. While many banks use screening to assess flood risks of business clients, flood risks are not consistently embedded in credit risk assessments, and such risks are not priced into financial services. The inability to accurately assess risk exposures and quantify potential losses limits risk-based pricing, including for insurance premiums, and limits the scope for risk transfers, for instance, to insurance and re-insurance companies. There is also limited monitoring and reporting of banks' exposures to flood risks, which can be partly explained by banks not tracking flood risks among their clients. Furthermore, there are limits to potential flood risk diversification. Because flood risks are not random—that is, significant losses tend to occur simultaneously and in geographically clustered areas—financial institutions face concentrated and correlated risks. A large and diverse client base is crucial for their ability to diversify away from flood risks. In the case of ITOs,

the non-mandatory nature of flood insurance and the limited depth of the insurance market in Malaysia makes it challenging for ITOs to build a sufficiently large pool of uncorrelated risks, as clients more highly exposed to risks (such as those in high-risk geographical areas) are the ones more likely to purchase insurance protection.

**In this context, financial institutions fail to serve Malaysian businesses, especially high-risk ones, adequately.**

Indeed, the evidence in this report points toward a *de facto* exclusion of a set of high-risk, vulnerable businesses from access to financial products. The evidence indicates that a set of high-risk businesses, especially smaller ones, are either priced out or outright excluded from the insurance market. For example, about 17 percent of businesses affected by floods over the past three years were refused insurance quotes. Another 32 percent of SMEs and 27 percent of large businesses affected by floods were asked to retrofit their premises to obtain further insurance coverage. Doing so can be particularly difficult when businesses face constraints in access to finance for adaptation and resilience. And depending on businesses' past exposure to floods, banks may require them to purchase flood insurance or develop and implement adaptation plans as prerequisites for access to financing. These results suggest that there might be a vicious cycle between bank financing and insurance, in which limits in access to one source of external funds can further curb access to other sources of finance.

## The Role of Policies to Support Private Sector Adaptation and Resilience to Flood Risks

**The findings in this report show that there is scope to strengthen the role of the public sector to further support private sector adaptation and resilience to flood risks, which ultimately would lead to more sustainable and resilient economic development for Malaysia.** As noted above, the public sector has a crucial role to play as the primary provider of large-scale flood control infrastructure as well as ensuring that critical infrastructure and service delivery are resilient to flood risks, among other responsibilities. In doing so, the public sector can reduce businesses' exposures and mitigate their vulnerabilities to floods. However, other public sector policies can also play a vital role. For instance, the landscape for financing investments to enhance private sector resilience to flood risks is marked by a range of market failures, frictions, and inefficiencies that call for policy

intervention. Tackling these challenges will require a deliberate and holistic approach by the public sector to catalyze private capital while incentivizing businesses to manage flood risks. This report outlines a range of complementary policy actions in six key areas, focusing on how policy makers in Malaysia can support and foster private sector resilience to floods, with emphasis on policies to enhance the role of the financial sector. This report leaves a more in-depth assessment of the range of actions that businesses can undertake and their effectiveness for future research.

### RECOMMENDATION 1

**Enhance data availability, accessibility, and affordability to support flood risk assessments, which are vital for risk management, informed investment**

### decisions, and the development of financial markets.

In Malaysia, public sector support is needed to close critical data gaps related to flood risk information. The government's role is critical in building the appropriate climate information infrastructure for flood risks to mobilize private investment in adaptation activities. Flood risk maps are among the most essential tools to provide information in support of climate change adaptation decisions. This information is crucial to risk modeling and pricing of products as well as the structuring of financial solutions by the financial sector and can also benefit the public and the private sectors. Without appropriate and timely information, neither private nor public stakeholders can adequately assess their exposures, and consequently, understand the investments needed to mitigate risks and minimize losses. Because significant positive externalities are associated with sharing credible and timely climate-related information, governments should be responsible for providing this information.

- *In the short term, the Government of Malaysia should publish flood hazard maps to expand public access to information and develop legal and regulatory frameworks to support the collection and dissemination of data to manage the legal risks. In the medium term, the Government should also improve the quality of the primary data on flood hazard risks to address concerns with limited time horizons, frequency of updates, limited coverage, and geographical comparability by investing in hydro-met services and exploiting new technologies. The Government should also promote the development of technologies and expertise in monitoring and assessing flood risks not only in the public sector, but also in the private sector and the scientific and academic communities. Moreover, the Government could consider establishing partnerships with private stakeholders to complement and enhance public sector initiatives, leveraging their capabilities and expertise in the development of risk models, while reducing fiscal costs.*

## RECOMMENDATION 2

**Develop a long-term national adaptation strategy, clearly outlining and communicating the priorities for the Government of Malaysia and defining the scope of action for the public sector.** A national adaptation strategy has first-order importance by establishing the level of risk retention by the public sector, thereby reducing policy uncertainty and facilitating the assessment of flood risks for the private sector. As

noted above, private sector adaptation and resilience efforts should build on and complement those of the public sector. In the absence of a clear definition of the responsibilities of the public sector, effective intergovernmental coordination, and transparent policy priorities—critical elements currently lacking in Malaysia—private sector efforts risk being fragmented and misaligned with the critical needs of both businesses and the entire country. Therefore, it is important that the Government of Malaysia signals and commits to the direction of future policies to the largest extent possible, to enhance transparency and provide crucial information for the private sector and financiers alike.

- *In the short term, an immediate important foundational step for Malaysia is the articulation of a national adaptation strategy with a prioritized action plan that outlines clear adaptation goals toward flood risks. The strategy should also: (i) strengthen institutional structure and arrangements for disaster risk management; (ii) establish effective cooperation and coordination mechanisms across the various stakeholders; (iii) establish in the legal framework the responsibilities and liabilities of national, regional, and local government authorities and other relevant stakeholders about flood risk management in its entirety, encompassing the periods before, during, and after floods; and (iv) encompass robust governance arrangements to promote transparency and accountability in public sector policy action—for example, by conducting an effective public consultation process and establishing regular monitoring and reporting against set targets. In the medium term, complementing these, the national and sub-national governments should issue detailed adaptation investment plans, outlining their portfolio of high-priority projects, thereby facilitating the identification of residual risks associated with floods for the private sector. By recognizing that climate change poses a significant threat to the long-term sustainability of public sector finances, the Government should also consider developing a disaster risk finance framework to institutionalize disaster response and recovery systems while leveraging innovative contingent financing instruments. Such a framework would outline comprehensive ex-ante financial protection strategies for managing the costs associated with disasters like floods, aimed at limiting their impact on public sector finances.*



**RECOMMENDATION 3****Strengthen the enabling environment for the financial sector to foster adaptation and emergency financing.**

While Recommendations 1 and 2 aim to facilitate the quantification of flood risks by closing data gaps and reducing uncertainty, the third recommendation goes one step further. Policy actions should also foster the mainstreaming of such risks for the financial sector to enhance accountability, ensure adequate risk management, and foster financing toward adaptation and resilience. Harnessing investment opportunities should go closely together with risk management. Financial institutions can only mobilize finance to adaptation and resilience if they can effectively manage flood risks in their portfolios. In addition, effective flood risk management is essential to preserve financial stability. Financial sector regulators should thus develop a robust climate information architecture conducive to the management of flood risks.

- *In the short term, financial sector regulators should rebalance the focus of the climate information architecture by placing greater emphasis on climate change adaptation, for instance, by (i) raising awareness and strengthening the policy discourse and advocacy for adaptation and emergency financing related to flood risks, and (ii) publishing implementation guidance for taxonomies and climate-related disclosure frameworks focused on investments and activities related to adaptation and resilience to flood risks. In the medium term, as data availability and quality improve, the regulators should undertake flood risk assessments for the financial sector to inform other prudential policy actions required to preserve financial stability. The frequency of such assessments should improve as information on flood risks and capabilities develop. The regulators also should carefully monitor the implementation of new policy tools and financial sector responses to guard against unintended consequences for financial inclusion and financial stability.*

**RECOMMENDATION 4**

**Deploy targeted interventions to support access to finance for adaptation and recovery efforts, especially targeting the most vulnerable businesses, such as SMEs.** Support to the enabling environment is necessary, but it is not sufficient to foster adaptation and emergency financing related to flood risks, so targeted financial interventions are still needed. Such interventions should focus on the most vulnerable

businesses. Adopting an evidence-driven approach for designing and implementing targeted policy support would ensure effective outreach. The evidence in this report indicates that targeted interventions should focus on enhancing access to finance for SMEs, which tend to be among the most vulnerable and under-resourced, partly because of more constrained access to finance and lower capacity to adopt resilience strategies to help them adapt to floods.

- *The Government of Malaysia with the financial sector regulators should consider developing a policy framework outlining priorities in supporting access to finance for adaptation and recovery. Greater efforts are needed to strengthen the coordination of public sector policies to enhance the effectiveness and impact of interventions and prevent duplication of efforts. The policy framework could establish priorities and specific strategies (including specific policy instruments) to address the financing gaps for the most vulnerable businesses (especially SMEs), drawing from the principles discussed in the report about the use of concessionality, de-risking instruments (such as credit guarantees), and the adoption of robust monitoring and evaluation (M&E) frameworks. To enhance the effectiveness of policy support, policy makers should adopt M&E frameworks across the range of targeted support currently available to businesses, including existing financial relief mechanisms provided by financial regulators. The deployment of targeted support should leverage public entities, such as development financial institutions, and existing financial support schemes for businesses.*

**RECOMMENDATION 5**

**Deepen insurance markets to enhance the range of financial instruments that can support the financial resilience of businesses in Malaysia.** In Malaysia, ITOs face significant challenges to adequately quantify, price, and diversify flood risks, which hampers their ability to provide flood risk protection to businesses, especially vulnerable ones such as SMEs. The increasing prevalence of floods and their associated costs suggest the need for more active support by the public sector to further develop the segment within insurance markets. Harnessing the capacity for risk diversification of the insurance industry toward flood risks could yield considerable upsides. However, doing so will involve consideration of a range of potential pathways for policy support to expand insurance market depth while ensuring affordability. The status quo for Malaysia is that

vulnerable businesses largely shoulder the financial risks of floods. Solutions could aim to either transfer financial risks to the public sector or to cross subsidize such risks across a wider pool of insured assets, for instance, through some form of requirement for insurance uptake across lower-risk businesses, where permissible and appropriate. The different solutions would thus affect incentives for businesses, ITOs, and the public sector, with consequences for market dynamics. While having the potential for significant distributional impacts depending on the extent to which different parties effectively bear the financial costs associated with floods, solutions could be designed to incentivize an enhanced role for the private sector with well-crafted public policy and interventions. Ultimately, the level of insurance protection available in the marketplace should reflect the Government of Malaysia's position on the distribution of the costs associated with floods between the private and the public sectors.

- *The Government of Malaysia and the financial sector regulators should conduct an in-depth assessment of arrangements for public sector support for the insurance market, examining the relevant trade-offs of specific solutions in light of the challenges faced by Malaysian businesses and Malaysia's climate risk profile. These authorities should also consider establishing a framework for collaboration between the public sector and the insurance industry and defining the scope for public sector funding and other policy support. Because this assessment will take time, in the short term, the authorities should conduct a more in-depth and granular diagnostics assessment to identify critical vulnerabilities among businesses and gaps in insurance coverage, especially among vulnerable SMEs, and consider adopting temporary, targeted public sector policies to support financial resilience for vulnerable businesses.*

#### RECOMMENDATION 6

**Strengthen policy efforts to enhance flood risk awareness and build capabilities to foster greater efforts toward adaptation and resilience.** Public sector intervention should focus on closing awareness gaps, particularly for businesses with lower capabilities and those prone to greater information asymmetries, such as SMEs. As flood risks evolve due to climate change, public sector interventions should also target businesses in areas where the frequency of flooding is not historically high but might be on the rise. Policy makers should also prioritize capacity building as an integral element of the policy agenda to enhance private sector resilience to flood risks. For instance, even

when flood-related data become more widely available, businesses may face difficulties using the information to assess the risks and impacts on their operations. Business may also be unable to properly assess the cost-effectiveness of different adaptation and resilience strategies. Furthermore, the large indirect impact of floods through supply chain disruptions shown in this report highlights the need for the design of policy support programs to build the capacity of businesses to enhance the resilience of their supply chains.

- *In the short term, the Government of Malaysia could leverage the publication of flood risk maps with awareness raising, for example, by using interactive platforms with information on flood hazards, exposures, and adaptation efforts. The Government could also develop well-targeted awareness campaigns to mainstream flood risk management for businesses, especially among vulnerable segments. In the medium term, the Government of Malaysia should also deploy programs specifically designed to strengthen the capacity of businesses to map and assess the resilience of their supply chains, providing guidance in identifying vulnerable links for which preventive action may be warranted. Interventions supporting capacity building for both businesses and financial intermediaries can be deployed alongside directed financial support to improve the likelihood of impactful outcomes. Financial sector regulators can also enhance their capacity building efforts to foster the mainstreaming of flood risks into business operations, risk management practices, and investment decisions of financial institutions.*



## CHAPTER 1

# A Framework for Flood Risk Management





## Key Messages

- **Building resilience to flood risks is imperative for sustainable private sector development and growth in Malaysia.** Yet, empirical evidence on the vulnerability of businesses to flood risks has been scarce in Malaysia. Little is known about which businesses are most vulnerable and the most significant challenges hindering greater adoption of risk mitigation strategies, both ex-ante preparedness and ex-post coping strategies.
- **The impact of floods on businesses depends on a combination of three factors: hazard, exposure, and vulnerability.** These three elements interact with each other and are fundamental to understanding private sector resilience to floods.
- **Hazard reflects “where and when” shocks might occur.** It is the probability of a flood event and its physical characteristics, including intensity and duration.
- **Exposure reflects “who and what” would be affected if floods were to occur.** It comprises not only businesses and their assets but also infrastructure, such as roads, water, sanitation, drainage, flood protection infrastructure, and other public infrastructure such as health care and school facilities.
- **Vulnerability reflects the “how and how much.”** It refers to the degree to which exposed businesses and their assets would be adversely affected by floods, taking as given hazards and exposures. Vulnerability can vary substantially depending on the adaptation and financial resilience measures in place to protect exposed businesses and their assets.
- **While businesses have limited ability to address hazards and exposures, they can adopt a range of coping strategies to mitigate their vulnerabilities.** Businesses can strengthen their resilience by planning and investing in both precautionary measures and emergency responses and recovery efforts. Such efforts minimize business risks and strengthen their resilience.



# 1.1 Introduction

## Recent large-scale floods have caused significant damage and disruptions to businesses in Malaysia.

Flood-related disasters are the most common natural disaster in Malaysia. Such events result in economic losses and may pose significant financial risks to businesses. At the national level, the Department of Statistics Malaysia (DOSM) estimates that damages caused by the flood events in December 2021 and January 2022 alone at RM6.1 billion (about \$1.35 billion and equivalent to 0.4 percent of the country's nominal GDP), with business premises, manufacturing, and the agriculture sector accounting for RM1.5 billion (about \$330 million) or 25 percent of total damages.<sup>6</sup> In addition, the federal government allocated RM1.2 billion (about \$260 million) in financial aid and other forms of relief associated with the flood events. The 2021 floods were by no means an isolated event. Climate change alongside rapid economic development is threatening to increase the frequency and intensity of floods. Recurring floods also mean that businesses (and households) are constantly recovering from and bracing for new flooding events, thus affecting their economic prospects.

**This report focuses on the management of flood risks for Malaysian businesses.** Building resilience to flood risks is imperative for sustainable private sector development and growth in Malaysia. Yet, empirical evidence on the vulnerability of businesses

to flood risks has been scarce, not only in Malaysia but across emerging market and developing economies (EMDEs). Little is known about which businesses are most vulnerable and the most significant challenges hindering greater adoption of risk mitigation strategies, both ex-ante preparedness and ex-post coping strategies. In addition, in Malaysia there is a lack of data and research in this area that is comprehensive and updated on a regular basis. Therefore, it is difficult for policy makers to identify and prioritize support policies to strengthen private sector resilience. An evidence-driven approach to designing and implementing policy support is essential for an effective outreach to the most vulnerable businesses. Only then can public sector policies support private sector resilience efficiently and sustainably, improving the odds of credible impact. This report is a step toward bridging this knowledge gap to shed light on how policy makers in Malaysia—namely, the Government of Malaysia, including the Ministry of Finance and relevant line ministries and their respective agencies, financial sector regulators (Bank Negara Malaysia and Securities Commission Malaysia), and development financial institutions—can support and foster private sector resilience to floods, with emphasis on policies to strengthen the role of the financial sector in supporting business adaptation and resilience to flood risks.

# 1.2 Conceptual Framework

**The impact of floods on businesses depends on a combination of three factors: hazard, exposure, and vulnerability (Figure 1.1).** Hazard is the probability of a flood event and its physical characteristics—including the type of floods (e.g., fluvial, pluvial, or storm surges) and its intensity. This factor reflects “where and when” shocks might occur. Exposure reflects “who and what” would be affected if floods were to occur. It comprises not only businesses and their assets but also infrastructure, such as roads, water, sanitation, drainage, flood protection infrastructure, and other public infrastructure such as health care and school facilities. Finally, vulnerability

refers to the degree to which exposed businesses and their assets would be adversely affected by floods, taking as given hazards and exposures (Cardona et al., 2012). That is, the “how and how much.” Vulnerability can vary substantially depending on the adaptation and resilience measures in place to protect exposed businesses and their assets. Hazard, exposure, and vulnerability are not static concepts; they can vary over time. While there is some predictable natural variability in the occurrence of floods, there is a high degree of uncertainty in measuring the hazard of floods, especially in a changing climate, as discussed later in this report.

<sup>6</sup> See DOSM (2022) and Box 2.1 for more details.

**Businesses' vulnerabilities depend on the various channels through which floods can impact them.**

Businesses can be directly impacted by floods through losses in inventories or damages to machinery, equipment, or facilities (including buildings). Businesses can also incur indirect losses, such as those associated with the disruption of businesses. Floods can negatively impact suppliers, customers, and infrastructure. For example, floods can disrupt

transport networks and other essential services like electricity, gas, and telecommunication. Such disruptions affect the availability, quality, and cost of inputs, thereby impairing businesses' ability to produce and deliver goods and services. Floods can also lead to reduced customer demand. More broadly, value chain linkages can amplify the impacts of floods, though this transmission channel depends on their sector and position in the chain.

**FIGURE 1.1**  
Conceptual Framework



**While businesses have limited ability to address hazards and exposures, they can adopt a range of coping strategies to mitigate their vulnerabilities.**

Individual businesses have virtually no control over hazards, and few strategies are available to reduce exposures. Relocation away from high-risk locations is potentially the only viable option to reduce their exposures. The scope for business action is broader in terms of mitigating their vulnerability to floods. Businesses can strengthen their resilience by planning and investing in both precautionary measures (for example, ex-ante investments in preparedness) and emergency responses and recovery efforts (for example, by purchasing insurance and developing business continuity plans that can speed up recovery time, among others). Such investments minimize business risks and strengthen their resilience. Thus, it is fundamental to encourage businesses to invest in adaptation and build resilience to flood risks, both to reduce their ex-ante exposures and vulnerabilities and mitigate the impact of floods if they are affected.

**Limited access to financial services, both credit and insurance or takaful protection, can hinder efforts to strengthen business resilience, particularly for small and medium enterprises (SMEs).<sup>7</sup>**

Constraints in access to finance can exacerbate businesses' vulnerability to flood risks by constraining both ex-ante investments in preparedness and ex-post recovery and reconstruction efforts, thereby reducing their ability to cope with adverse shocks. Insurance can also provide invaluable financial resources if risks materialize. Constraints in access to flood insurance might also limit the range of funding sources for businesses' recovery efforts, and affect businesses' financial resilience. Ultimately, limited access to financial services can hamper the private sector efforts to enhance their resilience and, consequently, increase the fiscal burden of floods on the public sector, especially as it is compelled to step in and provides relief in the aftermath of floods.

<sup>7</sup> For simplicity, this report adopts the term insurance to refer to both insurance and takaful protection.

## 1.3 Objectives of this Report

**The report starts with a characterization of Malaysia's flood risk profile.** Within the framework presented above, Chapter 2 discusses the hazards and exposures of Malaysian businesses to flood risks, discussing differences across geographical locations within the country. The chapter discusses the frequency and severity of floods at the country level in a comparative setting against other countries worldwide. The chapter then provides estimates of the aggregate impacts of future floods in Malaysia, discussing the differing effects across sectors and the extent to which a range of adaptation measures can help reduce potential losses. The chapter also provides an assessment of the possible risk exposures of the banking sector to flood risks. The assessment provides estimates of the potential costs and benefits of broad public sector policy strategies for managing flood risks in Malaysia while highlighting the importance of greater resilience in the private sector.

**Chapter 3 assesses the challenges for Malaysian businesses, especially SMEs, in managing flood risks.** The chapter draws on a novel business-level survey conducted on 1,500 businesses to explore the factors discouraging businesses from investing in adaptation and resilience to flood risks. Specifically, this demand-side survey provides evidence of challenges related to climate risk knowledge and awareness, the identification and availability of cost-effective mitigation and adaptation measures, and the financial capacity to implement these measures. The assessment also discusses the management of the recovery process when floods hit businesses. The chapter zooms in on the challenges in access to finance and the uptake of flood insurance.

**Switching perspective to the supply-side, Chapter 4 discusses the challenges the financial sector faces**

**in providing financial services to support adaptation and resilience for Malaysian businesses.** As discussed above, access to relevant financial services and products can improve the ability of these businesses to cope with adverse shocks, including those linked to floods, and reduce the fiscal burden on the government. Specifically, drawing from a novel supply-side survey conducted on financial institutions in Malaysia, this chapter evaluates the factors constraining the provision of financial services by commercial banks and insurers and takaful operators (ITOs) to support adaptation and resilience efforts by businesses.

**Chapter 5 brings together the findings from both the demand and supply assessments to discuss the range of public sector policies to strengthen private sector resilience and enhance the management of flood risks for businesses, zooming in on policies for the financial sector.** The chapter focuses on policies that recognize and act upon the barriers preventing businesses from effectively adopting more resilient and sustainable practices while creating an enabling environment that encourages private financing toward these investments.

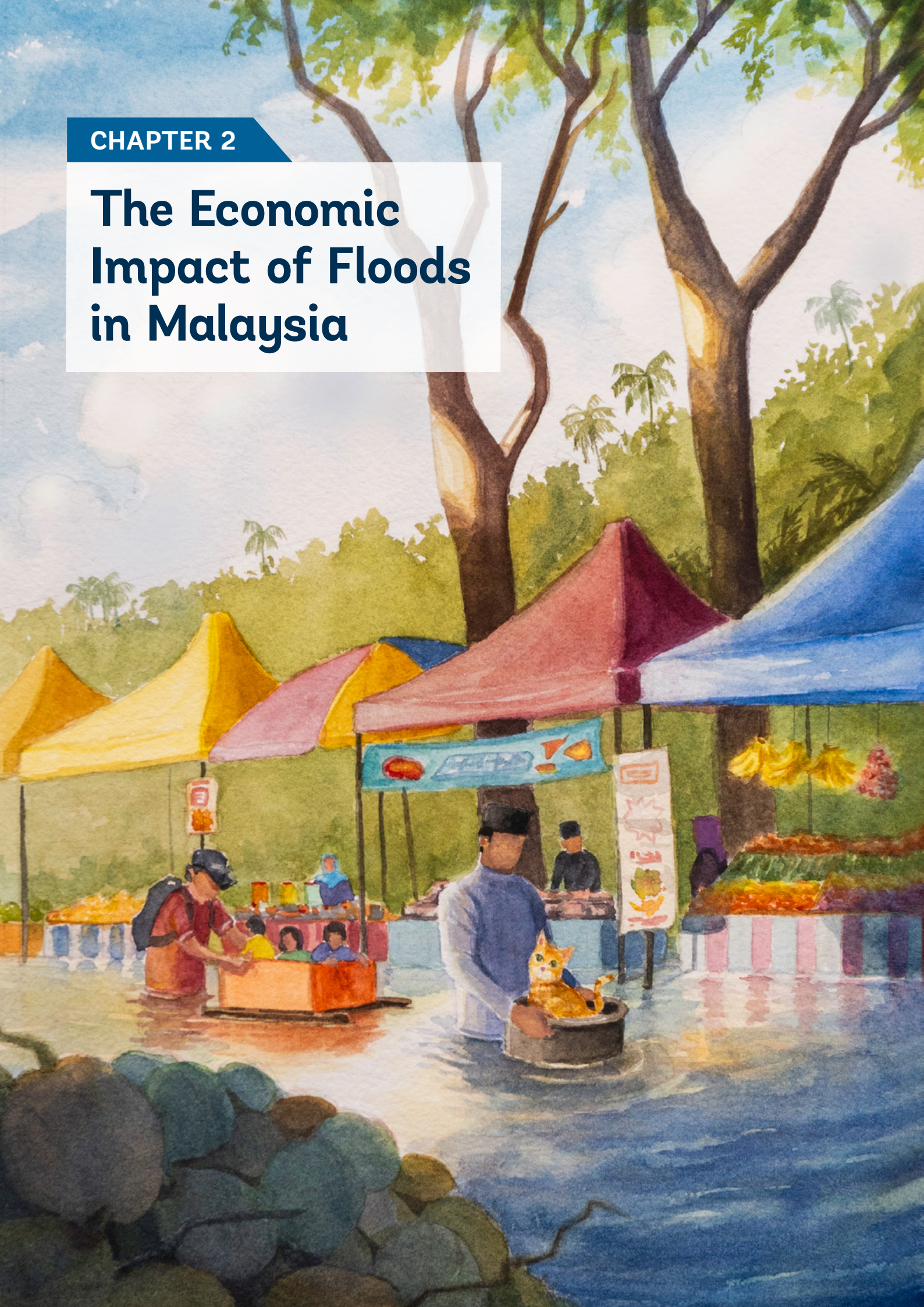
**The report concludes in Chapter 6 with a roadmap for policy action.** Notably, the roadmap focuses on strengthening adaptation and resilience for the private sector. As such, it offers a partial view of the range of policies needed to strengthen flood risk resilience in Malaysia. Effective flood risk management entails complementary actions aimed at reducing hazards, exposures, and vulnerabilities, not only by businesses but also by households and the government. Hence, effective policy action based on this roadmap should be viewed as needed and welcome, but remains insufficient to address all the challenges posed by floods in Malaysia.





## CHAPTER 2

# The Economic Impact of Floods in Malaysia





The background of the page is a watercolor illustration. It depicts a tropical scene with several trees in the upper left, a river or stream flowing through the middle, and a bridge with colorful pillars in the lower left. The style is soft and painterly, with visible brushstrokes and a mix of green, blue, and earthy tones.

## Key Messages

- **Floods have been Malaysia's most frequent natural disaster, accounting for 85 percent of all natural disasters since 2000.** Compared with other countries around the world, Malaysia experiences relatively frequent but not necessarily severe floods. For example, Malaysia ranks 12<sup>th</sup> in the world in terms of the frequency of floods, but 78<sup>th</sup> in terms of the average annual damages associated with large-scale floods.
- **Malaysia has experienced high and increasingly frequent rainfall, and projections indicate further increases in precipitation in Malaysia.** If not mitigated, higher precipitation will expose the country to higher flood risks. The projected increase in precipitation means that what would historically have been a 1-in-100-year flood event could become a 1-in-50-year or 1-in-25-year event.
- **This study is a first attempt to assess the macroeconomic and financial sector impact of flood events, despite the limited availability of granular data.**
- **Floods can have a sizable impact on the economy.** The macroeconomic analysis shows that the impact of a hypothetical 1-in-20-year flood is expected to cost Malaysia up to 4.1 percent of GDP in 2030. The estimates also indicate a significant impact on jobs from floods that could lead to up to a 2.2 percentage point increase in Malaysia's unemployment rate. There is however significant heterogeneity in the potential impact across sectors.
- **Floods can also have an impact on the banking sector.** Because of its large relative size in the banking system loan portfolio, 44 percent of the total potential losses would occur in the services sector. However, the proportion of loans for the service sector potentially impacted by floods is relatively low at 3 percent.
- **Adaptation efforts could significantly reduce the macroeconomic and financial impact of floods.** The estimates indicate that a comprehensive combination of regulatory measures, climate resilient infrastructure investments, and ecosystem improvements could reduce the economic impact of floods by more than 40 percent.
- **Businesses also have an important role in strengthening flood risk resilience in Malaysia.** For example, supply chain resilience can reduce the potential impact of floods by more than 50 percent for less severe events, but it has a more limited role during severe floods.
- **The findings in this chapter highlight the necessity of flood risk management for both the public sector and the private sector.** While adaptation and resilience efforts by the private and public sectors can go a long way in reducing the potential losses associated with floods, residual risks are likely to remain, and they could still entail sizable economic costs. For businesses, this puts a premium on efforts to strengthen their adaptation and resilience efforts.



**Climate change pose challenges to Malaysia's developmental aspirations, with potentially sizable impacts on growth and employment.**

In the coming years, Malaysia aims to become a high-income country through good governance, sustainable development, and harmony. Such aspirations, however, are threatened by climate change. Malaysia already has one of the world's highest levels of exposure to floods, and the risks posed by such disasters are only expected to rise, possibly leading to significant economic damage and affecting many people and businesses every year.

While the Government of Malaysia has increasingly focused on the need for adaptation and resilience to flood risks, there is limited evidence on the economic costs and benefits of potential adaptation strategies or on the role of the public sector and the private sector in undertaking such critical adaptation investments. This chapter focuses on the disruptive effects of floods on Malaysia's economy, including its potential impact on financial stability through an assessment of flood risk exposures in the financial sector.

## 2.1 Characterizing Flood Risks in Malaysia

**With its tropical climate, Malaysia has experienced high and increasingly frequent rainfall.**

The average annual precipitation is 3,085.5 millimeters (mm), and the level of precipitation is relatively constant throughout the year, ranging between 200 mm in June and July and 350 mm in November and December (Figure 2.1, panel A).<sup>8</sup> Malaysia experiences two monsoon seasons between May and September (Southwest Monsoon) and November and March (Northeast Monsoon).<sup>9</sup> Between 1951 and 2020, precipitation levels in Malaysia persistently increased (Figure 2.1, panel B). Within 30-year windows, the average precipitation was 2,698 mm per year during 1951 to 1980. It increased to 2,748 mm during 1971 to 2000, and further to 2,887 mm during 1991 to 2020.

**Projections indicate further increases in precipitation in Malaysia.**

The Ministry of Natural Resources and Environmental Sustainability (NRES) estimates an increase in average annual precipitation between 14 and 25 percent and an increase in sea level of about 0.7 meters in Malaysia by the end of the 21<sup>st</sup> century.<sup>10</sup> Projections reported in the Intergovernmental Panel on Climate Change (IPCC) Working Group I Atlas and the World Bank Climate Change Knowledge Portal (CCKP)

are consistent with national estimates and also indicate marked increases in precipitation over time. Although a majority of models project an increase in precipitation over time, there is a large uncertainty around precise point estimates, with significant variation depending on model assumptions. For example, panel C in Figure 2.1 shows the heterogeneity in projected changes in the annual distribution of precipitation between 2020 and 2099 for two scenarios of varying GHG emissions: SSP1-2.6 in which temperatures stay below 2°C warming relative to the median 1850-1900, with implied net zero GHG emissions after 2050, and SSP2-4.5 which is a scenario approximately in line with the upper end of the world's aggregated Nationally Determined Contribution GHG emission levels by 2030 and represents temperature warming of around 2.7°C during the same period.<sup>11</sup> Independently of the chosen scenario, projections consistently show an increase in annual precipitation. If not mitigated, higher precipitation will expose Malaysia to higher flood risks, especially flash floods, according to the CCKP projections. The projected increase in precipitation means that what would historically have been a 1-in-100-year flood flow could become a 1-in-50-year or 1-in-25-year event in Malaysia.

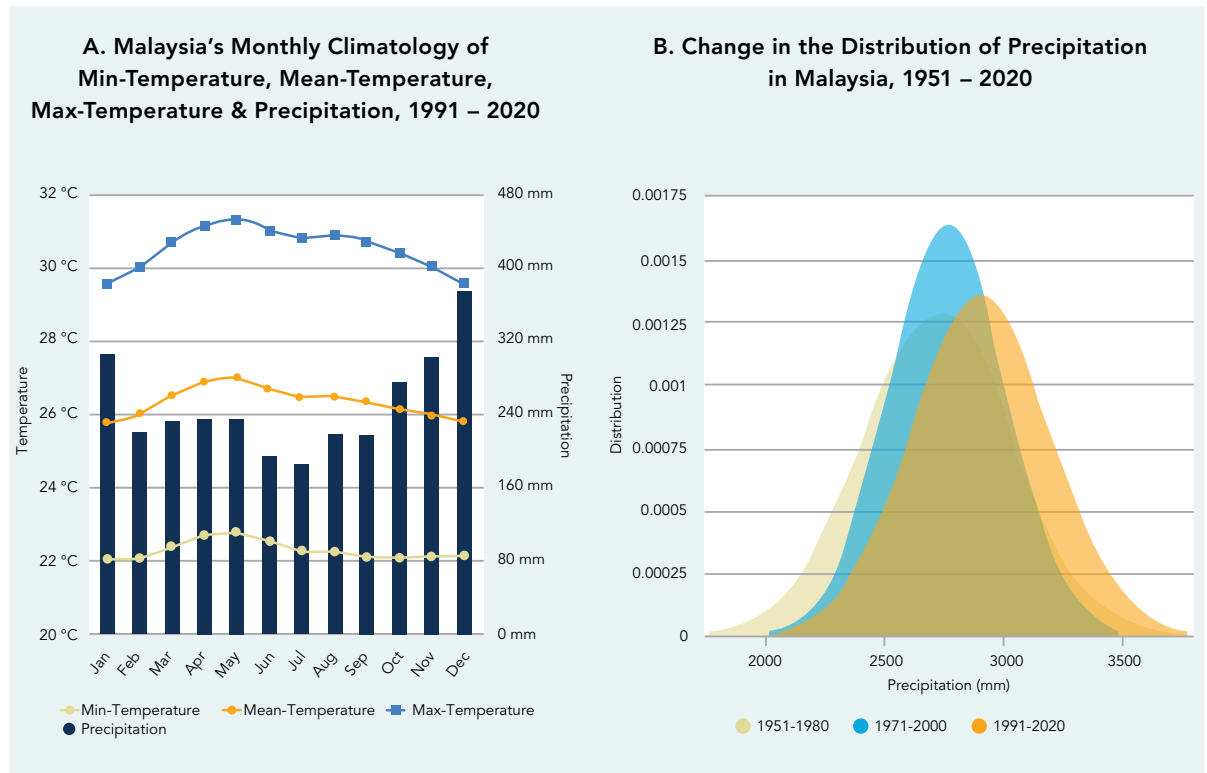
<sup>8</sup> See World Bank's "Current Climate: Climatology – Malaysia."

<sup>9</sup> The Northeast Monsoon brings heavy rain especially to the states on the east coast of Peninsular Malaysia, west of Sarawak and east of Sabah, while the Southwest Monsoon relatively shows drier weather. The transition period between these two monsoons is known as the inter-monsoon phase. See <https://www.met.gov.my/en/pendidikan/fenomena-cuaca/>.

<sup>10</sup> See United Nations' "Flood Management and Climate Change Adaptation in Malaysia."

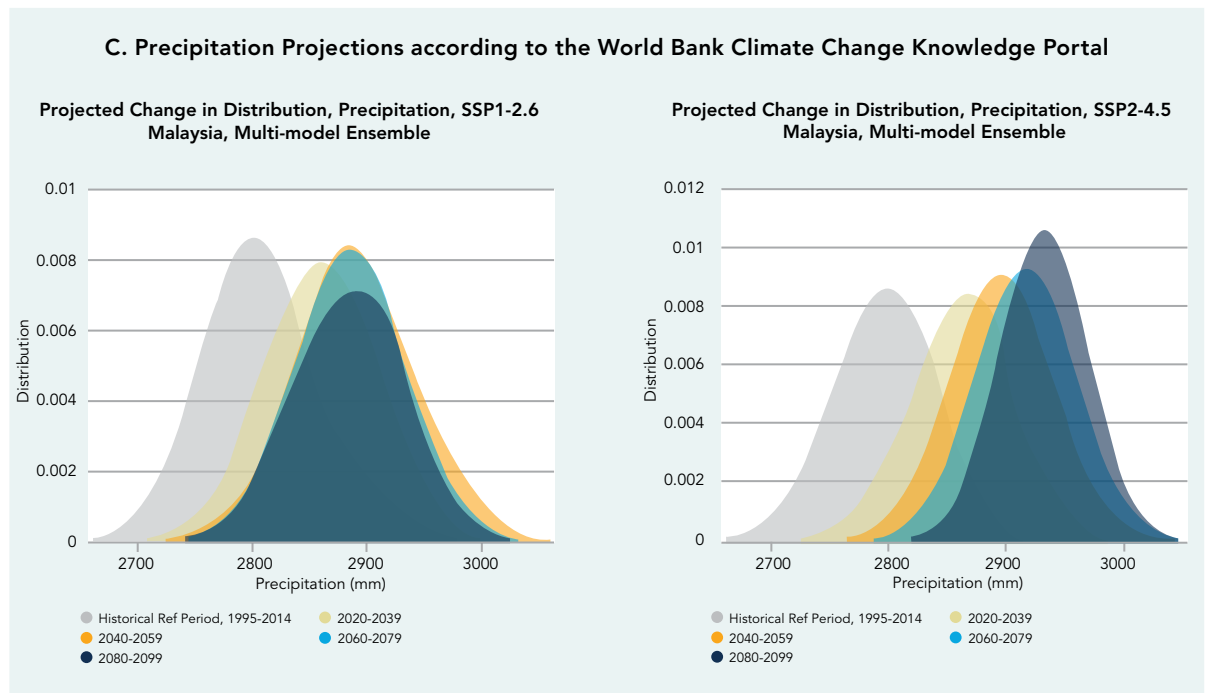
<sup>11</sup> The projections are based on global climate model compilations of the Coupled Model Inter-Comparison Projects (CMIPs) overseen by the World Climate Research Program. Data is derived from the Sixth phase of the CMIPs, which form the data foundation for IPCC's Sixth Assessment Report.

**FIGURE 2.1**  
Precipitation Trends in Malaysia



Source: World Bank CCKP

Source: World Bank CCKP



Source: World Bank CCKP

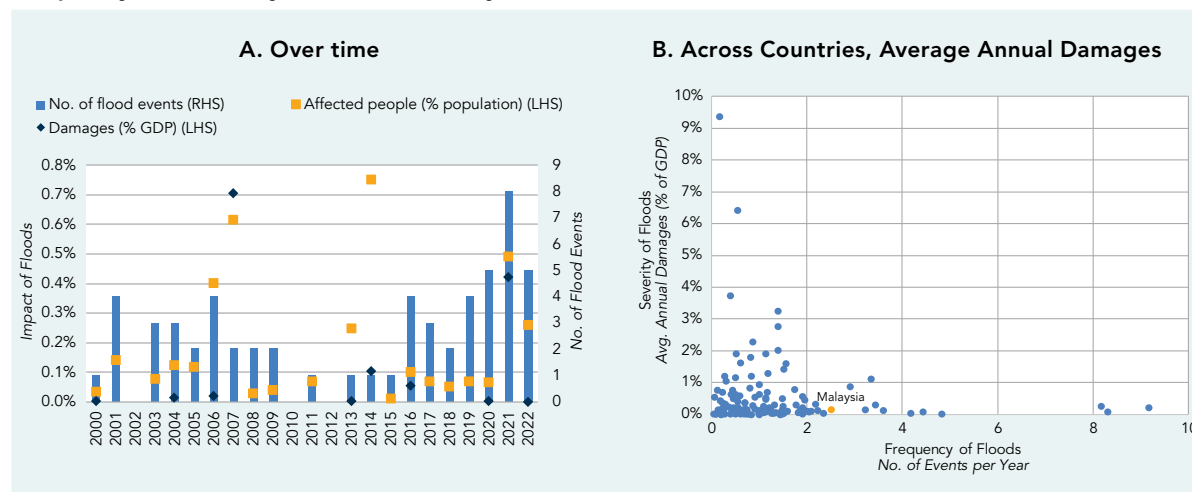
**Floods have been Malaysia's most frequent natural disaster, accounting for 85 percent of all natural disasters since 2000.** According to data from EM-DAT, a global database with information on over 26,000 mass disasters from 1900 to the present day, Malaysia has experienced, on average, 1 to 2 large-scale flood events per year since 2000, with more frequent flooding occurring about once every seven years (Figure 2.2A).<sup>12</sup> Large-scale floods have occurred more frequently since 2020. Historical records show that Malaysia has been more affected by floods than other natural disasters; other disasters include storms (7 percent of all disasters) and landslides (6 percent). Data from EM-DAT also reveals that floods constitute the most significant source of economic damage, affecting the greatest number of people compared to other natural disasters in Malaysia. For example, the EM-DAT database shows that in 2021 alone there were eight large-scale flood events, affecting about 165,000 people in Malaysia.<sup>13</sup>

**Compared with other countries around the world, Malaysia experiences relatively frequent but not necessarily severe floods.** Malaysia ranks 12<sup>th</sup> in high frequency of floods from 174 economies included in the EM-DAT database, with slightly more than two

large-scale floods per year on average over 2000–2022 (Figure 2.2B). Among countries with more frequent large-scale floods are several Southeast Asian economies such as Indonesia, Philippines, Thailand, and Viet Nam. Although the frequency of floods in Malaysia is higher than the average flood occurrence globally, the severity of large-scale flood events—as measured by the average annual affected population or annual damages—is relatively low compared to other countries. Malaysia is ranked 78<sup>th</sup>, with annual average damages associated with large-scale episodes of 0.13 percent of GDP during this period and 0.19 percent of the total population affected by such events. The countries with the most severe damages faced losses averaging over 2 percent of GDP. In most countries, large-scale floods tend to be low-frequency, high-severity events. In recent years, the most severe large-scale flood events occurred at the end of 2021 and the beginning of 2022 and resulted in RM6.1 billion (about \$1.35 billion) in losses, equivalent to 0.4 percent of Malaysia's GDP. Box 2.1 provides a brief discussion of the 2021–22 Floods, and Box 2.2 discusses the institutional arrangements regarding the emergency response and relief efforts by the public sector in Malaysia.

**FIGURE 2.2**

**Frequency and Severity of Floods in Malaysia**



Source: EM-DAT database, downloaded in May 2023.

Source: EM-DAT database, downloaded in May 2023.

12 EM-DAT is the International Disaster Database, compile by the Centre for Research on the Epidemiology of Disasters (CRED). The database is compiled from various sources, including UN agencies, nongovernmental organizations, re-insurance companies, research institutes, and press agencies. The CRED distributes the data in open access for non-commercial use. The database includes mass disasters with at least ten deaths (including dead and missing), at least 100 affected (people affected, injured, or homeless), or events with a call for international assistance or an emergency declaration. Less severe events are not included in the database. More details are available at <https://www.emdat.be/>.

13 Internal displacement refers to the forced movement of people within the country they live in. The Internal Displacement Monitoring Centre shows that 129,000 people were internally displaced by the end of 2021 due to floods. See <https://www.internal-displacement.org/countries/malaysia/#displacement-data>.

## BOX 2.1

## The Macroeconomic Impact and Response on Flood in 2021

In December 2021, Malaysia experienced 1-in-100-year rainfalls, which resulted in disastrous flooding events across many parts of the country and caused significant economic losses, almost 50 deaths, and the evacuation of about 400,000 people. The floods affected 11 states—Kuala Lumpur, Selangor, Pahang, Kelantan, Terengganu, Perak, Johor, Negeri Sembilan, Melaka, Sabah and Sarawak.<sup>14</sup> One of the worst affected areas in Selangor, Taman Sri Muda, experienced floodwaters reaching four meters in depth, causing up to 95 percent of the area to be under water. Many roads leading to the flood areas were submerged, making evacuations and assistance by government agencies challenging.

**Losses were widespread.** According to estimates by the Department of Statistics Malaysia (DOSM), losses to business premises amounted to RM0.5 billion (\$110 million), manufacturing plants suffered losses estimated at RM0.9 billion (\$200 million), and the agriculture sector had losses of about RM90 million (\$20 million). Selangor was the worst affected state, with the highest losses on manufacturing sector assets at RM884.5 million (\$197 million) and business premises at RM396.4 million (\$88 million), especially in the Petaling and Klang districts.

The government revived the National Security Council (MKN) to coordinate relief efforts and flood relief packages in response to the disaster.<sup>15</sup> In addition, Bank Negara Malaysia established the Disaster Relief Facility with RM500 million (\$110 million) to alleviate the financial burden of micro, small, and medium enterprises (MSMEs) affected by the floods. Additionally, several financial institutions offered loan moratoriums on housing or property financing, car financing, credit cards, and personal financing of up to six months to flood victims.<sup>16</sup>

**About a third of the losses, equivalent to RM2.2 billion (\$490 million), were covered by insurance.** About 82 percent of the gross insured losses were from the commercial sector, mainly from large corporates with high insurance coverage for commercial premises. Residential homes accounted for another 11 percent of the insured losses. The 2021 flood events led to the largest claim payout in Malaysia's insurance and takaful industry for flood events in the past decade.<sup>17</sup> Despite the large payout, the losses incurred by insurers and takaful operators (ITOs) did not pose risks for the industry because ITOs had sufficient liquidity and part of the risks had been transferred to re-insurance/re-takaful operators.

14 See DOSM (2022).

15 See Rahman (2022).

16 See New Straits Times (2021a).

17 See Bank Negara Malaysia. (2022b).

## BOX 2.2

# Institutional Arrangements in the Management of Flood Risks in Malaysia

**The Government of Malaysia plays a vital role in prevention and preparedness for flood risks through budget allocations and resource mobilization.** For example, the federal government has initiated several flood mitigation projects nationwide and has announced an allocation of RM22 billion (\$4.9 billion) during 2022–2025 in the 12<sup>th</sup> Malaysia Plan toward such projects as part of a long-term strategy to adapt to climate change since the 2021 flood disaster.<sup>18</sup> For 2024, the government allocated a budget of RM11.8 billion (\$2.6 billion) for 33 flood mitigation projects.<sup>19</sup> The flood mitigation projects comprise nature-based solutions, structural measures to mitigate river and flash floods, and non-structural measures, including upgrading the national weather forecast and flood warning systems.<sup>20</sup> Federal budget has also been allocated to various agencies, such as the National Disaster Management Agency (NADMA) and the Malaysian Armed Forces, to improve preparedness and provide flood relief assistance. Some of the projects have been completed—for example, as of August 2023, 25 out of 85 flood mitigation projects in Selangor worth RM1.1 billion (about \$245 million) had been completed.<sup>21</sup> In addition to the allocation by the federal government, the Selangor state government allocated RM615.1 million (\$137 million) for the Department of Irrigation and Drainage (DID) to implement 73 flood mitigation projects by 2025, while the Shah Alam City Council allocated about RM300 million (\$67 million) to upgrade drains and water pumps over the next five years.<sup>22</sup>

**DID conducts studies on river basins to help identify riverine flood mitigation projects in flood-prone areas.**

DID also develops structural and non-structural flood mitigation measures and manages flood management systems such as the Stormwater Management and Road Tunnel (SMART Tunnel) in Kuala Lumpur, flood control dams, river bunding, land use zoning, restriction of development, and resettlement of population.<sup>23,24</sup> For example, when the water flow in the Klang River reaches a certain threshold, DID activates the SMART Tunnel to divert large volumes of water to prevent floods.<sup>25</sup>

**There are several agencies involved in the deployment of early warning systems.** NADMA provides early warning systems through media and short-messaging systems to the public in affected areas, supported by forward-looking data provided by agencies such as the Malaysian Meteorological Department (MetMalaysia), DID and the Public Works Department.<sup>26</sup> MetMalaysia, an agency under the Ministry of Natural Resources and Environmental Sustainability (NRES), is responsible for providing weather forecasts and warnings on thunderstorms and heavy rain based on continuous monitoring of atmospheric patterns, including rainfall, wind direction, and speed. MetMalaysia issues an alert with 'Alert,' 'Severe,' and 'Danger' categories to indicate the amount of rainfall within a specific period<sup>27</sup> to gauge the severity of thunderstorms and rainfall. This information helps state governments, the federal government, NADMA, and the public prepare for potential floods and other disasters. DID, a department under NRES, also provides warnings of river floods based on hydrological data, such as river water flow and the amount of rainfall that feeds into rivers, using flood forecasting models.

18 See Ministry of Finance (2022).

19 See The Star (2023).

20 See United Nations' "Flood Management and Climate Change Adaptation in Malaysia."

21 See Malay Mail (2023).

22 See Bernama (2023).

23 Bunding of rivers prevents overtopping and flooding of the low-lying adjacent areas.

24 See Department of Irrigation and Drainage's "Managing the Flood Problem in Malaysia."

25 See <https://smarttunnel.com.my/operational-modes/>.

26 See NADMA (2022).

27 See MetMalaysia's "Continuous Rain Warning Issuance Criteria."

**Emergency response and disaster relief operations associated with floods are managed as a collaborative effort involving the federal and state governments, government agencies such as NADMA, the Malaysian Armed Forces, and social organizations.** Disaster risks, including flood disasters in Malaysia, are managed by the National Disaster Relief Committee, chaired by the Prime Minister and with the National Security Council (MKN) as the secretariat. The Committee is empowered to declare a state of disaster to obtain financial assistance from the federal government for flood disaster relief efforts, subject to the Prime Minister's approval. It is also empowered to mobilize additional resources for relief operations. Members of the Committee include government agencies, such as NADMA, and social organizations, which provide shelter, rescue, and food supplies during disasters.<sup>28</sup> NADMA, an agency under the Prime Minister's Department, manages and coordinates flood relief efforts. NADMA is managed by three committees at the federal, state, and district levels: the Centre for Disaster Management and Relief Committee

(CDMRC), chaired by the Deputy Prime Minister at the federal level; the State Disaster Management and Relief Committee (SDMRC), chaired by the secretary of state; and the District Disaster Management and Relief Committee, chaired by the district officer.<sup>29</sup>

**Overall, adaptation, preparedness, and emergency response involve a complex set of actors, and responsibilities seem to overlap across different public sector entities, which can lead to uncertainty and hamper actions by the private sector.** Such a complex environment, especially for ex-post emergency response and disaster relief, can be prone to coordination failures, especially when actions are not closely coordinated across the different actors. In the context of unclear allocation of responsibilities, businesses in a high-risk flood zone may assume that different flood management actions are the responsibility of the local or national government, so they do not need to make their investments to reduce risks or adapt to climate change. These issues are further discussed in Chapter 5.

28 See Department of Irrigation and Drainage's "Managing the Flood Problem in Malaysia."

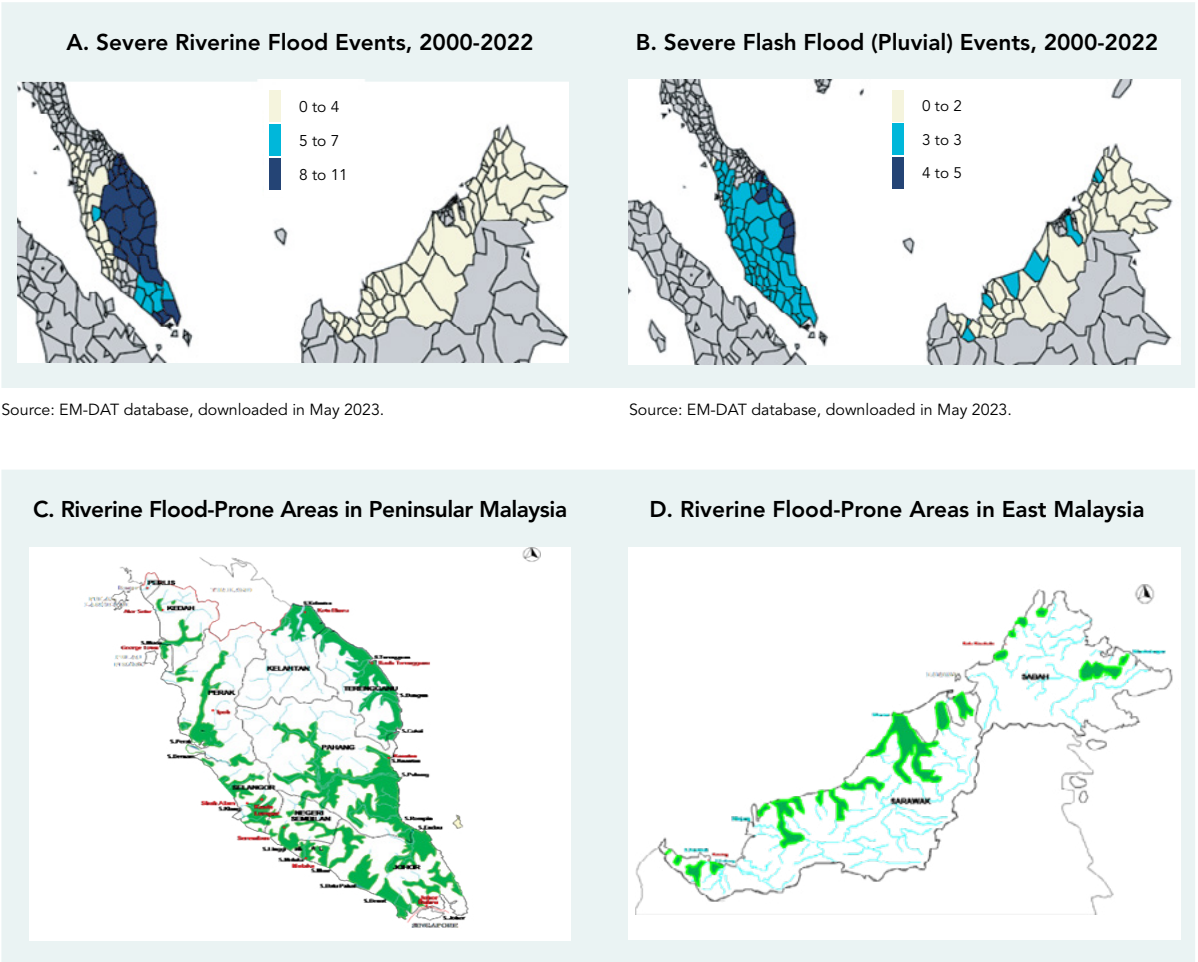
29 See New Straits Times (2019).



The East Coast and the South of Peninsular Malaysia are geographical regions that experience more frequent floods associated with the year-end Northeast Monsoon season exposures. According to EM-DAT, the East Coast of Peninsular Malaysia experienced mainly severe riverine floods (i.e., fluvial floods) over the last 20 years (Figure 2.3, panel A). In contrast, the rest of Peninsular Malaysia and some coastal cities in Sabah and Sarawak states have experienced primarily severe pluvial floods (i.e., flash floods) (Figure 2.3, panel B). The maps of flood-prone areas published by the Department of Irrigation and Drainage (DID), which covers only riverine floods, indicate similar patterns (Figure 2.3, panels C and D).<sup>30</sup>

In recent years, major cities, such as Kuala Lumpur and Kuching, and the state of Penang, have experienced more frequent flash floods. Rapid urban development, which contributed to insufficient drainage capacity and deforestation, has resulted in an increased frequency of floods in these cities.<sup>31</sup> Climate change has also made it more challenging to predict floods with a high level of accuracy due to the great uncertainty in the underlying weather patterns. Based on the SwissRe CatNet Map flood hazard maps, there is a higher probability (1-in-50-year event) of flash floods occurring in higher GDP areas based on property values such as Klang Valley, Alor Setar, Kota Bahru, Kuantan, and Batu Pahat (see Figure 2.4).

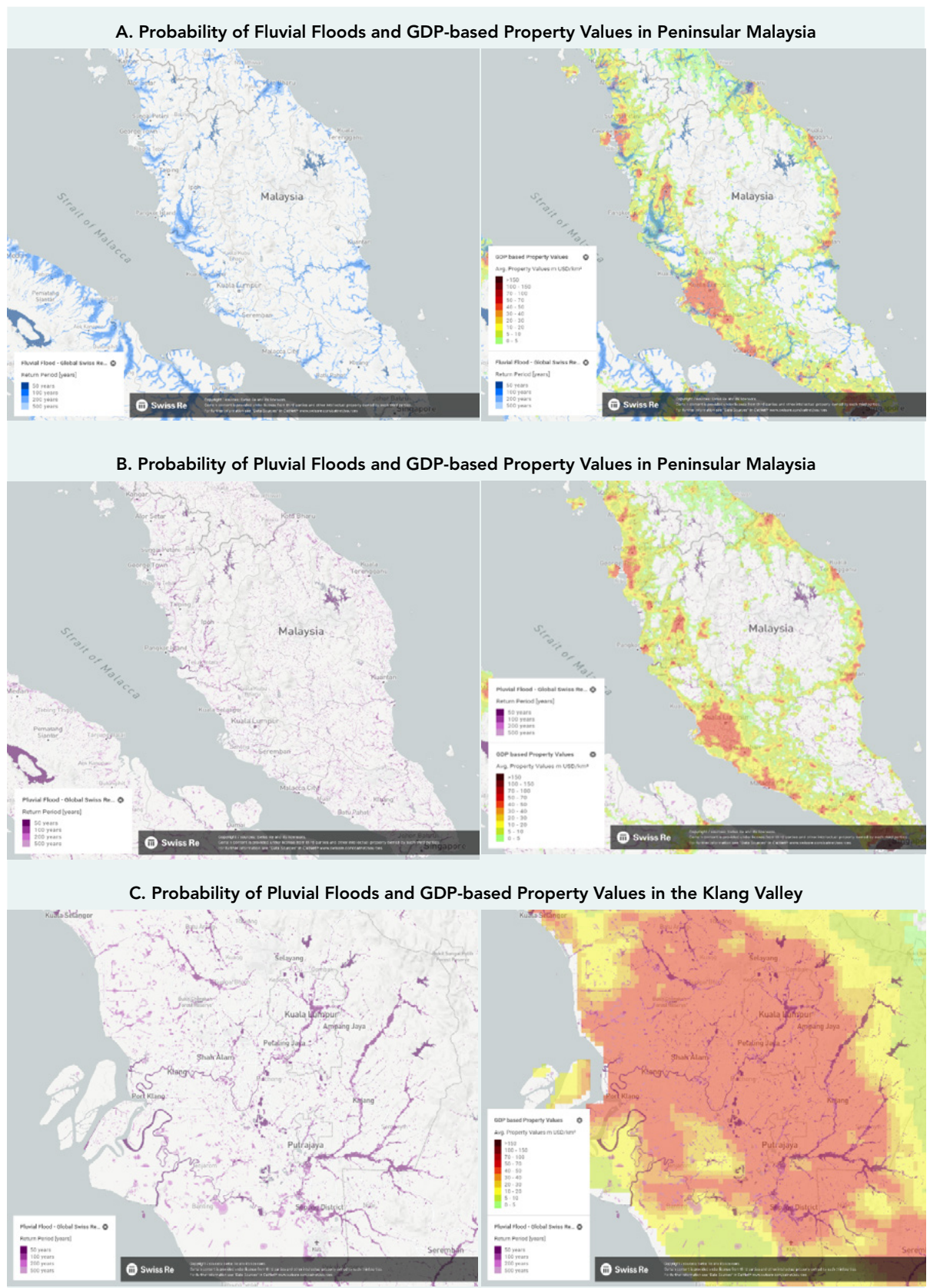
**FIGURE 2.3**  
Floods across Regions in Malaysia



<sup>30</sup> See Department of Irrigation and Drainage's "Flood Management – Programme and Activities."

<sup>31</sup> Department of Irrigation and Drainage. (n.d.). *Managing the Flood Problem in Malaysia*. <https://www.water.gov.my/jps/resources/auto%20download%20images/584130f6ea786.pdf>

**FIGURE 2.4**  
Flood Hazards in Peninsular Malaysia



## 2.2 The Macroeconomic Impact of Floods

### 2.2.1 The Modeling Approach

**The rest of this chapter presents estimates of the macroeconomic impact of future floods in Malaysia.**

The analysis is based on a two-stage input-output model which links different data sources on physical risks and economic information. The modeling approach can be interpreted as a simulation tool, allowing us to explore the impacts of floods of different return periods and the effects of adaptation efforts by the private sector.

**The first stage of the model is a mapping exercise.**

This exercise explores hazard data on floods (measured at granular geographical units) and a spatial representation of current and expected future assets exposed to flood risks in Malaysia. The primary data source for this analysis is the 2016 flood risk maps from the Fathom database, a proprietary database of flood risk maps widely used for research on flood risks worldwide.<sup>32</sup> This mapping exercise provides estimates of the share of assets at risk for the year 2030 in Malaysia, shown separately by economic sectors (see Section 2.2.3). The estimates are based on expected development patterns and potential climate change

effects in Malaysia. The length of future flood spells assumed for these estimates is based on historical averages, with no increases assumed within the analysis window. Estimates of the (average and total) time for economic production to recover from floods are based on the approach of Tanoue et al. (2020).

**The second stage of the analysis is based on the MINDSET model, in which the results of the first stage described above are used to estimate the aggregate economic impact of floods at the sectoral level.**

The different results from the first stage are combined with flood risk projections, allowing us to calculate each sector's total expected annual production losses based on expected flood risks. Such losses are then fed into the MINDSET macroeconomic model (see Box 2.3 for details). MINDSET estimates the supply chain effects from losses of demand to estimate the whole economy, aggregate impacts of floods in Malaysia. The aggregate impacts capture both direct and indirect impacts. The model also provides estimates of employment losses by sector, occupation, and gender.

<sup>32</sup> Similar analyses as those presented in this chapter were conducted based on flood risk maps from the JBA database. Despite different methodologies, flood map resolutions, and projection scenarios, the analysis yielded quantitatively similar aggregate results. There were, however, some variations in the sectoral and geographical assessments.

#### BOX 2.3

### The MINDSET Model

The World Bank has developed MINDSET, an input-output model designed to estimate the socio-economic impacts of climate shocks and the climate policy responses. The acronym stands for Model of Innovation in Dynamic Low-Carbon Structural Economic and Employment Transformations. The MINDSET model allows us to disaggregate the effects of climate change by impact channel. One important channel for the analysis is the impact of floods, capturing both direct and indirect effects.

MINDSET covers the whole economy, with information disaggregated at the sectoral level, and with 120 sectors in the analysis for Malaysia. The sectoral analysis is linked to detailed labor-market dynamics calculated from microeconomic data. The current version of MINDSET

uses the GLORIA multi-regional input-output database (see Lenzen et al., 2017 and 2021). The estimations in this chapter only consider flood impacts on Malaysia. They do not take into account potential cross-border linkages.

It is important to note that MINDSET is a non-equilibrium model, and as such, it is particularly well-suited to assess the short-term impacts of floods and other sudden economic shocks without giving the economy time to adjust to a new equilibrium outcome.<sup>33</sup> The model estimates for flood events represent both the effects of lost factors of production (e.g., factories unable to operate) and the effects of disruption that prevent markets from matching demand and supply (hence, achieving equilibrium outcomes).

<sup>33</sup> MINDSET is a demand-driven macroeconomic model. In its current version, there are no supply-side constraints as the model assumes that there is always spare capacity available to raise production levels if effective demand increases. The approach is therefore complementary to a general equilibrium model.

## 2.2.2 Scenarios

The scenarios are designed as “what-if” possibilities and do not explicitly predict when floods will occur. The analysis estimates the direct impact of a 1-in-20-year flood on physical assets in Malaysia. That is, a flood event that has a five percent probability of occurring on any given year. Between 2024 and 2030, the 1-in-20 odds translate into a 30 percent probability that such flood event will occur. While the results presented in this chapter consider this baseline probability, robustness assessments were conducted for more severe events, such as 1-in-50-year and 1-in-100-year floods.

The baseline estimates consider two scenarios, with robustness assessments in Section 2.2.6. The two scenarios considered are as follows: (i) Scenario 1 considers a hypothetical 1-in-20-year flood; and (ii) Scenario 2 considers a hypothetical 1-in-20-year flood, with the adoption of additional adaptation measures. The scenarios include a range of other channels through which climate change, more broadly, can affect

the economy in Malaysia. The results show that floods are one of the most important channels of impact, as described further below. However, it is not the only one and the estimations consider these other channels, as outlined in Table 2.1. One such channel works through impacts on agricultural yields and prices (World Bank, 2016). A loss of yield for Malaysian agricultural producers can be largely mitigated by the higher prices farmers would receive on global markets, partly because other countries would also see losses of yields due to climate change impacts. This impact on food prices further affects households that experience losses in real incomes. Another impact channel is through declines in labor productivity because of heat stress effects, though this channel is independent of any impacts from floods. Lastly, the model also considers potential losses of revenues from a combination of infrastructure damages and diversion of tourism flows to countries with cooler climates.

**TABLE 2.1**  
Estimates of Climate Impacts

Impact Channel	Quantification in the Model	Data Sources
Flood Damages	1-in-20-year flood	Derived from the Fathom database
Agriculture (farmers)	A small increase in revenues (0.04% of GDP) due to higher prices	World Bank (2016)
Agriculture (consumers)	Loss of real incomes because of higher food prices (2% of GDP)	World Bank staff estimates based on World Bank (2016)
Reduced labor productivity	1.7% in all sectors	NGFS analysis
Loss of tourism	4.5% of output in hospitality	World Bank staff estimates

## 2.2.3 The Direct Impacts of Floods

The conceptual framework outlined in Chapter 1 can shed light on the mechanisms underlying the estimations of the direct impact of floods. These estimates consider Scenario 1, in which a 1-in-20-year flood takes place, hypothetically. In the context of the framework presented in Chapter 1, this would be the hazard adopted in the estimations. The key metric for assessing the direct macroeconomic impacts of floods is the proportion of assets exposed to flood events because this determines the extent of potential losses in economic production. This would be equivalent to the exposure in the conceptual framework. The

analysis focuses on the sectors that use the different assets rather than the type of asset per se. In this way, the analysis relates the direct impacts of the floods to production losses. In the baseline estimates, there are no actions related to vulnerabilities. That is, the baseline scenario does not consider the impact of additional adaptation measures, such as new investments for flood resilience infrastructure between now and 2030, for calculating the impact of floods on aggregate output and employment. The role of adaptation investments will be explored in the following scenario.



The results show marked variation across sectors in the extent to which assets are exposed to flood risks, with significantly greater exposures in the agriculture and transport sectors (Table 2.2). The largest exposures are estimated to be on transport and agricultural assets, reflecting their diffuse nature. The loss of essential transport linkages when floods occur is worth special consideration because it can be an important factor exacerbating the direct economic impacts of the flood (see Section 2.2.6 below). Transport linkages may also be critical in relief operations and the early stages of clean-up and repairing damaged capital. It is worth emphasizing, that the methodology adopted in this chapter is not well-suited to identifying specific vulnerabilities in Malaysia. Consequently, it does

not allow quantifying specific effects working through disruptions in transportation networks. While exposed assets in agriculture and transport cover around 30 percent of the total assets of these sectors, exposures are significantly lower in all other sectors, estimated at between seven and 10 percent of total assets. Because of the larger size of these other sectors in absolute terms, especially the services and industrial sectors, aggregate exposed assets can be sizable. The average estimated depth of the potential flooding across different sectors is also substantial, suggesting that widespread damages would be likely. Notably, these sectoral estimates display a high degree of uncertainty, and quantitative results may vary depending on the resolution of underlying flood risk maps and projection scenarios.

**TABLE 2.2**  
Estimated Asset Exposures to a 1-in-20-year Flood Event

Sectors	Share of Assets Exposed to Flooding (%)	Average Depth of Flooding for Exposed Assets (meters)
Services	8.7	2.0
Retail	9.6	1.6
Health	8.8	1.3
Industry	7.1	1.3
Education	8.6	2.4
Tourism	7.9	4.3
Transportation	32.1	2.3
Agriculture	28.6	3.9

## 2.2.4 Estimating Aggregate Impacts

The estimates show that floods are the main channel through which climate change can lead to production losses in Malaysia by 2030, with flood-related losses estimated at up to 4.1 percent of GDP. The total impact of climate change on output, as outlined in Scenario 1 (flood event, without adaptation measures), is estimated to be a loss of around 9 percent by 2030 (Figure 2.5).<sup>34</sup> The impacts from floods are estimated to be slightly less than half, at up to 4 percent in total output losses by 2030. Because intermediate demand of different sectors does not directly accrue in GDP, output losses tend to be larger than GDP losses. Total GDP losses associated with climate change are estimated at 8.4 percent. Floods account for almost half of the total climate-related impacts, with total losses associated

with a theoretical 1-in-20-year flood in 2030 estimated at up to 4.1 percent of GDP.<sup>35</sup>

**Floods are the largest source of climate change impact across most sectors of the economy.** The impact of floods on the assets of mining and quarrying, and services sectors account for about 53 percent of the estimated total losses for these sectors. Production losses associated with floods are also significant for the agriculture and the manufacturing sectors, representing 46 percent and 38 percent, respectively, of the estimated aggregate losses associated with climate change in these sectors. In relative terms, the losses of the agriculture sector account for 11.5 percent of the total output losses in Malaysia, whereas

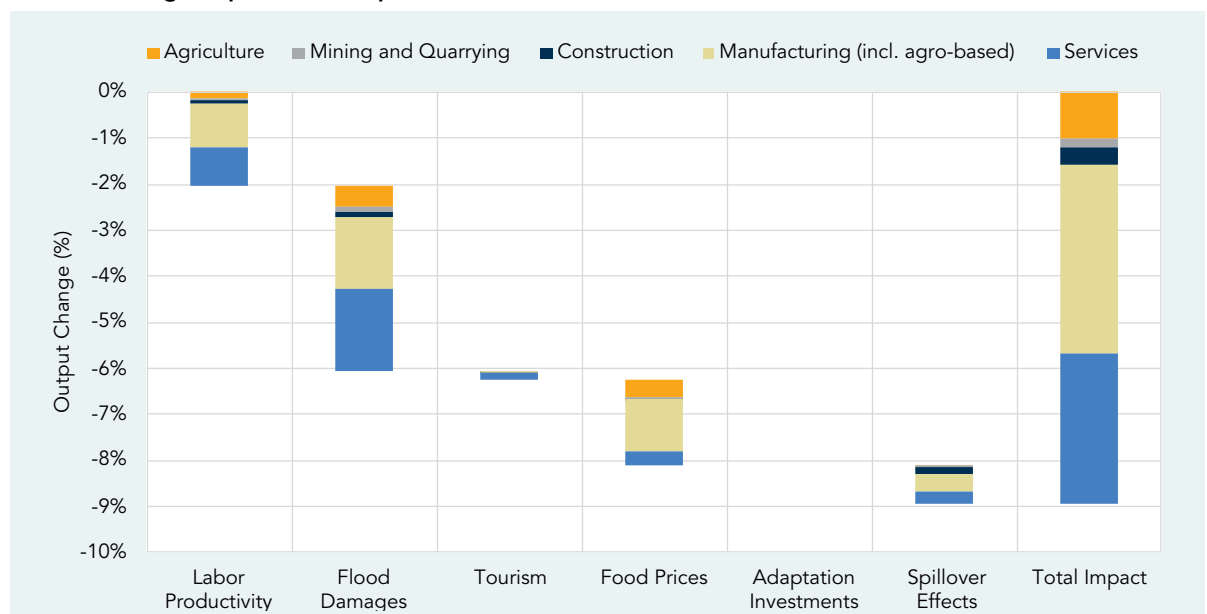
<sup>34</sup> For robustness, we conducted a similar analysis considering in Scenario 1 more severe floods. When Scenario 1 considered a 1-in-50-year flood instead of a 1-in-20-year flood event, the total output loss associated is estimated at 20 percent. For a scenario considering a 1-in-100-year flood event, the estimations show a total output loss of 23 percent.

<sup>35</sup> These results consider both direct losses from floods (such as damages to physical assets) and indirect losses (such as losses in revenues due to business disruptions). The results however do not consider reconstruction and rebuilding efforts which would likely moderate impacts on output and GDP.

together the manufacturing and service sectors account for more than 82 percent of the output losses due to floods, largely due to their relative size (see Box 2.4 for a discussion of these effects). The impact of floods on the assets of the transport sector account for about 73 percent of the estimated total losses for the sector. While the direct impact on the transport sector is relatively small, at less than 10 percent of the total losses due to floods, all other sectors may be indirectly impacted by disruptions in transport services, as discussed above. Similar effects can occur for utilities and other services. These sectors account for a small fraction of total output losses, but lack of access to power, water, sewage services, and other utilities could substantially impact production in other

sectors. The manufacturing and services sectors are also impacted by climate change effects with losses in labor productivity and, to a lesser extent, losses from higher food prices. The former accounts for about 25 percent of the total estimated losses for these sectors, arguably because of the relatively high labor intensity of production. Higher food prices have a marked direct effect on the food production industry, in part due to higher input costs. This channel also accounts for a significant share of the output losses in the agriculture sector in Malaysia. The tourism channel and spillover effects channel, such as those associated with foregone investments, are estimated to have more subdued impacts on aggregate output.

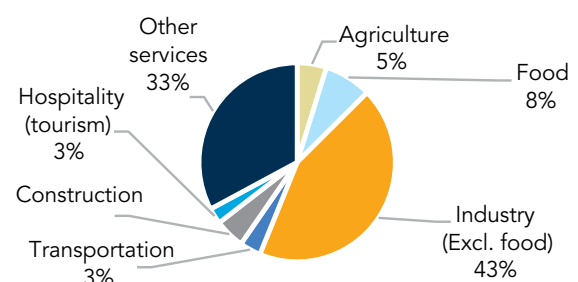
**FIGURE 2.5**  
Climate Change Impacts on Output



## BOX 2.4

# Production Shares in Malaysia

The 120 sectors used to estimate the MINDSET model are aggregated into seven broad sectors to simplify the interpretation of the results. However, as the chart shows, these sectors have different weights in total output for Malaysia. The industry and services sectors account for over three-quarters of the total output. The estimation results discussed in the main text reflect these relative weights, where sectors with larger weights account for a larger share of the impact of floods on total production and employment.

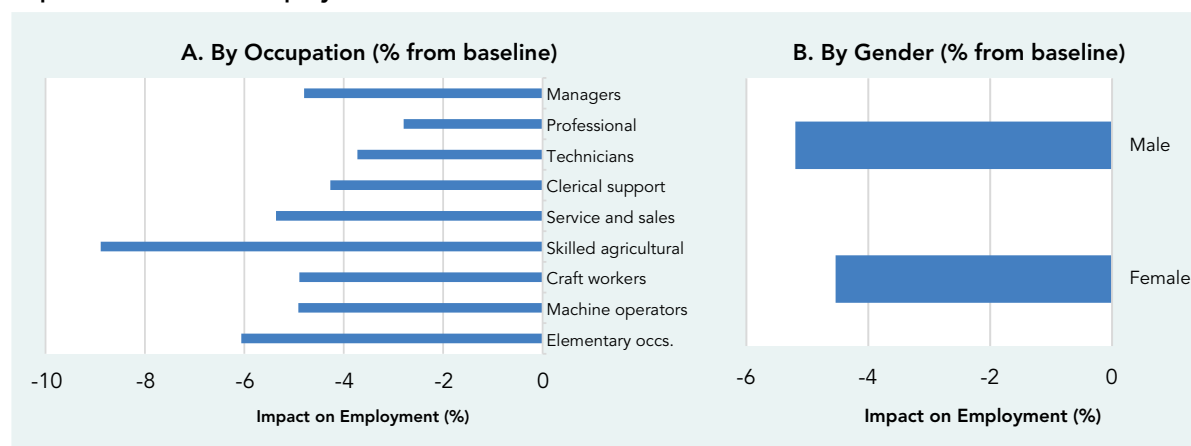


**The model also allows us to estimate the impact of floods on employment by occupation and gender.<sup>36</sup>**

The results are similar to those for output impacts. Flood risks are primary source of risks for employment when compared to the other channels through which climate change could impact jobs in Malaysia. The model estimates that up to 685,000 jobs would be affected, possibly lost, due to overall climate change effects. Assuming a baseline unemployment rate of 3.7 percent, this could lead to up to a 4.4 percentage point increase in Malaysia's unemployment rate.<sup>37</sup> Although the model does not yield a specific estimate of job losses due to floods, assuming that the relative impact of floods (vis-à-vis other channels) on jobs would be similar to that

on output yields some rough estimates. Such a “back of the envelope” calculation suggests that a 1-in-20-year flood could account for up to 318,000 impacted jobs by 2030, or up to a 2.2 percentage point increase in Malaysia's overall unemployment rate. The most significant impact on employment would occur in the agriculture sector, with estimates of nearly 10 percent impacted jobs directly resulting from floods (Figure 2.6, panel A). More than 6 percent of jobs in elementary occupations, once again linked to agriculture and transport, are also estimated to be impacted by floods. Because of the higher weight of labor in agriculture in Malaysia, male employment is affected slightly more than female employment under Scenario 1.

**FIGURE 2.6**  
Impact of Floods on Employment



**It is important to note that the model is not designed to capture indirect effects associated with the financial sector.** The financial sector itself is included in “services” in Figure 2.5. However, the current estimates through MINDSET do not capture the indirect effects associated with disruptions in the financial sector. The estimates only capture actual production losses, such as damages to office premises. Financial linkages,

for example, associated with financial instability or disruptions in the provision of financial services, would need to be estimated through a different model, specifically designed to capture such effects from financial sector portfolio exposure levels. Box 2.5 provides an assessment of banking system exposures to floods.

<sup>36</sup> The MINDSET results for the impact of climate change on employment are based on output-employment elasticities observed in the GLORIA multi-regional input-output database, calculated at the sector-country level. These elasticities capture how employment would change in each sector in response to production losses. One important caveat for the analysis in this chapter is that the elasticities are calculated from historical data based on permanent changes in output. In the case of flood impacts, output changes are likely to be more transitory. The statistics reported can thus be interpreted as the number of workers affected by floods. To the extent that the effects linger and become more permanent, impacted jobs would translate into job losses.

<sup>37</sup> Robustness analysis considering more severe floods yield larger increases in unemployment. When Scenario 1 considered 1-in-50-year and 1-in-100-year flood events, the estimations show that the impact of floods on jobs could lead to an increase in the unemployment rate of up to 8.7 and 10 percent, respectively.



## BOX 2.5

## Banking System Exposures to Floods

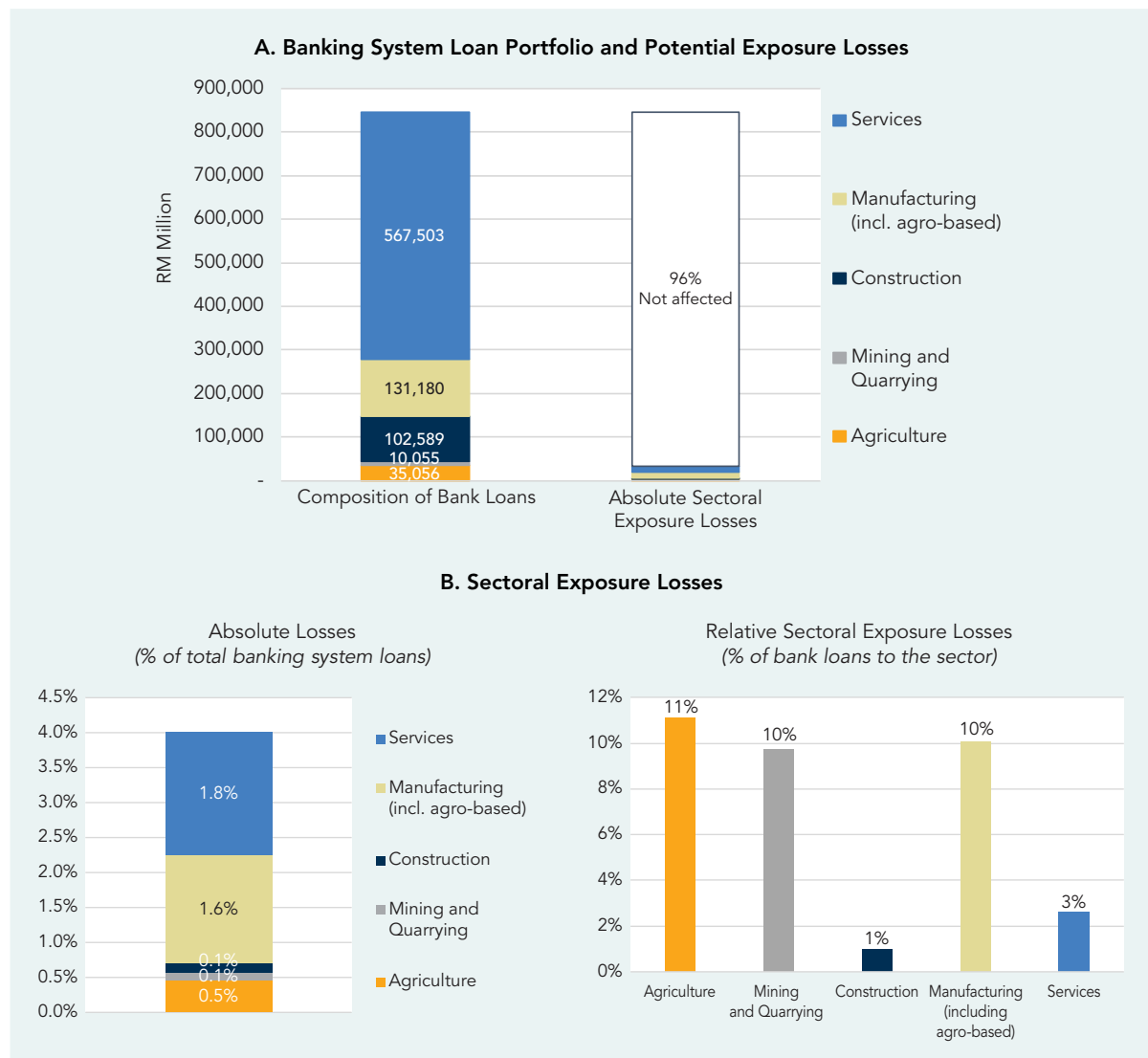
As discussed above, the estimations show that Malaysia is expected to suffer up to 4 percent in total output losses by 2030, based on the impact of a theoretical 1-in-20-year flood. A “back-of-the-envelope” calculation, exploring the sectoral impact of floods estimated through MINDSET, sheds light on the distribution of potential losses for the banking system from such a flood event by 2030.

To estimate the potential impact of floods in the banking sector, the estimated impact on gross output (i.e., 4 percent) is applied to total outstanding bank loans. The composition of bank loans across sectors that could be impacted in this scenario is shown in Figure B2.1, panel A. Figure 2.5 above shows the differentiated impact of floods across sectors. These losses are then distributed across sectors according to the sectoral impact of floods estimated through MINDSET (reported in Figure 2.5).

Figure B2.1, panel B, shows the results of such estimations. Because of its large relative size in the banking system loan portfolio, 44 percent of the total potential losses would occur in the services sector (Figure B2.1, panel A). However, the proportion of loans for the service sector potentially impacted by floods is relatively low at 3 percent (Figure B2.1, panel B). In contrast, the agriculture sector would account for 12 percent of total potential losses, but the sectoral share of impacted loans would be higher at 11 percent.

This represents a conservative estimate of the impact of floods given the lack of granular data. BNM intends to refine its methodology for the computation of flood-related impacts to provide greater precision and granularity in future estimations.

**FIGURE B2.1**  
Estimated Potential Exposure Losses in the Banking System



Source: Calculations based on the MINDSET estimations and the aggregate banking system loan portfolio as of December 2023.

## 2.2.5 The Role of Climate Adaptation Measures in Reducing Flood Damages

**The estimations based on Scenario 2 assume that Malaysia will undertake climate adaptation measures.**

In the simulations, the impact of adaptation measures is only applied to losses associated with floods. As described in a World Bank report (World Bank, 2017), the potential climate adaptation measures include improvements to land use planning, enforced building standards and norms, more resilient infrastructure, and improvements to natural ecosystems. Early warning systems can also play a role in mitigating losses because they allow businesses and households to prepare for the impact of floods (further discussed in Chapter 5). World Bank (2017) notes that land use planning improvements could be especially effective at reducing the impacts of floods and, as a result, could be particularly relevant to Malaysia.

**However, the lack of detailed information on a specific set of adaptation measures for flood risks in Malaysia constrains the scope of the analysis presented in this section and warrants some caution when interpreting these results.** The lack of information arguably reflects the lack of an integrated, coordinated approach to the management of flood risks in the country, as briefly discussed above. To overcome this challenge, while still providing relevant evidence for policy making, the analysis in this section explores regional and global data of a similar nature. In other words, the data on adaptation measures, a critical input for the estimations, are not specific to individual projects in Malaysia. They entail to a large extent measures that are softer in nature, such as preventing new construction in flood-prone areas.

**The modeled scenario assumes that there is effective implementation of these hypothetical adaptation measures.** That is, for the full benefits to be realized, all adaptation measures would need to be fully

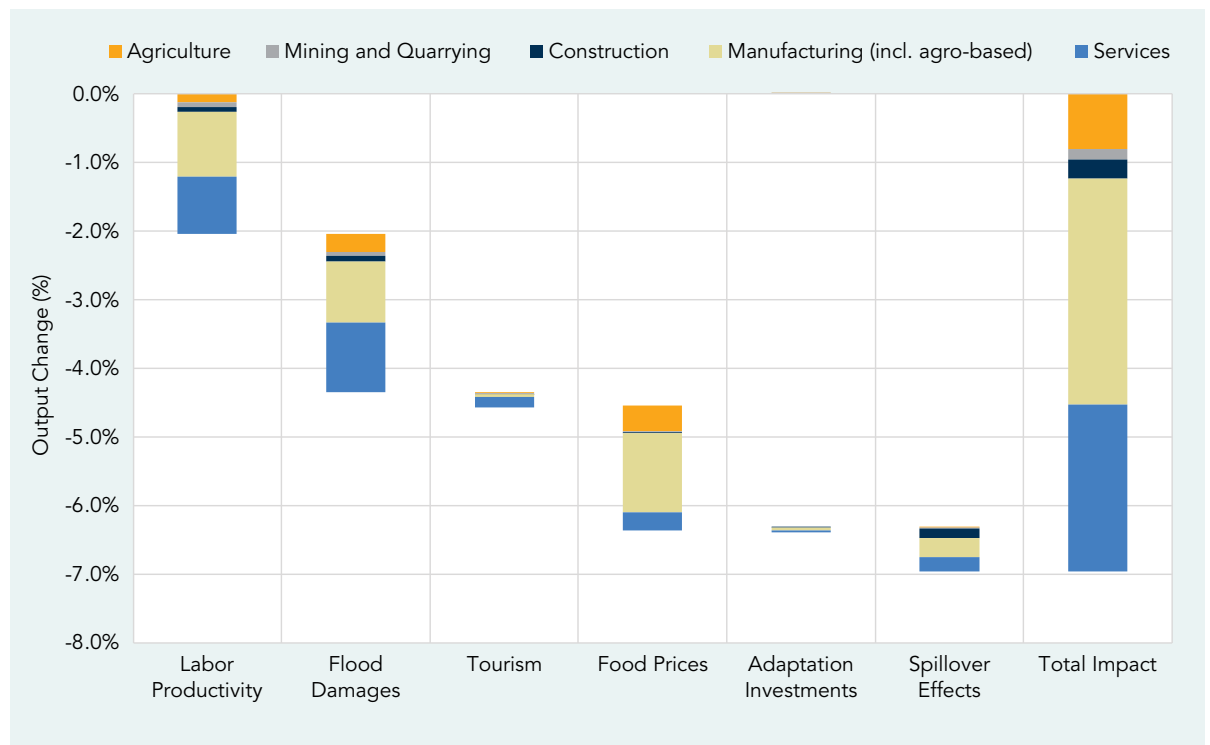
implemented. Within the context of the analysis in this chapter, the estimates should be interpreted as an upper bound for the potential benefits of adaptation measures.

**The overall cost of adaptation measures for managing flood risks is estimated to cost around 0.2 percent of annual GDP.<sup>38</sup>**

In the estimations, these costs are assumed to be funded by increased taxes. It is important to note that global experience reveals that some of the most impactful adaptation measures are “softer” in nature, which would have little cost compared to new infrastructure investments (such as the building of flood walls). The measures considered in these estimates would cover only new infrastructure and do not consider the needed investments to adapt existing assets. For instance, land use planning would apply only to new infrastructure. In practice, the adaptation measures considered here must be complemented with investments to improve the resilience of existing areas and assets at risk from floods. Such investments would lead to further reductions in potential damages; although the adopted framework here is unable to estimate their overall impact. A more in-depth study of the cost-benefits of potential adaptation measures in Malaysia is left for future research.

**Such adaptation investments could reduce the economic impact of floods by more than 40 percent, as shown in Figure 2.7.** Losses associated with a theoretical 1-in-20-year flood in 2030 are estimated to cost up to 2.3 percent of GDP, compared to up to 4.1 percent in the absence of adaptation efforts. By assumption, these adaptation measures effectively reduce only the losses from flood events. For instance, the total production losses associated with climate change are reduced by around two percentage points from implementing such adaptation measures to about 7 percent of output (or 6.4 percent of GDP).

<sup>38</sup> World Bank (2010) provided an estimate for the average costs for adaptation investments across emerging economies and developing countries at 0.2 percent of annual GDP.

**FIGURE 2.7****Climate Change Impacts on Output Conditional on the Implementation of Adaptation Measures**

## 2.2.6 The Role of Private Sector Resilience

**It is important to emphasize that the analysis reported in this chapter is subject to significant uncertainty.** Estimations need to consider complex interactions between economic development and climate change, especially floods. These interactions are subject to high uncertainty, and dependent on policies (not only Malaysia's national policies, but also global policies). This section explores the primary sources of uncertainties underlying the estimates to assess the robustness of the findings.

**One source of uncertainty relates to complex supply chain linkages.** The MINDSET analysis in previous sections includes direct demand-side effects, for instance through upstream supply chain linkages. For example, if floods disrupt car production, then providers of engines and other car parts will see production delays and potential losses as well. However, they excluded indirect, downstream supply-side economic effects which can cause cascading economic impacts.<sup>39</sup>

Following a similar example, if floods prevent the production of car engines, they could lead to reduced production of cars, which in turn would affect other businesses, including some that provide inputs into the production of car engines. In this section, the analysis introduces such indirect, downstream supply chain linkages to shed light on the potential macroeconomic consequences of floods.

**These indirect supply chain effects were excluded from the previous estimates due to the high uncertainty and complexity in mapping them out.** If a supplier is hit by floods that disrupt production, businesses could switch suppliers, possibly turn to imports, or use a substitute product (depending on the specificity and availability of the needed inputs). In addition, some inputs may not be critical or time-dependent (for example, marketing activities). For other, perhaps more critical inputs, businesses may keep reserve buffer stocks to compensate precisely for losses or disruptions of

39 The microchip shortage in 2021 showed that the knock-on effects from a loss of access to inputs can be substantial.

supply.<sup>40</sup> The impact can also be sizable when critical utility services are considered. For instance, lack of access to electricity could halt production in almost all businesses that do not have backup generators, arguably impacting smaller businesses more severely.

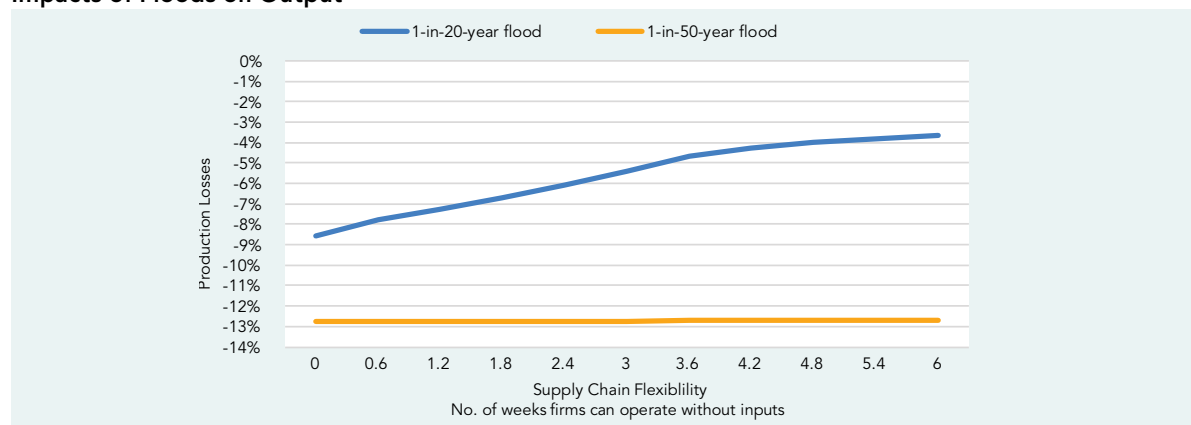
**To account for these knock-on supply chain effects, the results in this section present estimates conditional on the degree of supply chain flexibility.** This section presents estimates of the impacts under a range of scenarios of business preparation and supply chain resilience as measured by the amount of stock held by businesses. The flexibility in supply chains is thus measured as the number of weeks each business can withstand a loss of material inputs while still producing as usual.

**The estimates also consider more variations in the intensity and frequency of floods.** The analysis here considers flood events as being more severe than the 1-in-20-year events covered in previous sections. The analysis here distinguishes between floods that last for more extended periods or take longer to rebuild from (for instance, due to the speed at which floods happen).

**The results show that supply chain resilience can mitigate the impact of floods by more than 50 percent**

**for less severe events, but it has a more limited role during severe floods.** Figure 2.8 presents the estimated production losses from a 1-in-20-year and a 1-in-50-year flood event in Malaysia, conditional on different degrees of supply chain flexibility. The assumptions about the length of floods remain the same as those in the analysis presented in the previous sections. The estimates here also do not include the adoption of adaptation measures. The additional knock-on supply chain effects lead to significantly higher impacts on output than previously reported in Section 2.2.4. Nonetheless, maintaining supply chain flexibility can offset the damaging impacts of floods by more than half, reducing the potential losses of production from 8 percent to about 3 percent. The full impact of the 1-in-50-year flood would be even more damaging, with losses of production estimated to be around 13 percent. For a flood event this severe, the offsetting role of supply chain flexibility is muted due to more widespread impact of flooding across supply chains—businesses would be either directly impacted by floods or would face a decline in demand for their products from widespread economic disruptions, regardless of whether they can maintain production levels.

**FIGURE 2.8**  
Impacts of Floods on Output



**The estimates vary significantly depending on the length of floods.** Figure 2.9 shows variants of a 1-in-20-year flood along their duration spells, considering floods of very short duration to floods that last twice as long. The solid line in the figure for 1-in-20-year flood matches the estimates depicted in Figure 2.8. Considering floods of the same severity (1-in-20-year event), the range of impacts goes from virtually no impact when floods have very short duration to more

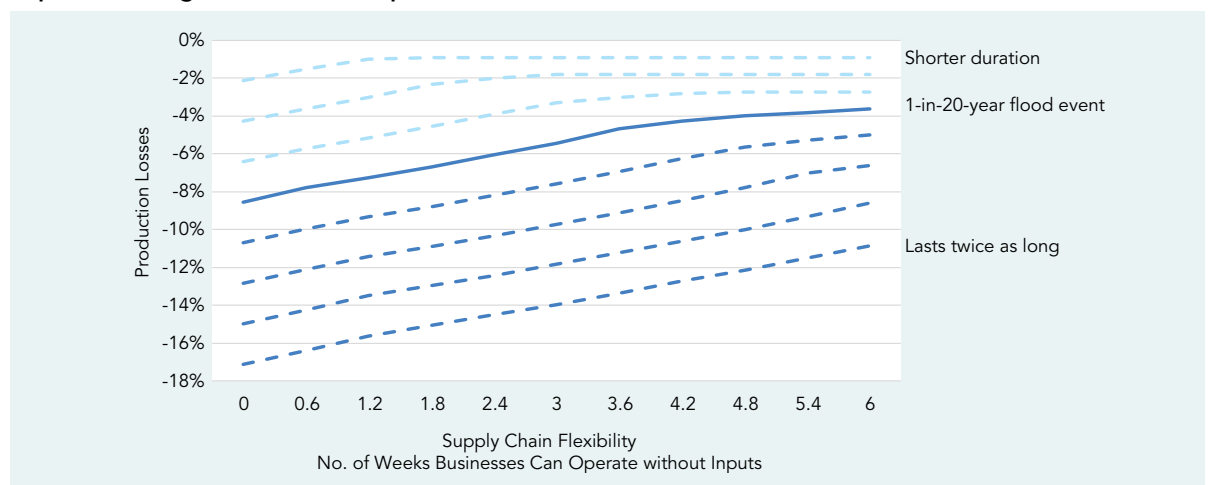
than 17 percent in output losses when floods last twice as long as those in the baseline estimates. The effects are non-linear due to the offsetting supply chain coping mechanisms. For shorter floods, damages can be reduced to direct impact with supply chain resilience measures offsetting any knock-on effects. However, the negative impact on output can be significantly larger for longer floods, with longer recovery times, due to cascading effects across various economic sectors.

<sup>40</sup> See, for example, Pichler et al. (2020) and Colon et al. (2021).

**The simulations suggest that the effects of longer floods can be larger than the effects of more severe, but shorter duration floods.** The main reason behind this differential relates to indirect effects through supply chains. During severe floods, many of the indirectly impacted businesses are likely to also be directly affected by the floods. In comparison, longer floods imply extended disruption periods, further delaying recovery and rebuilding efforts. However, caution is warranted for this finding as it partly reflects assumptions from the modeling framework. About

90 percent of the losses in aggregate output occur during the recovery phase rather than during the flood itself. The main factors underlying output losses are post-flood disruptions, for example, due to water damages or interruptions in supply chains. This effect is further discussed and validated at the micro level in Chapter 3 based on a granular business-level survey analysis. Although not explicitly modeled, it would be reasonable to expect that more severe floods would also have an extended recovery period, leading to an increase in the estimated value of output losses.

**FIGURE 2.9**  
**Impacts of Longer Floods on Output**



**Lastly, the model is assessed against the December 2021 floods in Malaysia.** A comparison of model simulations with historical data is not straightforward. First, a judgment call is needed to assess how well a specific historical event matches: (i) the theoretical 1-in-20-year occurrence for the estimates throughout this chapter, and (ii) the geographical distribution of impacts. In addition, the model needs to consider other factors that impacted the economy over the period. Actual aggregate output would reflect the mitigating impact of emergency relief, rebound effects (due to the quarterly frequency of the statistics), and recovery and reconstruction investments. These effects are not easily incorporated through the methodology adopted in this chapter.

**The estimates of up to 4.1 percent of GDP losses are broadly consistent with the impact of the 2021 floods in Malaysia.** As large scale floods took place during the last couple of weeks of December 2021, so the impact was largely felt in the subsequent month. First quarter real GDP growth in 2022 in Malaysia was 2.7 percentage points lower than growth in the previous quarter and 1.7 percentage points lower than the

growth rate in the following quarter when considering seasonally adjusted statistics. These patterns suggest a reduction of about two percent in total production in the first quarter of 2022, largely due to the impact of floods. These losses would be higher if emergency relief and recovery efforts could be removed through a counterfactual analysis. Moreover, the baseline estimates in this chapter consider the impact of floods in 2030, assuming no new investments in adaptation to flood risks. Floods are also expected to be more frequent, as indicated above.

**In summary, the sensitivity analyses presented in this sub-section highlight the uncertainty around the baseline estimates presented in the previous sections.** The sensitivity analyses indicate that the baseline results in Section 2.2.4 are, in fact, conservative estimates based on cautious assumptions about the direct, and especially, the indirect impact of floods on the economy. Furthermore, the analysis indicated the significant benefits of preparedness. Significantly larger socio-economic impacts from floods are possible if adaptation measures are not taken and if businesses are not well prepared to withstand the shocks.

## 2.3. Conclusions

**Malaysia experiences relatively frequent floods, and, although not necessarily severe, floods have a sizable impact on the economy.** The macroeconomic analysis shows that the impact of a 1-in-20-year flood is expected to cost Malaysia up to 4.1 percent of GDP by 2030 without adaptation efforts. These estimates consider historical data regarding flood hazard risks. The estimates also indicate that there could be a significant impact on jobs associated with floods. Climate change is projected to increase the frequency of precipitation and, consequently, the likelihood of floods, which could lead to even larger aggregate impacts on output and employment. The increase in the aggregate damages by floods would occur simply by the increased frequency of floods, even if floods do not become more severe.

**The analysis in this chapter shows that floods are an important source of risks for a broad set of businesses.** Sectoral analysis revealed that losses can be particularly sizable for the agricultural, services, and industrial sectors. The vulnerability of transport infrastructure and other utilities is particularly concerning because of indirect effects, as other sectors rely on such services for production. Employment effects could also be substantial, particularly in rural and agricultural communities. There is, however, a high degree of uncertainty around the sectoral estimates, with variations in the results related to the resolution of flood risk maps and variations in flood risk projections.

**Adaptation efforts could significantly reduce the macroeconomic impact of floods.** The analysis in this chapter indicates that adaptation efforts can have a sizable impact in mitigating flood losses in Malaysia. The estimates indicate that a comprehensive combination of regulatory measures (for example, on zoning, building regulations, and early warning systems), climate resilient infrastructure investments, and ecosystem improvements could offset a significant share of the economic damages caused by floods. Moreover, the estimates indicate that adaptation costs about 0.2 percent of annual GDP, making the measures likely cost-effective. But the analysis does not offer enough granular information about the range of measures that would be most adequate. The analysis does not enable

the identification of the most cost-effective adaptation options in Malaysia. A more in-depth study that considers the complementarities between the different measures, for instance, would be necessary to identify the most cost-effective adaptation options in Malaysia.

**The analyses also showed that businesses have a critical role in strengthening flood risk resilience in Malaysia.** By developing flood risk management strategies and investing in preparedness, businesses can ensure operational continuity while protecting their assets from damage. The estimates provide evidence that by building resilience in supply chains, and ensuring the continuity of production, businesses can reduce the expected losses due to floods by more than 50 percent. The estimates also show that adaptation investments can be particularly useful in mitigating the impact of frequent, less severe floods. Various projections indicate that such events will likely continue to increase in frequency in Malaysia, consequently putting a premium on such investments. However, supply chain resilience has a more limited role in mitigating the impact of severe floods when widespread supply chain disruptions are more likely to occur. Estimates vary depending on the severity and the duration of future floods—longer floods are associated with more significant losses.

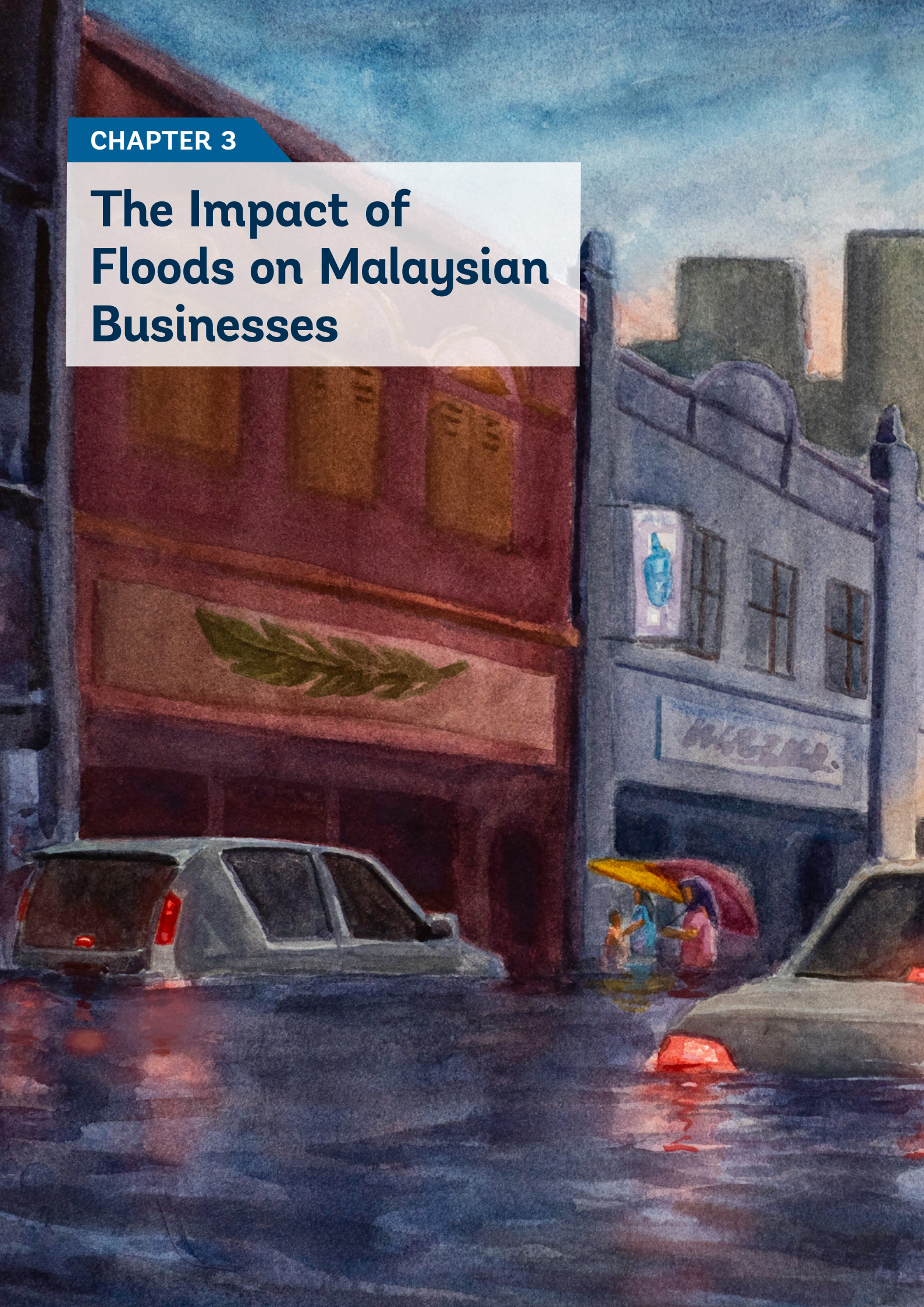
**The findings in this chapter highlight the necessity to manage flood risks for both the public sector and the private sector.** The results indicate that total prevention of floods may not be feasible. While adaptation and resilience efforts by the private and public sectors can go a long way in reducing losses associated with floods, residual risks are likely to remain, and they could still entail sizable economic costs. For businesses, this puts a premium on efforts to strengthen their financial resilience through adequate planning and ensuring they have access to funds post-disaster for an efficient and quick recovery. Access to credit and insurance could be beneficial in enabling ex-post access to resources that can be used for clean-up, recovery, and reconstruction efforts. The next chapter explores the role of access to financial services, and the broader challenges and opportunities for businesses in managing food risks.





## CHAPTER 3

# The Impact of Floods on Malaysian Businesses





## Key Messages

- **Based on a novel business-level survey conducted on 1,500 Malaysian businesses, this chapter assesses the vulnerabilities to flood risks among Malaysian businesses and the factors discouraging them from investing in adaptation and resilience.**
- **Small and medium enterprises (SMEs) are particularly vulnerable to floods in Malaysia, through both direct and indirect effects.** Although flood impacts over the past three years were more prevalent among large businesses, SMEs were 50 percent more likely to experience financial losses than large businesses. SMEs were also more likely to cite indirect losses due to the impact of floods on their customers and employees—for example, about 75 percent of small businesses stated that supply chain bottlenecks were the main cause for delays in return to operations.
- **SMEs tend to have less developed coping mechanisms.** SMEs are less likely to have disaster preparedness strategies and less likely to have insurance when compared to large businesses, even after taking into account differences in risk exposures and risk perceptions.
- **Flood risk awareness is a crucial factor underlying the extent of preparedness among businesses.** Consistently, the survey shows that Malaysian businesses that perceive flood risks as a recurrent risk are more likely to have disaster preparedness strategies and to purchase flood risk insurance. In fact, two key barriers to flood insurance uptake are the underestimation of flood risks and a lack of understanding of insurance products.
- **There are marked awareness gaps for SMEs in Malaysia.** SMEs are less likely to believe they have sufficient information about future flood risks. For example, 80 percent of large businesses stated that they had sufficient information about their future flood risk exposures, whereas only 40 percent of small businesses stated so.
- **Limited access to insurance protection and finance for adaptation and resilience is a significant barrier for Malaysian businesses, especially SMEs, hampering their ability to manage flood risks.** Notably, businesses with limited access to financial resources for flood preparedness had three times greater revenue losses associated with floods than businesses that did not mention it. Limited access to insurance can also constrain recovery efforts as surveyed businesses, especially SMEs, noted that insurance payouts represent an important source of funding for such expenditures.
- **These patterns suggest an active, urgent role for public sector policies in supporting greater access to finance and insurance for businesses, especially SMEs.** Policy efforts should concentrate on improving access, especially for SMEs, which tend to be more vulnerable to the impact of floods. The results indicate that enhancing access to finance for both ex-ante preparedness and ex-post recovery efforts could significantly enhance business resilience and adaptation.



**As shown in the previous chapter, businesses in Malaysia are increasingly vulnerable to climate change through the impact of floods on their businesses.** Businesses can be directly impacted by floods, which can lead to asset damages and losses. Businesses can also be indirectly hit by floods, for instance, due to supply chain disruptions or from infrastructure outages and damages.<sup>41</sup> Floods can also affect their employees and their customers. As discussed previously, service delivery and infrastructure disruptions can also negatively impact businesses. As evidenced by the 2021-22 floods, adverse shocks can result in temporary and permanent business closures that, in turn, lead to output and job losses, with significant aggregate economic and social impact. These risks can be exceptionally high for SMEs than for larger enterprises as SMEs are perceived to have less developed coping mechanisms, leaving them more vulnerable to potentially large (direct and indirect) losses from floods.<sup>42</sup>

**However, there is no comprehensive assessment of the business costs of floods in Malaysia.** As a result, there is limited understanding of how businesses are affected by and cope with floods, including indirect effects associated with infrastructure damages and critical service disruptions such as utilities. This makes it challenging for policy makers to identify and prioritize investments and develop policy interventions to support business adaptation and enhance business resilience to floods. Such a knowledge gap is not unique to Malaysia, and the literature exploring the impact of climate change on businesses remains scarce.

**This chapter focuses on businesses' adaptation and financial resilience to flood risks in Malaysia.** The analyses in this chapter shed light on three questions: (i) which businesses are more vulnerable to flood risks; (ii) what the direct and indirect costs of floods to businesses are, including those related to supply chain disruptions; and (iii) what are the barriers for businesses to manage and mitigate flood risks before floods (that is, to invest in ex-ante preparedness) and after floods (for example, adopting robust financial resilience practices), in case they are affected by floods. In exploring these questions, the analyses in this chapter zoom in on the role of financial markets—access to financial products and services, such as credit and insurance—in enabling businesses to manage flood risks better.

**The analyses draw from a novel survey of 1,500 businesses in Malaysia conducted in the first half of 2023.** Respondents are in senior management positions at their businesses (such as owners, C-suite, or director level). The sampling methodology is stratified random sampling, in which all businesses are grouped within homogeneous groups, and simple random samples are selected within each group. The strata for the survey were business size, business sector, and geographic regions.<sup>43</sup> Within these strata, businesses were sampled randomly from an online business panel database of over 100,000 businesses in all sectors and sizes across Peninsular and East Malaysia. A minimum sample size was obtained for sectors important to Malaysia's economy while preserving the sectoral and regional shares in the sampling frame. The chapter presents unweighted statistics, but census weights present qualitatively similar patterns, suggesting that the findings are representative of the business population in Malaysia.<sup>44</sup>

41 See, for example, Snyder and Shen (2006), Hallegatte et al. (2019), Hallegatte (2019), and Lund et al. (2020).

42 See, for example, IMF (2022).

43 Annex 1 provides a detailed breakdown of the surveyed business across size, sector, and geographic location. The strata for business size focused on small, medium, and large businesses. It did not explicitly sample micro businesses or individual entrepreneurs.

44 Annex 2 presents the same set of tables and figures reported in this chapter using 2015 census weights.

## 3.1 Exposures and Vulnerabilities to Floods

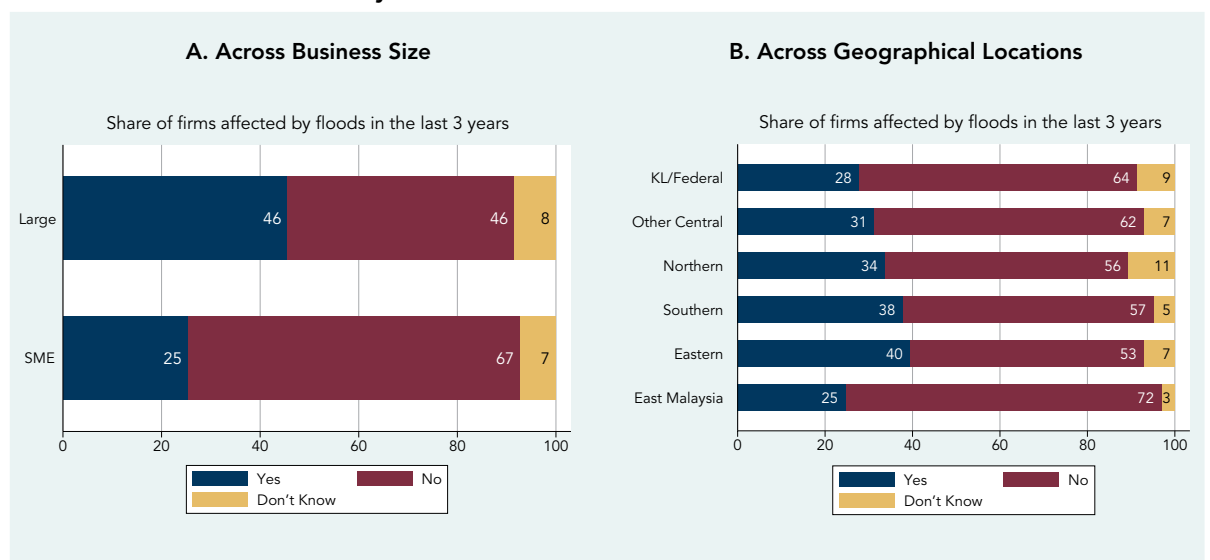
### 3.1.1 Which Businesses Were Hit by Floods over the Past Three Years?

While about 30 percent of Malaysian businesses were affected by floods over the past three years, the impact was more prevalent among large businesses and businesses in the agriculture and manufacturing sectors (Figure 3.1). For example, while nearly half of large businesses, defined as businesses with revenues above RM50 million (\$11 million), were affected by floods, about a quarter of SMEs stated flood-related disruptions.<sup>45</sup> Across sectors, businesses in the agriculture sector were particularly hard hit, with 41 percent of surveyed agri-businesses being affected by floods. This high exposure to flooding in the agriculture sector is broadly consistent with results in Chapter 2, which shows a high proportion of agricultural assets exposed to flooding. A large share of automotive, machinery, and equipment manufacturing businesses and utility businesses (water, sewage, and waste

management) were also affected. The latter indicates that floods could have had sizable indirect impacts on businesses due to disruptions in infrastructure and basic service delivery (see more below).

There are also regional differences in the extent to which businesses have been affected by floods, consistent with the variation of exposures in the flood hazard maps presented in Chapter 2. Businesses in Eastern and Southern Malaysia were more likely to be affected by floods than businesses in other regions within Peninsular Malaysia. About 40 percent of surveyed businesses in these regions were affected by floods in the last three years. The flood maps indicated that these regions were indeed more prone to both fluvial and pluvial floods (Figure 2.3).

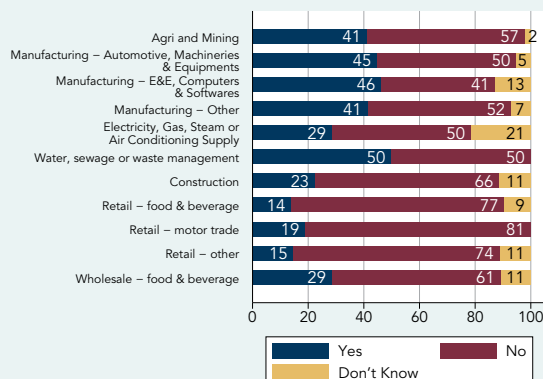
**FIGURE 3.1**  
Profile of Businesses Affected by Floods in the Last Three Years



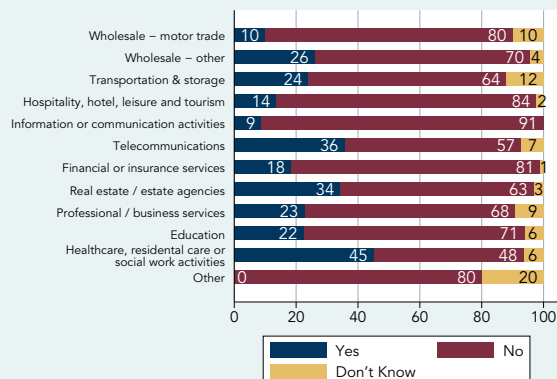
<sup>45</sup> These results may underestimate the actual SME exposure to floods due to survivorship bias, as many SMEs may not have survived flood incidents and thus would not have been captured in the survey.

## C. Across Sectors

Share of firms affected by floods in the last 3 years (%)



Share of firms affected by floods in the last 3 years (%)



## 3.1.2 The Extent of Flood-related Losses for Businesses

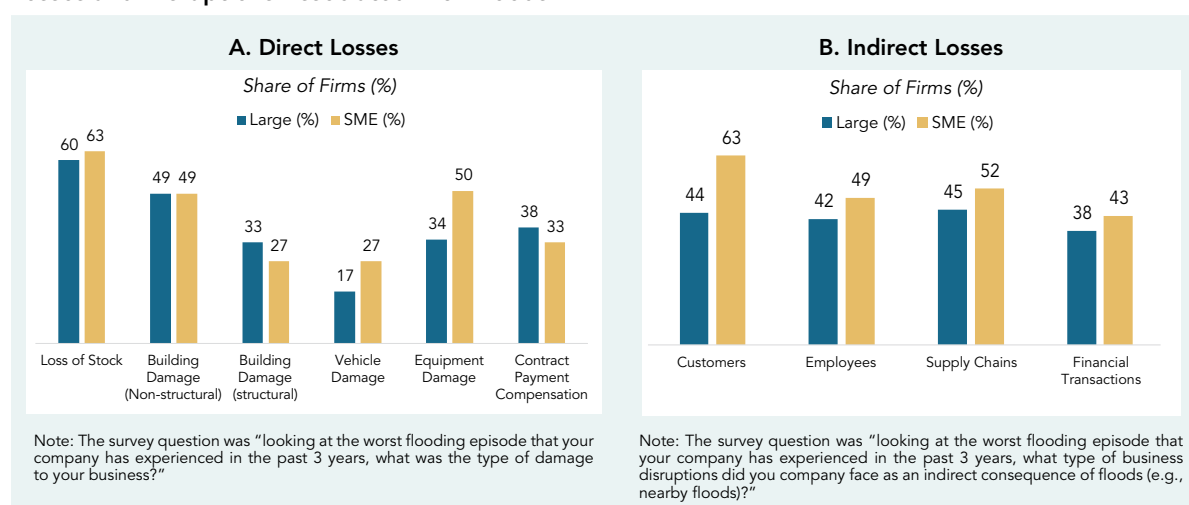
Although more prevalent among large businesses, SMEs were more likely to experience financial losses and business disruptions associated with floods, suggesting they are more vulnerable to floods.

Businesses affected by floods reported both direct and indirect losses (Figure 3.2).<sup>46</sup> Over 60 percent of the businesses cited direct loss of inventories and about 50 percent of affected businesses mentioned (non-structural) building damages. SMEs were 50 percent more likely to mention asset damages than large businesses. For example, 50 percent of SMEs mentioned equipment damages due to floods in comparison to 34 percent of large businesses. The incidence of vehicle

damage was also significantly higher among SMEs compared to large businesses—27 percent versus 17 percent, respectively. SMEs were also more likely to cite indirect losses due to the impact of floods on their customers and employees. While 63 percent of SMEs mentioned disruptions due to floods impacting their customers, 44 percent of large businesses stated so. Supply chain disruptions affected more than half of all businesses, and smaller businesses were more likely to be affected—more than two-thirds of small businesses (a sub-category of SMEs) indicated disruptions in supply chains.<sup>47</sup>

FIGURE 3.2

Losses and Disruptions Associated with Floods



<sup>46</sup> Regression estimates show that the reported differences between SMEs and large businesses are statistically significant, even when controlling for differences in the geographical location of businesses.

<sup>47</sup> Small businesses are those with up to 30 employees.

**In the aftermath of floods, businesses typically took about a month to resume operations fully.** The underlying causes for business disruptions include closures to allow for renovation and retrofitting, a lengthy clean-up process, and the re-establishment of essential infrastructure, with more than 40 percent of SMEs mentioning these factors. These results are consistent with the findings in Chapter 2, which highlighted that an estimated 90 percent of aggregate production loss occurred during the clean-up and repair period rather than during the flood itself. Furthermore, consistent with the results in Chapter 2, supply chain disruption was cited as one of the leading causes of delay in returning to operations by about 30 percent of businesses. SMEs, especially small businesses, were particularly vulnerable to such indirect effects—75 percent of small businesses cited supply chain bottlenecks as the main cause for delays in return to operations.

**Businesses affected by floods stated that lack of awareness of flood risks (especially among smaller businesses) and lack of preparedness (especially among large businesses) were the main reasons behind their losses.** About 40 percent of small businesses stated that lack of awareness exacerbated losses from floods, whereas 26 percent mentioned not being prepared despite being aware of risks. In contrast, 32 percent of

large businesses mentioned a lack of awareness, and 50 percent mentioned a lack of preparedness, even though they were aware of risks. In other words, while the evidence indicates that lack of awareness was a key factor underlying the flood losses for SMEs, for large businesses, it was a lack of preparedness. Awareness is also mentioned as an important factor for businesses downstream in supply chains, such as businesses in the services and retail sectors. Lack of preparedness was more often cited among businesses in the agriculture sector and some in manufacturing. These perceptions are relatively robust across businesses, independent of whether businesses have experienced relatively high or low flood-related losses.

**Overall, these survey results indicate that floods disproportionately affect smaller businesses compared to larger ones.** The differential impact is particularly marked regarding indirect losses associated with supply chain disruptions. Therefore, SMEs are particularly vulnerable to flood risks in Malaysia, even though the survey indicates that larger businesses may be more exposed to floods. Lack of awareness and preparedness are critical constraints underlying the losses due to floods for Malaysian businesses, which highlight the significant space to enhance flood resilience among SMEs in Malaysia.

## 3.2 Adaptation Strategies among Businesses

**When aware of flood risks, businesses can prepare themselves and devise strategies to mitigate risks and reduce the impact of floods.** Businesses can undertake various coping strategies to mitigate their vulnerabilities by reducing losses, speeding up recovery, and spreading expenses over time to ensure robust business performance.<sup>48</sup> This may involve investments in floodwater pumps, backup generators for electricity, and water tanks, and building of designated flood-proof storage areas for sensitive machinery and inventories. Strategies may also entail investments to enhance the resilience of supply chains. Businesses may choose to diversify their suppliers and even customers. They

may also choose to geographically spread production facilities.<sup>49</sup> However, such strategies are likely to come at a cost, as the impetus for diversification may lead to more expensive inputs, less efficient supply chains, or more extensive inventories. Hence, businesses need to assess the cost-benefits of specific strategies in light of the risks of floods that they face. Specific solutions and adaptation strategies are highly dependent on business-specific characteristics, including the geographical location of the business. This section sheds light on this theme by providing evidence of the adoption of adaptation strategies to cope with floods across businesses in Malaysia.

<sup>48</sup> See, for example, Dormandy et al. (2017) and Rentschler et al. (2019).

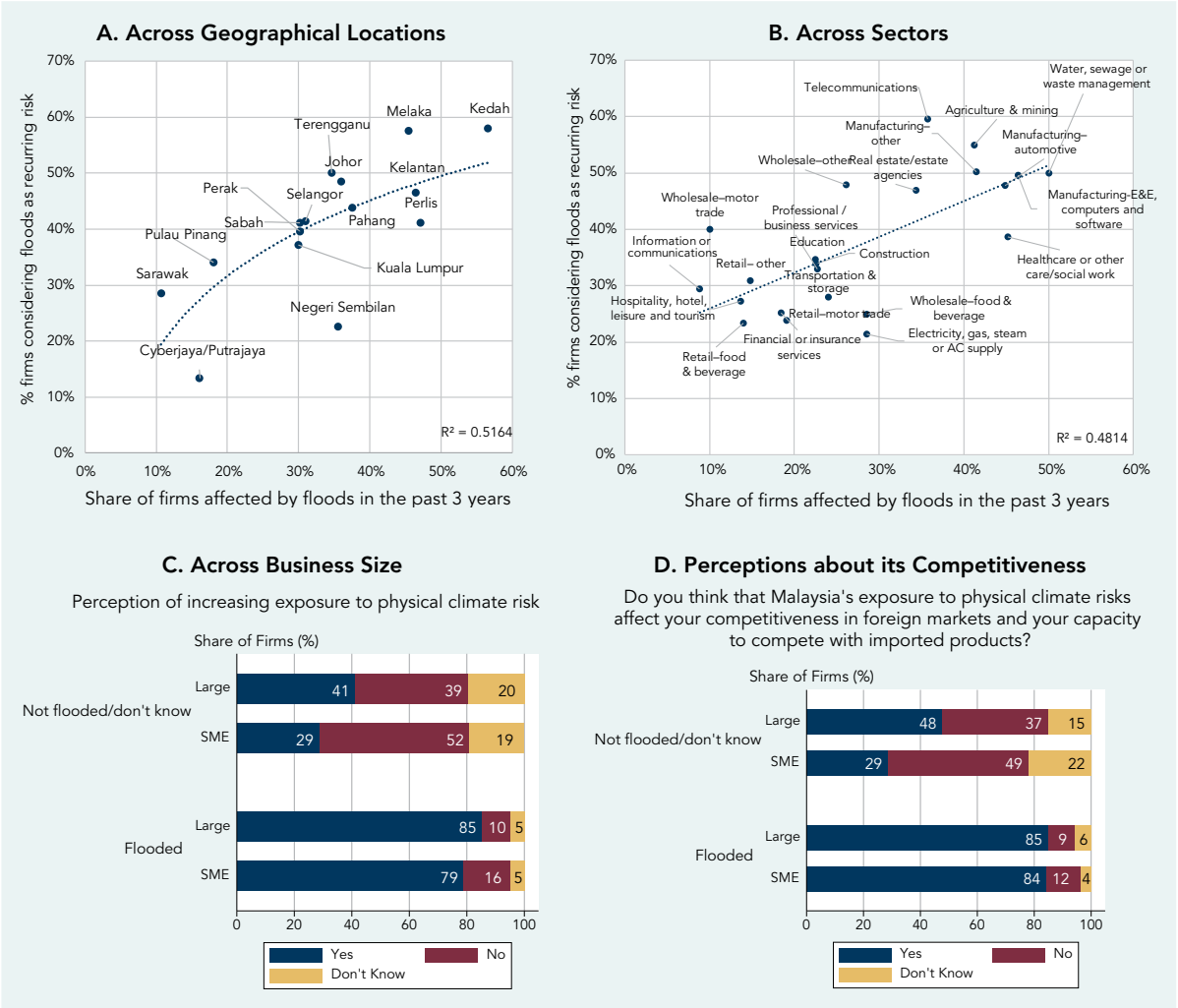
<sup>49</sup> See, for example, Rentschler et al. (2021).



The survey results show that businesses hit by floods during the last three years are more likely to perceive floods as a recurring risk when compared to those that were not hit, especially among SMEs. For example, businesses located in states more severely impacted by floods—proxied by the share of businesses affected by floods—are more likely to consider floods as a recurring risk (Figure 3.3). This finding reaffirms the findings in Chapter 2, which attribute recurrent flooding to the annual Northeast Monsoon. Similar patterns hold across sectors and sizes. Not surprisingly, the perception of floods as a recurrent risk is less widespread among businesses that have not been hit by floods. This is particularly so among SMEs, reinforcing the results in the previous section about lack of risk awareness being a more significant challenge for SMEs. About

80 percent of both SMEs and large businesses hit by floods tend to view floods as a growing source of risks, whereas 41 percent of large businesses and 29 percent of SMEs that are not affected by floods acknowledge that they are increasingly exposed to flood risks.<sup>50</sup> Being affected by floods also affected the businesses’ perception of their resilience and ability to compete in foreign markets. For example, 85 percent of all businesses affected by floods stated that the exposure to flood risks affect their competitiveness (Figure 3.3, panel D).<sup>51</sup> In contrast, 48 percent of large businesses and 29 percent of SMEs not impacted by floods had a similar awareness that their exposure to flood risks can affect their competitiveness abroad.

FIGURE 3.3  
Flood-Hit Businesses and Flood Risk Awareness



50 The share of small businesses is smaller, at 66 percent of surveyed small businesses.

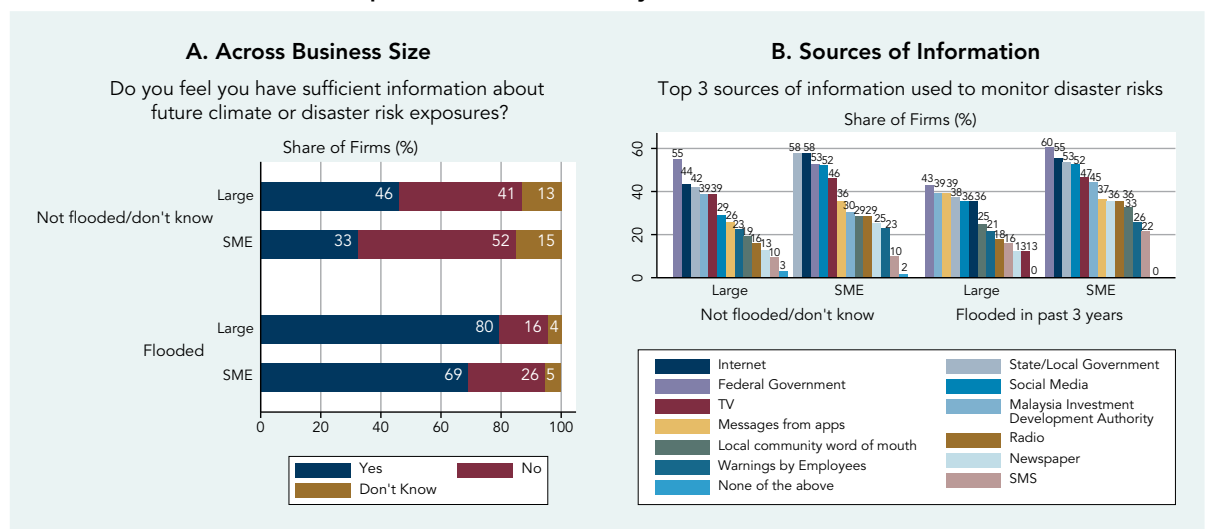
51 The share of small businesses is smaller, at 62 percent of surveyed small businesses.

**Businesses hit by floods are more likely to believe they have sufficient information about future flood risk exposures than businesses that were not affected by floods (Figure 3.4).** This perception of insufficient information about future flood risks is particularly marked among SMEs that have not been hit in the past three years—more than half of SMEs noted so. The risk awareness gap between SMEs and large businesses is also observed among businesses hit by floods. While 20 percent of large businesses stated that they either did not have sufficient information or did not know, 31 percent of all SMEs (and 60 percent of small businesses) did so. Interestingly, businesses in Malaysia tend to rely on public sources of information, such as the federal or sub-national government, independent of whether they have been hit by floods or not. Another widespread source of information is the internet, including social media.

**Businesses with larger exposures to flood risks, based on actual or perceived risks, are more likely to have a disaster preparedness plan in place, or to purchase insurance and takaful protection.<sup>52,53</sup>** Figure 3.5 shows that adopting flood risk preparedness strategies generally correlates with both businesses' direct experience with disasters and with their expectations of such risks (such as perceptions of floods as recurrent risks). Positive correlations are observed at

the sectoral level and the geographical level. There are also marked differences across businesses of different sizes. For example, about 30 percent of SMEs not hit by floods stated that they did not have any preparedness strategy, whereas only 2 percent of those affected by floods did so. Similar patterns, though with smaller differences, are observed among large businesses. While all surveyed large businesses hit by floods had preparedness plans, 91 percent of those not affected by floods had such plans. Businesses mentioned a wide range of coping strategies, from simply monitoring weather forecasts and disaster risk news and buying pumps and power generators to more complex ones involving investments in resilient inputs, acquisition of better vehicles, retrofitting buildings, and shifts in production to other premises. In addition, businesses with greater flood risk exposures are also more likely to buy flood insurance or takaful protection.<sup>54</sup> Figure 3.6 shows a positive correlation between flood risk exposures and insurance and takaful uptake across sectors, geographical locations, and business size. For example, insurance and takaful uptake is greater among states or sectors with a larger share of businesses exposed to flood risks.<sup>55</sup> More broadly, there is a positive correlation between flood insurance and takaful uptake and the adoption of preparedness plans.

**FIGURE 3.4**  
**Flood-Hit Businesses and Perceptions about Availability of Information**



52 This relation among past own experience, greater awareness, and future disaster preparedness is well documented in the literature, including for businesses. See, for example, Tierney (1997), Dahlhamer and Souza (1995), and Josephson et al. (2017).

53 The survey results do not indicate that the severity of the impact of floods—for instance, as measured by actual losses—significantly alters business behavior. Businesses tend to display similar behavior, largely independent of the extent of their losses during previous flooding episodes.

54 Patterns on insurance uptake documented in this chapter are similar across different types of assets—business premises, vehicles, inventories, and equipment.

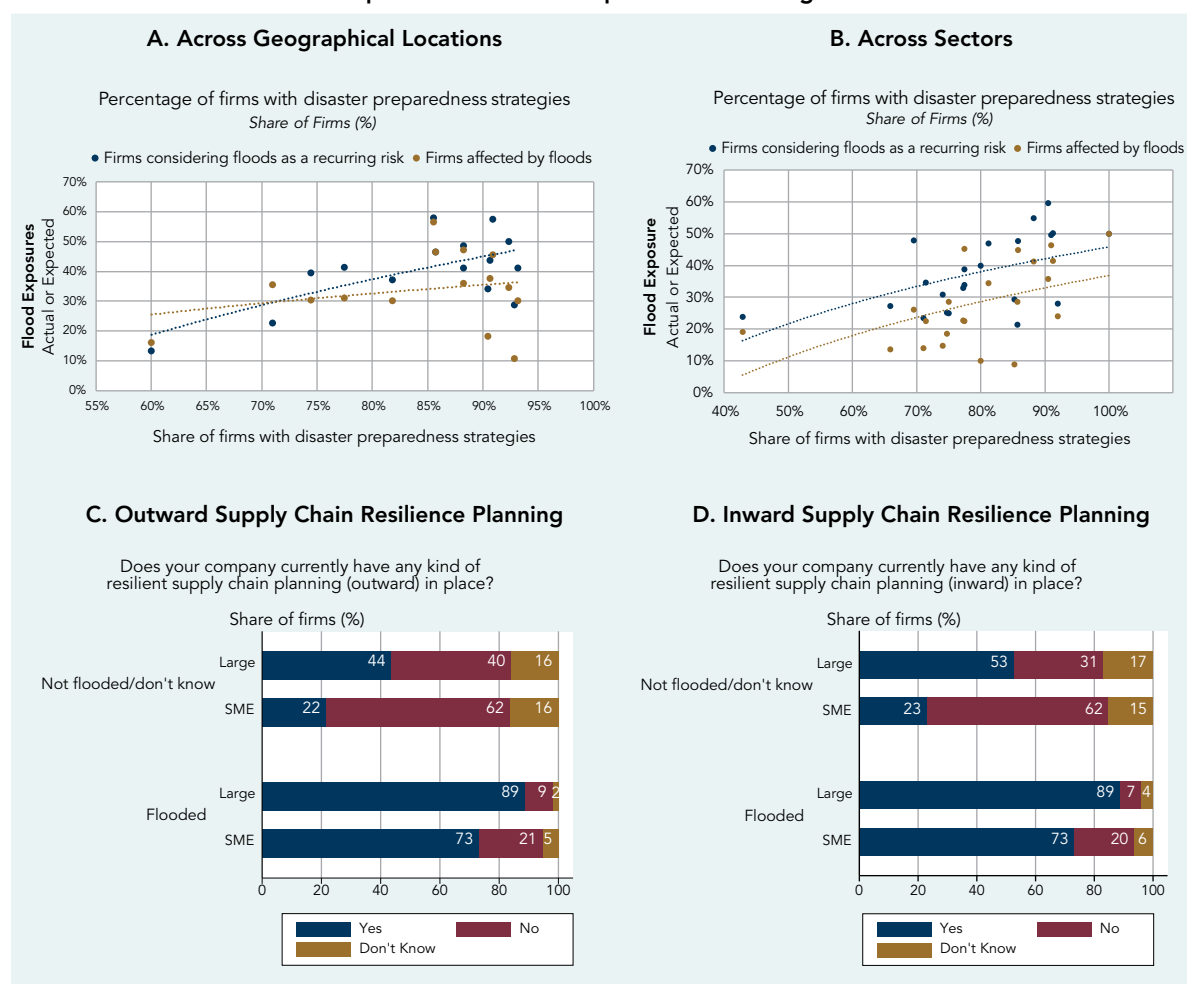
55 See Annex 3 for disaggregated results, portioning businesses hit by floods versus those not affected by floods across estates and sectors.

Interestingly, perceived exposure to risks is associated with more significant action toward strengthening flood risk resilience than actual exposures. The scatter plots in Figures 3.5 and 3.6 provide evidence that a larger share of businesses that perceive flood risks as recurrent risks have adaptation strategies than businesses that have been affected by floods. Regression results shown in Figure 3.6 panel D also support this assessment. The estimates show that perceptions of flood risks as a recurrent risk have a larger marginal effect on the probability of flood insurance uptake than past experience with floods after

controlling for business size, sector, and geographical location. For instance, the estimates suggest that businesses that have been hit by floods but do not perceive floods as a recurrent risk are less likely to purchase insurance than those that believe that floods are a recurrent risk for their business. Furthermore, the regressions indicate that sector and geography do not affect the likelihood of insurance uptake once individual risk exposures are controlled for. The regressions indicate no marked gaps in insurance uptake within specific regions or sectors. However, the results vary across business sizes.

**FIGURE 3.5**

**Flood Risk Awareness and Adoption of Disaster Preparedness Strategies**



Note: Panels A and B show the share of firms adopting at least one of the following disaster preparedness strategies: reduce financial risk (i.e. buy insurance), keep and monitor weather forecast and disaster risk news, invest in retro-fitting building, invest in better vehicles (SUVs or trucks with higher ground clearance), invest in software/apps that help crisis preparedness, move premise to higher grounds, ensure there is a crisis center, have a crisis preparedness plan, acquire pumps and/or power generators, move equipment and materials to higher ground, shift production/inventories to other premises, invest in more resilient inputs (weather-resistant machineries, resilient seeds in agriculture).

**SMEs are less likely to have preparedness plans and are less likely to have insurance when compared to large businesses, even after taking into account their risk exposures.** This gap is notable, for example, for

insurance uptake, which is supported by the regression analysis as summarized in Figure 3.6 panel D. Among the businesses that have not experienced flooding over the past three years, 88 percent of those with revenues

greater than RM500 million (\$110 million) had insurance, in comparison to 36 percent among businesses with revenues less than RM5 million (\$1.1 million) (Figure 3.6, panel C). These differentials between large and small businesses also hold among businesses hit by floods. All businesses with revenues above RM500 million (\$110 million) that have been affected by floods stated having insurance, whereas 81 percent of businesses with less than RM5 million (\$1.1 million) in revenues and that have been affected by floods have insurance. Similar results are observed for the adoption of supply chain resilience strategies (Figure 3.5, panels C and D). For instance, large businesses are more likely to have both inward and outward supply chain resilience planning than SMEs. Although to different degrees, marked differences are observed both within businesses hit by floods and within those not hit by floods. The adoption of supply chain resilience is particularly low, at around 22 percent, among SMEs not hit by floods.

**The evidence that a history of being affected by natural disasters is associated with increased awareness of risk exposures, and consequently, greater preparedness for businesses in Malaysia is consistent with the experience of other countries.**

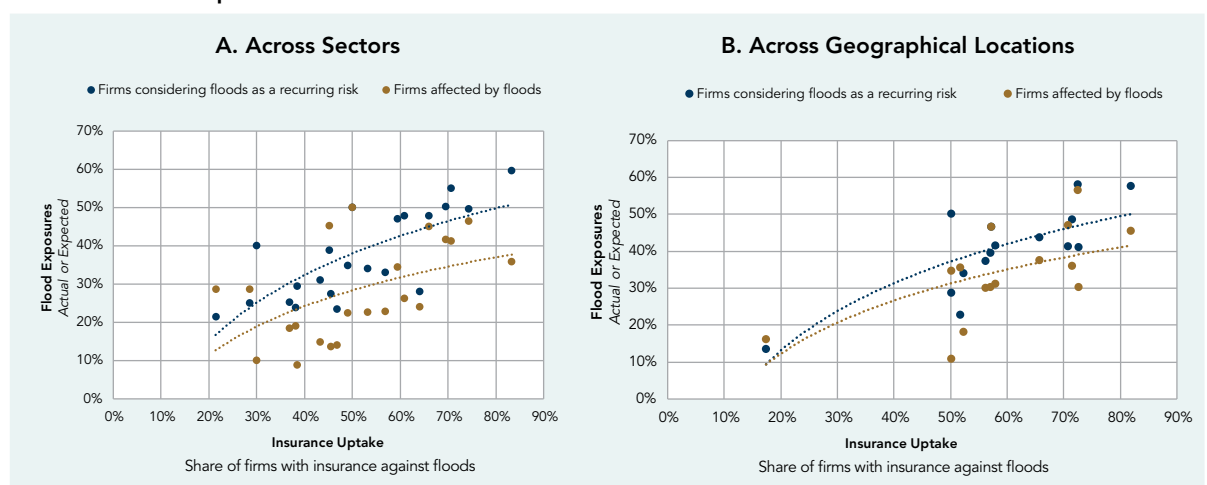
Although research is scarce, the findings for Malaysia are similar to other studies conducted for a selected set of businesses in the region. For example, Verrest et al. (2020) provide empirical evidence that businesses in Jakarta, Don Mueang, and Pasig City tend to build their beliefs about disaster risks based on past experience rather than technical or scientific knowledge. Similarly, Kato and Charoenrat (2018) provide some evidence that SMEs in Thailand were not only unprepared to deal

with extreme weather events, but only those affected by natural disasters were likely to develop coping strategies to manage risks. Evidence from Thailand and Indonesia shows similar patterns of relative unpreparedness toward flood risks among SMEs. For example, Neise and Diez (2019) focus on Indonesian manufacturing businesses in Jakarta and Semarang. They show that larger businesses were adapting more efficiently compared to small businesses. A study on SMEs in Thailand by Pathak and Ahmad (2016) also finds that SME owners tend to underestimate flood risks and have inadequate long-term coping strategies for recurring floods.

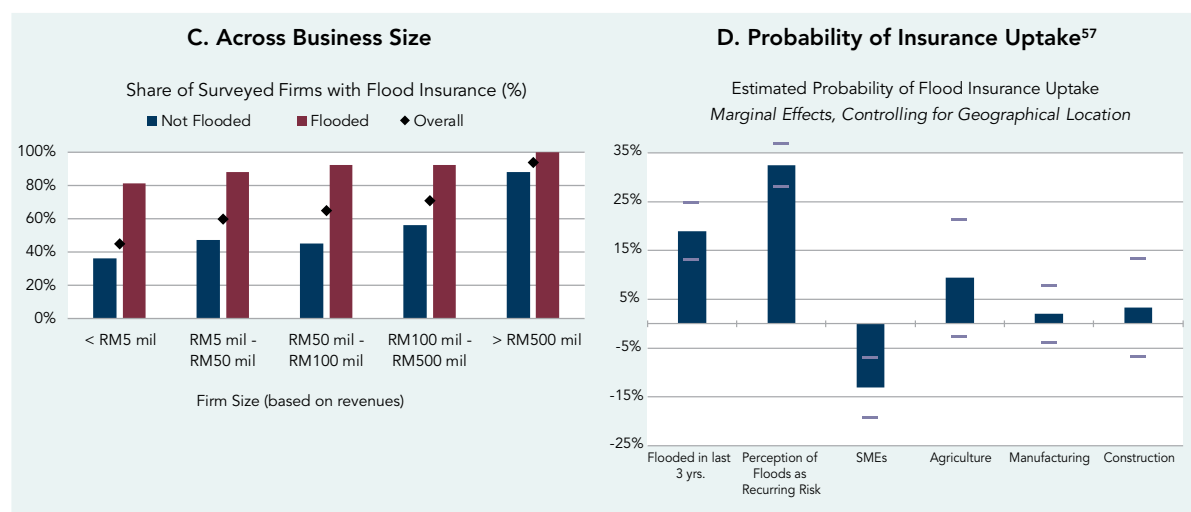
**In addition to businesses own risk exposures and perceptions, the actions of other businesses also seem to impact the extent of business preparedness.**<sup>56</sup>

Regression estimates confirm that businesses with larger exposures to flood risks, based on actual or perceived risks, are more likely to have a disaster preparedness plans in place. The results also confirm that SMEs are less likely to have such preparedness plans when compared to large businesses, even after taking into account their risk exposures. Moreover, the regressions show that the adoption of preparedness strategies by “peers” also affect business adaptation and resilience. Specifically, businesses are more likely to have ex-ante adaptation and ex-post financial resilience strategies in place when a larger share of businesses in their own sector or in their own geographical location also have similar strategies in place. These results suggest that competitiveness pressures can be a driver for business adaptation and resilience efforts.

**FIGURE 3.6**  
**Flood Insurance Uptake**



56 The results are based on regression estimates that control for business size, sector, geographical location, and age.

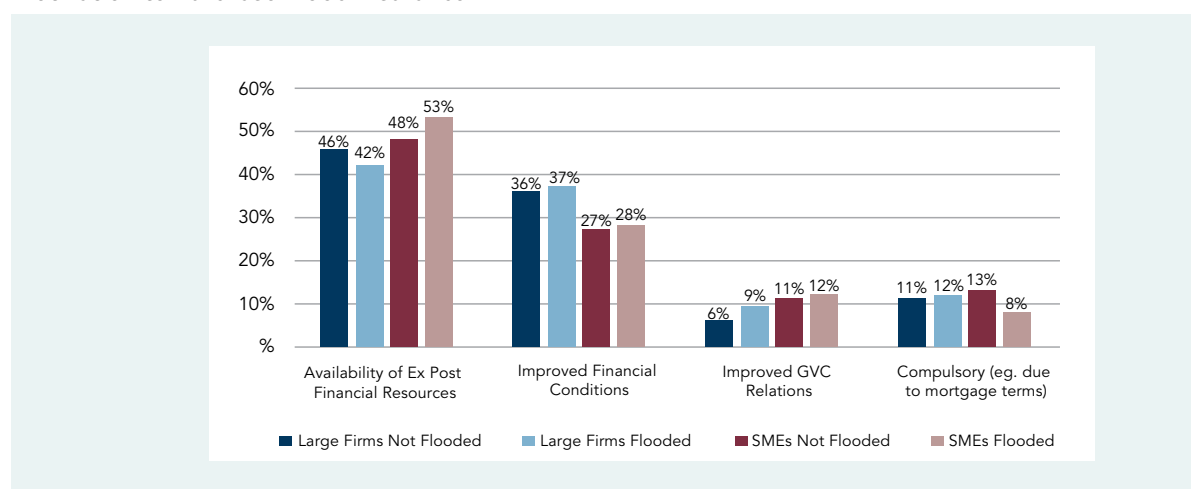


The primary motivation for Malaysian businesses to obtain flood insurance rests primarily with access to ex-post financial resources for recovery and reconstruction expenses, indicating that businesses are aware of the benefits of financial resilience.

This motivation is particularly strong among SMEs, especially small businesses. For example, among businesses that have suffered floods over the last three years, 53 percent of SMEs stated the availability of financial resources after being affected by floods as their main motivation for obtaining insurance (Figure 3.7). For some businesses, especially large ones, the primary motivation was the auxiliary benefits associated with insurance uptake. For example, almost 40 percent

of large businesses hit by floods mentioned improved financial conditions (e.g., better loan terms) as the main reason for insurance, compared to 28 percent of flood-hit SMEs. Another auxiliary benefit is the possibility of better financial terms, which is cited as the main benefit of insurance by a greater share of large businesses than among SMEs—37 versus 28 percent, respectively. Similar results are observed if businesses are split among those with or without flood insurance. Overall, these results raise the possibility that the impact of insurance uptake on access to external finance is different for SMEs versus large businesses. The survey does not allow us to shed light on this issue, which is left for future research.

**FIGURE 3.7**  
Motivation to Purchase Flood Insurance



<sup>57</sup> The estimated baseline probability is 47.9 percent, applicable to businesses not affected by floods, not considering floods a recurring risk, in the services sector, and located in Selangor. The figure shows the marginal effects over this baseline probability for businesses with different characteristics.

## 3.3 Challenges in Developing Adaptation Strategies

### 3.3.1 Limited Access to Finance

**Limited access to insurance and finance for adaptation and resilience is a significant barrier for Malaysian businesses, especially SMEs, hampering their ability to manage flood risks.** Among businesses that consider floods a recurring risk, limited access to finance in particular and limited financial resources more broadly, are ranked as the main barriers to implementing strategies toward preparedness by 43 percent of SMEs and 34 percent of large businesses (Figure 3.8, panel A). Splitting businesses according to whether they have been hit by floods or not over the last three years yields similar results. Businesses in the agriculture and construction sectors were more likely to mention limited resources than those in other sectors. Notably, businesses citing limited access to financial resources as a barrier to implementing flood preparedness had three times greater losses associated with floods as a share of revenues than businesses that did not state limited access to resources. Limited access to insurance can also hamper recovery efforts as insurance payouts represent an important source of funding for such expenditures, especially for SMEs. For example, 37 percent of SMEs mentioned insurance payouts as a main source of funding for recovery and reconstruction, compared to 24 percent of large businesses.

**Consistent with access to finance hindering business adaptation and resilience to flood risks, businesses tend to finance the implementation of preparedness strategies and their recovery and reconstruction efforts with internal resources.** Almost a third of the businesses use internal resources as the main source of funds for ex-ante investments (Figure 3.8, panel B). For SMEs, especially small businesses, funds from the owner also feature as an important source of capital.<sup>58</sup> Only 20 percent of all businesses (and only 12 percent of small businesses) state that they have used bank loans as a source of finance. Businesses also tend to rely on internal resources as a critical source of capital for reconstruction (Figure 3.8, panel C). For example,

33 percent of large businesses and 34 percent of SMEs mentioned using internal resources. About 27 percent of businesses also mentioned using government grants or borrowing supported by government programs. BNM's Disaster Relief Facility was widely mentioned by businesses as a source of funds for those affected by floods. At least partly due to the widespread use of such a facility, a larger number of SMEs have used bank financing for reconstruction (34 percent) efforts than for preparedness investments.

**SMEs cited high costs and, to a lesser extent, lack of suitable products as the main reasons for difficulties in obtaining financing for disaster preparedness.** As shown in Figure 3.8 panel D, high interest rates were mentioned as a top-3 challenge by 29 percent of SMEs (for SMEs that perceive floods as a recurrent risk, 36 percent cited high interest rates). The inability to find a suitable financial product for their needs was cited by 20 percent of SMEs and 23 percent of large businesses, and almost a quarter of large businesses also mentioned short maturities as a constraint. About 15 percent of all surveyed businesses also mentioned the inability to renew or obtain new financing for adaptation efforts.

**While similar reasons are also mentioned as constraints to finance recovery and reconstruction efforts, lack of collateral appears as an additional, key challenge.** For businesses affected by floods over the past three years (Figure 3.8, panel E), lack of collateral is perceived as a top-3 barrier for access to finance for recovery and reconstruction expenses for 34 percent of all surveyed businesses. Despite greater reliance on bank financing for post-disaster expenses, about 15 percent of businesses mentioned rejected credit applications; 20 percent, on average, could not extend or renew credit lines; and 19 percent could not obtain new leases. These patterns could reflect that flood-hit businesses likely had asset losses that reduced their collateral (for example, damages to machinery, equipment, vehicles, and inventory losses, as discussed above).

<sup>58</sup> An extensive empirical literature shows that SMEs tend to have greater reliance on internal funds, as well as funds from their owners, than larger businesses. See for example Didier and Cusolito (2024). The research largely draws from business surveys, such as the World Bank Enterprise Surveys. The Productivity and Investment Climate Survey for Malaysia, conducted in 2019, reveals similar results for Malaysian businesses.



### 3.3.2 Limited Uptake of Flood Insurance

**Limited uptake of flood insurance also hinders business resilience, especially for SMEs for which insurance payouts represent an important source of funding for ex-post reconstruction efforts.** As discussed above, surveyed SMEs are less likely to purchase insurance for flood risks than large businesses—51 percent of SMEs stated having flood insurance in comparison to 74 percent of large businesses.<sup>59</sup> At the same time, 37 percent of SMEs mentioned insurance payouts as their main source of funding for recovery and reconstruction, compared with 24 percent of large businesses (Figure 3.8, panel C). This result is consistent with the results discussed above, which showed that SMEs value insurance precisely because access to such resources can help them manage post-flood efforts, more so than large businesses. In addition, businesses also mentioned that they rely on insurance payouts as a source of funds to implement disaster preparedness strategies. For example, 33 (21) percent of flood-hit SMEs (large businesses) mentioned using insurance payouts for adaptation investments, the second most-cited source of funds for disaster preparedness activities. This result indicates that businesses, especially SMEs, tend to have a reactive approach to flood risk management, often acting only after being hit by floods.

**The main challenges Malaysian businesses mentioned associated with flood insurance are concerns with the payout process and inadequacy of products for their business needs (Figure 3.8, panel F).** For example, 34 percent of SMEs and 33 percent of large businesses flooded in the last three years mentioned difficulties in the claim payout process. This was the most cited obstacle for businesses to obtain insurance or takaful coverage for flood risks. In addition, another 29 percent of SMEs and 21 percent of large businesses mentioned lack of information about payout processes. The second most

cited reason among businesses affected by floods over the past three years—32 percent of SMEs and 30 percent of large businesses—relates to product availability and coverage being inadequate for their business needs. Consistently, among businesses that were not satisfied with their insurance protection—10 percent of businesses that were affected by floods and had insurance—was the mention of the time-consuming payout process (55 percent of businesses), insufficient coverage given the extent of losses (40 percent), and inability to make a claim (e.g., lack of evidence despite suffering losses) (45 percent). Among businesses not affected by floods over the past three years, concerns with the payout process and the complexity of insurance products were perceived as key challenges to getting insurance.

**The survey provides evidence suggesting that a set of high-risk businesses, especially smaller businesses, are being either priced out or outright excluded from the insurance market.** For instance, 31 percent of SMEs and 27 percent of large businesses affected by floods were asked to retrofit their premises to obtain flood insurance coverage, which can be expensive and not feasible within reasonable time frames. Doing so can be particularly difficult when businesses face constraints in access to finance. Such requirements can effectively exclude some businesses, likely high-risk ones, from the insurance market. Unaffordability was mentioned as a key challenge for 21 percent of small businesses that have been affected by floods and 27 percent of those that have not been affected by floods. It was, in fact, the most cited reason across this latter segment. Arguably due to their high riskiness, about 17 percent of SMEs and 21 percent of large businesses affected by floods over the past three years were refused quotes.

### 3.3.3 Limited Awareness and Capabilities

**Both SMEs and large businesses mentioned a lack of awareness, knowledge, and technical capabilities as barriers to adopting flood resilience practices.** Regarding the implementation of disaster preparedness strategies, about 33 percent of businesses that perceived floods a recurring risk mentioned lack of awareness and knowledge, and about 30 percent cited limited technical capacity to implement such strategies. Moreover, 28 percent of SMEs and 33 percent of large businesses that considered floods a recurring risk cited difficulties in identifying cost-effective adaptation measures.

**Finally, businesses believe that adaptation strategies they implement would not be effective in reducing damages.** These perceptions are stronger among businesses that identify floods as a recurrent risk than among those that do not as well as among large businesses in comparison to SMEs. The survey shows that 27 percent of SMEs identifying floods as a recurrent risk do not believe that adaptation strategies that they could undertake would be effective, in comparison to 18 percent of SMEs not identifying flooding as a recurrent risk. Among large businesses, a significant share also considers that adaptation strategies at their level would

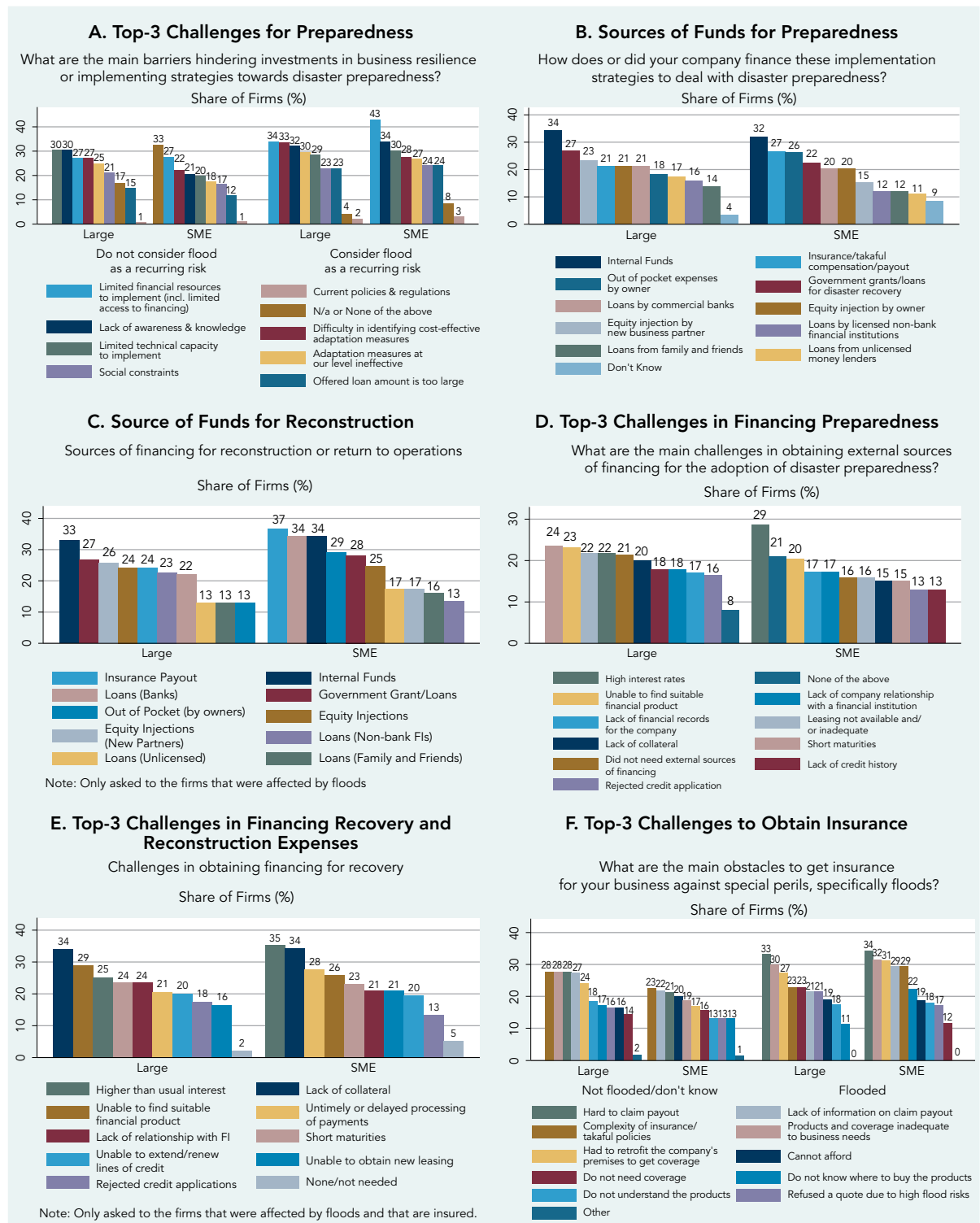
<sup>59</sup> The Persatuan Insurans Am Malaysia (PIAM), the General Insurance Association of Malaysia, reported that the take up rate for flood optional coverage within the motor and fire policies stood at 12 and 31 percent of the total number of policies, respectively, at the end of 2022. Although these statistics cover all customers (including households), they suggest that the take up of flood insurance among surveyed Malaysian businesses is relatively high when compared to the universe of Malaysian businesses.

be ineffective—30 percent among those identifying floods as a recurrent risk and 25 percent among those not identifying floods as a recurrent risk. These results provide some evidence that challenges for businesses are not limited to a lack of awareness about flood risks. Among businesses with some information about their

vulnerabilities to flood risks, there is a need for capacity building efforts highlighting the potential benefits (and costs) of flood resilience strategies, especially financial resilience. These results also highlight the importance of public sector actions to support business resilience.

**FIGURE 3.8**

**Constraints in Access to Finance for Adaptation Strategies**



## 3.4 Conclusions

**To deploy effective public sector support to help strengthen businesses' adaptation and resilience to floods, policy makers need to understand which businesses are most vulnerable to flood risk and why they are vulnerable.** This information is essential for the design of policies—for instance, to focus outreach toward the most vulnerable segments and to address the underlying barriers hindering business adaptation and resilience. Only then can public sector policies support private sector resilience efficiently and sustainably, improving the likelihood of credible impact. This chapter provides evidence shedding light on these questions.

**The survey results reveal three key findings. First, SMEs are particularly vulnerable to floods in Malaysia.**

The analysis shows that although flood impacts over the past three years were more prevalent among large businesses, SMEs were more likely to experience damages and disruptions associated with floods. SMEs were also more likely to cite indirect losses due to the impact of floods on their customers and employees. Smaller businesses were more likely to be affected by supply chain disruptions. Overall, the evidence suggests that SMEs tend to have less developed coping mechanisms. SMEs are less likely to have disaster preparedness strategies and less likely to have insurance when compared to large businesses, even after taking into account differences in risk exposures and risk perceptions.

**Second, flood risk awareness is a crucial factor underlying the extent of preparedness among businesses, but there are marked awareness gaps for SMEs.**

The survey results show that businesses that perceive flood risks as recurrent risks are more likely to have disaster preparedness strategies and purchase of flood insurance. That is, if businesses do not view floods as a source of risks for their business, they will not invest in resilience.<sup>60</sup> This result suggests limited risks of overadaptation (e.g., due to overreaction to sporadic past flood exposures). Moreover, research suggests that two key barriers to flood insurance uptake among businesses are their underestimation of flood risks and a lack of understanding of insurance products. The results also indicate a risk awareness gap between large businesses and SMEs in Malaysia. For example, SMEs

are less likely to believe they have sufficient information about future flood risks. The survey results also show marked differences between large businesses and SMEs in awareness that vulnerability to flood risks can impact their competitiveness, including in foreign markets.

**These findings indicate the need to improve risk awareness to foster action within the private sector, especially among vulnerable SMEs in Malaysia.**

Policy makers could consider deploying programs designed to raise awareness and enhance capacity to ensure businesses have adequate knowledge of their exposures and vulnerabilities and technical capabilities to plan and implement cost-effective disaster preparedness strategies.

**Third, limited access to finance for adaptation and resilience is a significant barrier for Malaysian businesses, especially SMEs, hampering their ability to manage flood risks.**

Among businesses that consider floods a recurring risk, a significant share of SMEs cited limited access to finance as a critical barrier to flood risk preparedness. SMEs mentioned as specific constraints affordability, and to a lesser extent, the lack of a suitable range of financial products, as well as limited collateral to finance recovery efforts. The most cited challenges curbing access to insurance were the complexity of payout processes and the inadequacy of products to meet businesses' needs. Notably, businesses citing limited access to financial resources as a major barrier to flood preparedness had significantly larger losses associated with floods over the past year than businesses that did not mention it.

**These patterns suggest an active, urgent role for public sector policies in supporting greater access to finance and insurance for businesses, especially SMEs.**

The results indicate that enhancing access to finance for both ex-ante preparedness and ex-post recovery efforts could significantly enhance business resilience and adaptation. Policy efforts should concentrate on improving access, especially for SMEs, which tend to be more vulnerable to the impact of floods. Notably, the design of policies is crucial for their effectiveness, especially in mitigating moral hazard concerns, in which policies could reduce the incentives for greater private

<sup>60</sup> These patterns are consistent with the evidence in the literature. See, for example, OECD (2016).

sector efforts in strengthening resilience. The survey evidence suggests that such incentives seem to be currently lacking for a significant set of businesses in Malaysia, as discussed later in Chapter 5.

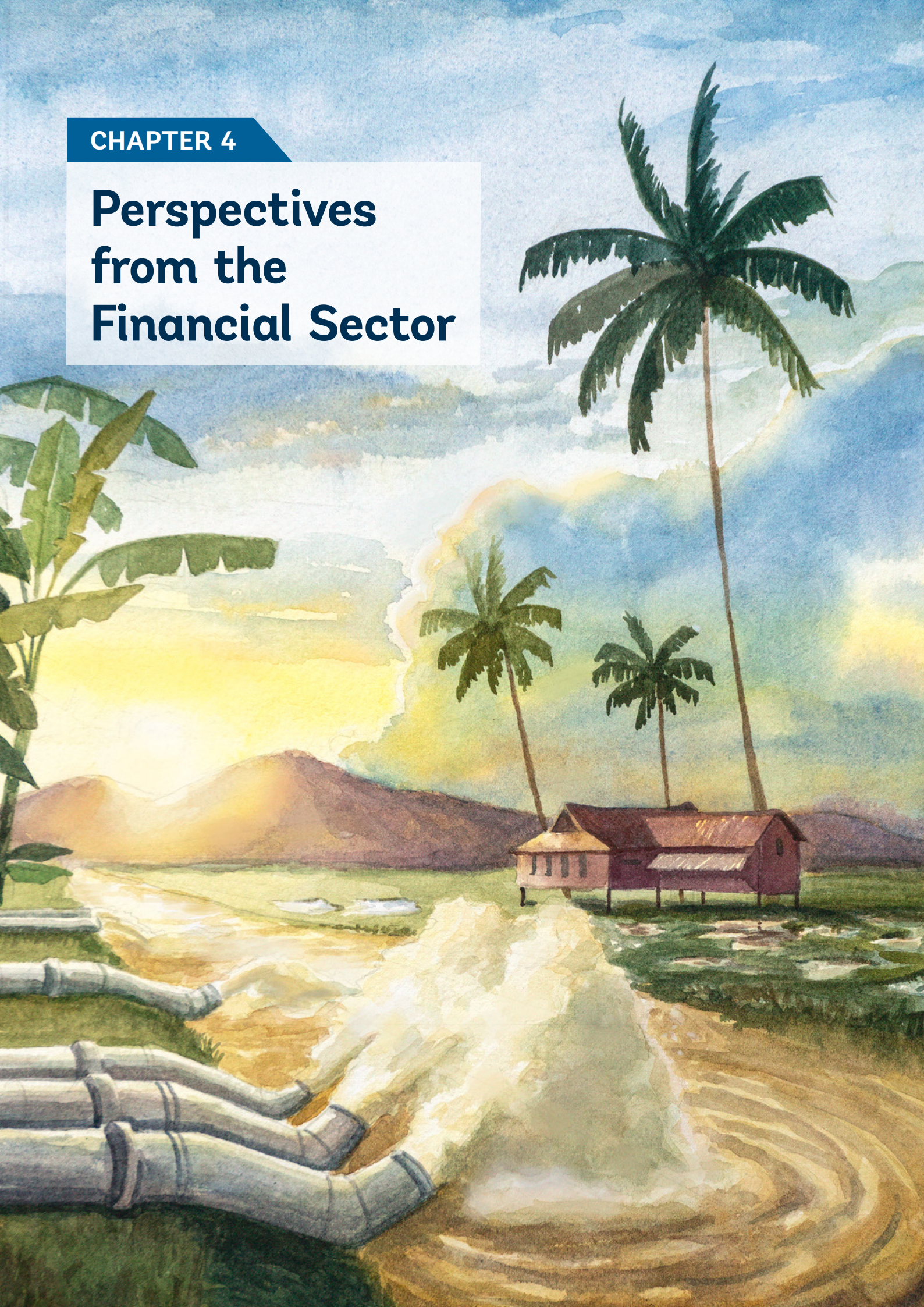
**There is a key role for public sector policies to reduce flood risk exposures and vulnerabilities.** The policy implications listed above focus primarily on reducing vulnerabilities for businesses in Malaysia, according to the conceptual framework outlined in Chapter 1. However, public sector policies focused on reducing risk exposures can lower uncertainties and help mitigate private sector vulnerabilities. The survey points toward several such policies. First, businesses indicated there was room for improvements in forecasts and early warning systems. According to the Malaysian businesses surveyed, the two most frequently cited inadequacies in the government's

past flood response were the lack of timely forecasts (mentioned by 20 percent of businesses) and the limited lead time provided by early warning systems (stated by 21 percent of businesses). Second, there is room for improvements in coordination and transparency across government agencies. Businesses mentioned uncertainty about responsibilities (25 percent of businesses), lack of effective coordination (20 percent), and lack of transparency in actions (20 percent) as areas that were inadequate based on recent flood episodes. Finally, businesses also noted marked deficiencies in public infrastructure—such as drainage systems (22 percent of businesses), transport networks in and out of flooded areas (18 percent), and untimely interruption of utilities (20 percent). An even higher share of small businesses, about 30 percent, cited reasons related to public infrastructure.



## CHAPTER 4

# Perspectives from the Financial Sector







## Key Messages

- **Evidence from a survey of financial institutions in Malaysia reveals that banks have limited engagement in supporting businesses' adaptation and resilience.** Financing for flood risk adaptation and resilience, especially emergency financing remains relatively small, with a limited range of financial products available to businesses. About 40 percent of banks stated that they do not provide any emergency support to businesses, and about 20 percent of banks stated that they have no specific product for the financing of adaptation investments. Although adaptation financing is small, it is an emerging area of focus for Malaysian banks.
- **The survey also indicates limits to the scope of the insurance market.** For example, financial institutions believe that insurance coverage is skewed toward larger businesses, with the uptake of flood insurance among smaller businesses being less widespread.
- **At the core of the constraints on financing and insurance for businesses to manage flood risks are significant gaps in flood-related information.** The limited reporting on exposures and vulnerabilities to flood risks from businesses, and the limited availability and accessibility of flood-related information from public sources constrain the effective measurement of flood risks.
- **The underdevelopment of financial infrastructure for climate-related adaptation investments further complicates an intricate informational environment.** Policies such as taxonomies and disclosure and reporting frameworks have focused primarily on climate change mitigation efforts rather than adaptation. In Malaysia, there is a lack of clarity around the standards and definitions for adaptation investments, including standardized reporting frameworks with well-defined metrics that would allow financial institutions to better monitor and report flood risks.
- **Partly due to the data gaps and an inability to adequately quantify flood risks, financial institutions in Malaysia face challenges in pricing, monitoring, and managing flood risks.** In fact, risk management practices related to floods are not yet widespread, especially among banks.
- **There are also limits to potential flood risk diversification for financial institutions.** A large and diverse client base is crucial for the ability of financial institutions to diversify away flood risks. Yet, financial markets for flood risk management remain relatively small. There is also a perception among financial institutions of limited business demand for financial products for flood risk management, which, in turn, reduces the incentives for greater engagement by financial institutions.
- **These factors hinder the ability of financial institutions to serve Malaysian businesses, especially high-risk ones, adequately.** The evidence points toward a *de facto* exclusion of a set of high-risk, vulnerable businesses from access to either finance or insurance (or both). For example, about 17 percent of the surveyed SMEs affected by floods over the past three years were refused insurance quotes. Another 32 percent of the surveyed SMEs were asked to retrofit their premises to obtain further insurance coverage. Doing so can be particularly difficult when businesses face constraints in access to finance for adaptation and resilience.



**The financial sector can play a critical role in enhancing private sector resilience in the face of natural disasters, such as floods, alongside government efforts.** Access to financial products and services can enable businesses to be better equipped to face flood events by supporting ex-ante adaptation efforts and financial resilience, enabling faster recovery after floods, for example, via insurance payouts and access to finance for emergency relief and recovery efforts. However, as shown in Chapter 3, businesses in Malaysia face challenges in managing flood risks, especially regarding access to finance and insurance, which are perceived as critical barriers to private sector adaptation and resilience efforts.

**The survey results provide new insights notably absent from available data sources on the current involvement of financial institutions with the financing of adaptation and resilience efforts by businesses**

**in Malaysia.** The survey also sheds light on current challenges hindering greater engagement by the financial sector. In Malaysia, macro and micro solvency stress test conducted by Bank Negara Malaysia (BNM) indicates that the financial sector remains resilient in the face of severe simulated flood events. Therefore, financial institutions can strengthen their role in enabling greater business resilience. To shed light on the main drivers and constraints underlying the provision of financial services and products to businesses, we conducted a supply-side survey among commercial banks and ITOs in Malaysia. The survey was circulated at the same time as the demand-side survey, during April-June 2023, and a total of 42 responses were received, effectively covering the universe of financial institutions in Malaysia. In addition, the survey was complemented by qualitative evidence gathered through interviews with a set of financial institutions in Malaysia.

## 4.1 Financing Adaptation

**Adaptation financing is a small but emerging area of focus for Malaysian banks.** According to the Climate Policy Initiative (2023), adaptation finance is dominated by public actors, which account for 98 percent of global financial flows, with fragmented financing from the private sector. A similar picture emerges in Malaysia, where financial institutions have just started expanding their financial offerings on adaptation financing. Banks have begun to offer financing and revolving credit lines (Figure 4.1, panel A). For example, Maybank Group has recently launched their Sustainable Product Framework 2022, that outlines a range of financial products and services (such as corporate financing and trade financing) dedicated to climate change adaptation projects, including protection against floods, such as flood barriers and flood warning systems. For some banks, engagement and advisory services are also offered to businesses related to the range of adaptation measures that can be taken to manage and mitigate flood risks. Banks have also used financial market instruments, like bonds and sukuk, specifically to support adaptation investments. For example, CIMB Group offers adaptation financing through their SDG Bond and Sukuk Framework, which covers financing for projects related to natural disaster prevention

infrastructure and mitigation measures. However, about 20 percent of the surveyed banks stated that they have no offering related to adaptation financing.

**While many banks use screening to assess flood risks for business clients, flood risks are not consistently embedded in credit risk assessments, and such risks are not priced in financial services.** For example, about 60 percent of banks stated that they consider flood risks when assessing the credit risks of business clients. Such an assessment is still in the early stages of development for a large share of banks in Malaysia. There is limited tracking by banks of whether businesses have flood insurance, and banks do not seem to conduct location-based due diligence to assess business prospects. Notably, over 30 percent of banks stated that they do not assess flood risks for new or existing clients. More broadly, flood risks are not embedded in the pricing of financing for businesses. Partly because of the limited information on flood risk exposures, banks are unable to price such risks, which in turn can limit their ability to provide finance, as discussed below.

**Best practices around managing and mitigating flood risks among banks are still in flux.** Although over 60 percent of banks consider flood risks when assessing

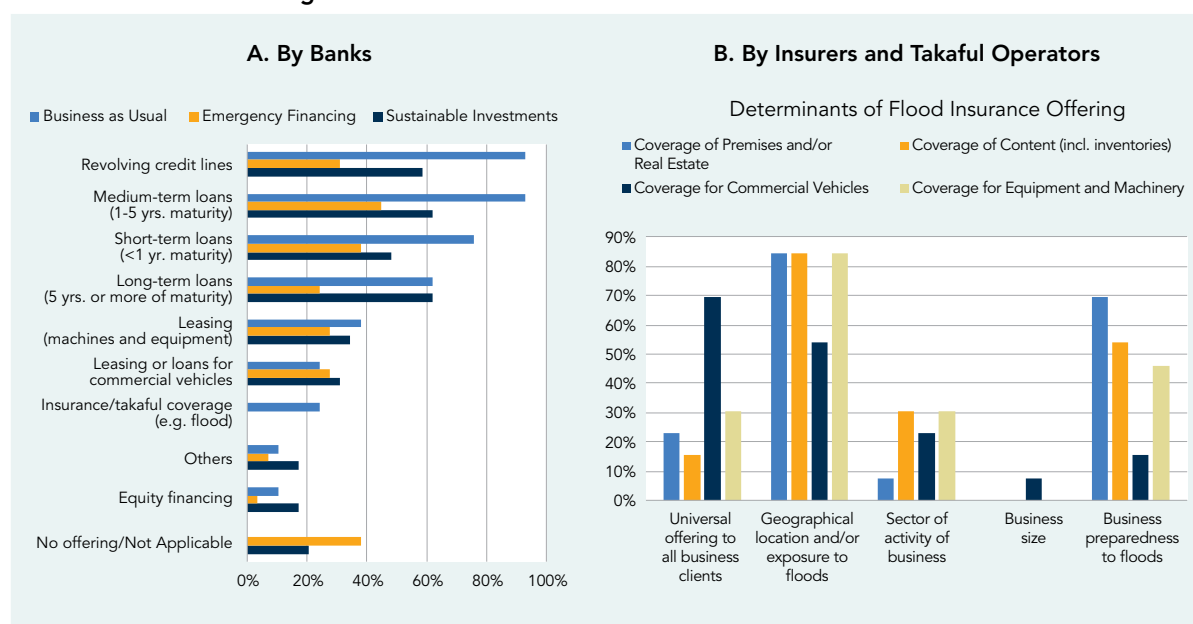
business clients, less than 30 percent monitor flood risks in their portfolios at least annually. The limited monitoring of banks' exposures to flood risks can be partly explained by banks not tracking flood risks among their clients. There is also limited reporting of flood-related risks—almost 70 percent of the surveyed banks stated that they do not report their risks on either internal or external assessments. Although monitoring and reporting flood risks for banks are still in their nascent stages, with banks only starting to develop plans and strategies to assess these risks in their portfolios, there remains a perception that flood risks have a limited impact on financial institutions' portfolios.

**Nevertheless, climate-related risk management practices of financial institutions are expected to improve in the near term in line with expectations put in place by BNM.** The Climate Risk Management and Scenario Analysis policy document comes into effect, in stages, between December 2023 and December 2024.<sup>61</sup> The policy document laid out expectations on financial institutions to integrate climate risk management into their governance, strategy, risk appetite, and risk management, including imposing requirements surrounding scenario analysis and disclosures. In addition, an industry-wide climate risk stress testing

exercise is scheduled to be carried out in 2024-2025. This exercise will provide insights into the industry's preparedness to measure, manage, and mitigate climate-related risks.

**Cognizant of the risks posed by climate-related physical risks, some banks have taken one step further and deployed risk mitigation actions when financing businesses.** Some banks use screening to determine whether the business premises for the financed activity are prone to flooding, typically drawing from historical information on past flooding, the latest headline news, flood risk models, or inputs from insurers regarding exposures to flood risks. Based on such an assessment, banks may require businesses to acquire flood insurance or develop and implement adaptation plans. Such efforts are mandatory prerequisite for financing. There are instances when banks deny financing to high-risk businesses, especially for new clients, when the risks are perceived as incompatible with the bank's risk appetite. This finding is consistent with the observations from flooding events in recent years. Banks are supporting businesses, but coverage remains uneven, and a small proportion of high-risk businesses are unable to access financial services and products, especially protection solutions (see more below).

**FIGURE 4.1**  
**Financial Product Offerings**



61 See <https://www.bnm.gov.my/-/pd-crmsa-2022>.



## 4.2 Emergency Financing

### **There is limited availability of emergency financing for businesses in Malaysia.**

The provision of emergency financing for businesses by banks is even more limited than adaptation financing in Malaysia, as shown in Figure 4.1, panel A. Less than half of the surveyed banks stated that they offer loans or credit lines to businesses when they are affected by floods. In some instances, financial institutions have supported businesses by allowing repayment deferrals on a temporary basis, such as through moratorium. For example, RHB's Flood Relief Assistance provided financial assistance to existing customers affected by the 2021-22 floods, including businesses.<sup>62</sup> This program includes deferment of housing loan payments for up to six months, waiver of late payment credit card charges for up to three months, and even waiver of card replacement fees. However, emergency finance offerings are not yet mainstream in Malaysia's banking sector. About 40 percent of the surveyed banks stated that they do not provide any emergency support to businesses.<sup>63</sup>

### **In Malaysia, emergency assistance has typically been offered officially through the government.**

Box 4.1 briefly outlines how emergency financing and relief have been typically deployed in Malaysia. Emergency financing and relief have been distributed exclusively to individuals and households. For instance, during the 2021-22 floods, no public sector funds were available for businesses despite the RM0.5 billion (\$110 million) loss in business premises incurred during these floods.<sup>64</sup>

Instead, businesses have been left only with the limited range of offerings from financial institutions.<sup>65</sup> This finding is consistent with the findings in Chapter 3, in which businesses noted a range of challenges associated with access to finance in the aftermath of floods, including for recovery and reconstructions efforts.

### **BNM has stepped in to support vulnerable businesses, bridging the gap in emergency sources of funds for businesses, especially smaller ones.**

As noted in Chapter 2, in the aftermath of the 2021-22 floods, BNM launched its Disaster Relief Facility providing financing for micro, small, and medium enterprises (MSMEs) affected by floods. The goal of the Facility was to enable businesses to resume their operations. The Facility offered partially guaranteed (up to 80%) financing of up to RM700,000 (\$155,000) per SME and up to RM150,000 (\$33,000) per micro enterprise, with a maximum financing rate of 3.5 percent per year, inclusive of partial guarantee fees. Financing is earmarked for expenses related to repairing and replacing of business assets and working capital.<sup>66</sup> As noted in Chapter 2, BNM allocated RM500 million (roughly \$110 million) to the Facility. The Facility has not yet been fully utilized, with 53 percent disbursed as of July 2023. BNM is currently assessing how to enhance its Disaster Relief Facility to provide support for access to finance for ex-ante adaptation and risk mitigation, in addition to the currently available support for ex-post financing for business recovery and rehabilitation.

<sup>62</sup> See RHB Group's Notice: [https://www.rhbgroup.com/files/others/highlights/Flood\\_Relief\\_Assistance\\_programme.pdf](https://www.rhbgroup.com/files/others/highlights/Flood_Relief_Assistance_programme.pdf).

<sup>63</sup> Financial institutions can provide emergency support to businesses through a range of temporary measures, such as, deferment of loan repayment, minimum payment waiver or reduction, interest rate reduction, and waive of fees and penalties on early withdrawals, among others.

<sup>64</sup> See DOSM (2022).

<sup>65</sup> See for example <https://www.abm.org.my/press-releases/banks-ready-to-assist-customers-affected-by-floods/>.

<sup>66</sup> See Bank Negara Malaysia. (2022a).

## BOX 4.1

## Emergency Financing and Relief during the 2021-22 Floods in Malaysia

**The 2021-22 floods, the most significant natural disaster to impact Malaysians in recent years, clearly demonstrate how emergency financing and relief are typically deployed in Malaysia.** The federal government supplied the largest proportion of emergency financing through the National Disaster Management Agency (NADMA), which focused primarily on supporting households.<sup>67</sup> For businesses, the government also distributed emergency funds through a coordinating agency, like SME Corp. For example, RM100 million (\$22 million) was allocated by the Malaysian Ministry of Entrepreneur Development & Cooperatives (MEDAC) to SME Corp for the SME 2.0 Emergency Fund (SMEEF 2.0) and distributed through financing to SMEs affected by natural disasters,

including floods, storms, droughts, beach erosions, and landslides.

**In addition, Malaysia has also received emergency financing from international organizations typically in the form of grants.** Such support typically focuses on individuals affected by disasters and health emergencies. For example, the International Federation of Red Cross (IFRC) have allocated \$3 million to Malaysia in their Disaster Response Emergency Fund (DREF), \$2 million specifically for victims of floods. The support was given as grants, according to DREF data.<sup>68</sup> According to the IFRC annual report, almost \$500,000 were distributed for emergency relief associated with the floods in Malaysia in 2021 and 2022.

67 The Malaysian Family Flood Aid 2021/2022 was prepared for the victims of the 2021 floods. About RM1.4 billion (\$310 million) was allocated for this program, distributed into different types of mechanisms such as the Bantuan Wang Ihsan (BWI), cash vouchers for electronics within the households, and for rebuilding houses destroyed due to the flood. See [https://portalbencana.nadma.gov.my/portal/images/nadma/documents/banjir/Mekanisme\\_Bantuan\\_Banjir.pdf](https://portalbencana.nadma.gov.my/portal/images/nadma/documents/banjir/Mekanisme_Bantuan_Banjir.pdf)

68 See IFRC's website, <https://www.ifrc.org/happening-now/emergency-appeals/disaster-response-emergency-fund-dref>.

## 4.3 Flood Risk Insurance Markets

**Flood insurance or takaful coverage is typically offered as a non-mandatory “add-on” peril to fire and motor protection products, and coverage for business interruption is supplementary.** Universal offering to business clients is not standard, except for coverage for commercial vehicles (Figure 4.1, panel B). Offerings are largely based on geographical location or exposure to floods. In addition, almost 80 percent of ITOs mentioned that they consider flood risks when assessing the prospects of business clients and a large share of ITOs tend to monitor flood risks annually or at a higher frequency. Akin to patterns observed for banks, insurance coverage is sometimes linked to business preparedness for flood risks. For example, 70 percent of the surveyed ITOs stated that business preparedness is an important determinant of whether flood insurance for premises is offered to businesses, and 50 percent stated so in the context of insurance coverage for content (including inventories). To the

extent that adaptation strategies are mandatory prerequisite for coverage for a set of high-risk clients, a portion of such high-risk clients may be excluded from the market. Consistently, the results in Chapter 3 show that a proportion of businesses (13 percent) are unable to obtain flood insurance coverage due to their high exposure to flood risks.

**While processing of claims is generally fast for households, processing of claims from businesses is marked by difficulties in assessing losses.** Claims from businesses generally require longer processing times. While most business claims are processed in less than ten business days, for about 30 percent of ITOs, processing times are longer than ten business days. ITOs stated that longer processing times for these claims were due to challenges related to verifying and quantifying damages amidst the limited availability of information from businesses. Such challenges

seem particularly marked in the case of SMEs, where record-keeping practices are less well-developed. For instance, real-time tracking and verifying inventories for assessing losses can be particularly challenging for smaller businesses.

**Pricing of flood insurance remains de facto tariff based.**

Currently, Malaysia is still in the process of liberalizing the pricing of insurance and takaful products; the current pricing framework for these products already provides some flexibility for ITOs to adopt risk-based pricing. However, due to a long-ingrained tariff pricing culture, flood protection products remain mostly at tariff pricing, particularly for the range of existing products in the marketplace. Some ITOs utilize deductibles to incorporate risk appetites and risk-based pricing into their offerings. Another critical constraint relates to the lack of adequate data and capabilities to price risks effectively and is further explained below.

**There is significant space to expand flood protection coverage among businesses in Malaysia, especially among MSMEs.**

The survey evidence in Chapter 3 showed that coverage is skewed toward larger businesses, with the uptake of flood insurance among MSMEs being less widespread, even after differences in risk exposure are considered. ITOs and banks hold similar perceptions. For example, large businesses are perceived to be “well-covered” by more than 80 percent of the surveyed ITOs and almost half of the banks offering insurance coverage (Figure 4.2). The rest of the surveyed financial institutions perceive their coverage to be moderate. In contrast, over half of the surveyed ITOs and 75 percent of banks stated that micro-business coverage is poor. The low penetration of insurance among MSMEs is particularly marked for

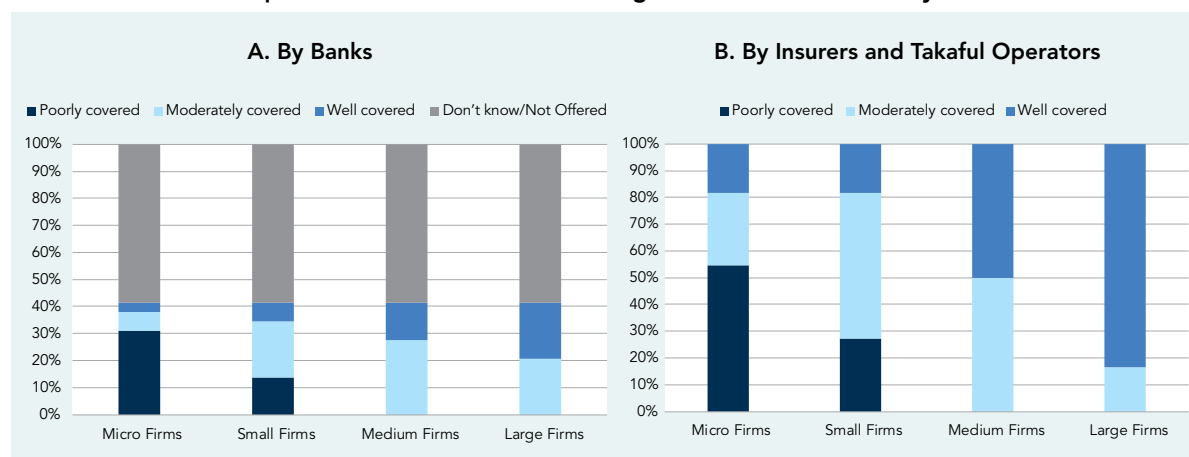
those in the agriculture sector, where ITOs have shied away, mainly due to the high riskiness of the segment.

**Although the surveyed ITOs perceive flood risks in Malaysia as non-systemic, with risks seen as diversifiable within Malaysia, the insurance market is highly dependent on re-insurance.**

The dependence on re-insurance is demonstrated by the relatively small impact of the 2021-22 floods on the insurance sector. Most of the insured losses were absorbed by the re-insurance segment. Nevertheless, flood risks have been re-priced since then, which, in turn, could lead to changes in the marketplace dynamics. There are already some treaty restrictions related to exposure to the agriculture sector. Given the market’s high dependence on re-insurance, such treaty restrictions curb the offer of protection for businesses in the segment. Interviews with re-insurance companies active in Malaysia revealed that risk absorption by the re-insurance industry is not perceived to be a constraint for market expansion at present. However, there is a perception in the marketplace that evolving flood risks, the re-pricing of risks, and additional treaty restrictions could, in the future, lead to effective constraints in the ability of domestic ITOs to transfer risks to re-insurance, which, in turn, could affect the capacity of the insurance and takaful segment to absorb flood risks. Specifically, ITOs may reduce their aggregate flood risk exposures, for instance, by further excluding high-risk customers. In addition, ITOs may re-price flood risks in their product offerings as the frequency of floods increases. Meanwhile, there is no substantial expansion in market depth that allows risk diversification across a large client base domestically, which could raise concerns about affordability.

**FIGURE 4.2**

**Financial Sector Perception of Flood Insurance Coverage for Businesses in Malaysia**



Note: The survey instrument did not provide a definition of firm size.

## 4.4 Supply-Side Challenges

### 4.4.1 Limited Availability and Accessibility to Flood-related Data

**At the core of the challenges for financial institutions, especially banks, in providing adaptation and emergency financing and protection for businesses are data gaps.** The survey shows that more than 50 percent of the banks highlighted as a top challenge for adaptation financing, the poor quality or unavailability of sustainability reporting from businesses. And almost 40 percent mentioned costly information gathering and processing (Figure 4.3). Banks acknowledged that these same factors thwart their ability to provide emergency financing. Similarly, 45 percent of ITOs also highlighted the lack of information on flood risks as a top challenge for providing flood protection to businesses (Figure 4.4).

**The data gaps in Malaysia reflect limited availability, access, and quality of information.** Flood risk assessments for the pricing of financial products and services require granular, detailed historical data of various types, including meteorological, hydrological, and topographical information and information on land use, flood protection infrastructure, and drainage systems and their relative effectiveness, among others. These data are typically combined in flood risk maps. These maps are largely unavailable in Malaysia. The information available to financial institutions is marked by the following limitations:

- *Limited coverage.* Public agencies and ministries collect information on riverine floods, but no information is currently collected or tracked on flash floods, which are precisely the type of floods that are expected to increase in frequency in Malaysia.
- *Temporal relevance.* Data is most useful when it can be relied upon to be accurate and up to date, especially for climate risk assessments and the need to understand rapidly evolving weather patterns. Data from public sources that are currently made publicly available only covers a short historical period (e.g., five years backward). There are no forward-looking projections nor sufficient information for financial institutions to develop their projections on the impacts of floods. In other words, limited historical information constrains robust forecast analysis.

- *Spatial granularity.* Floods are highly localized events. Hence, an adequate understanding of the impact of floods on businesses requires precise geospatial data on flood prone locations that is generally unavailable within Malaysia. All financial institutions collect information on their assets at the street and postcode levels. The absence of publicly available geocoded data enabling the identification of flood-prone locations for financial institutions prevents them from overlaying their asset-level exposure (and vulnerability) data with hazard information. Aggregated data—for example, at the postal code level—may mask the heterogeneity and granularity of flood impacts across different locations and asset classes. In addition, there are concerns about the comparability of information across geographical locations due to a lack of consistency in data collection.
- *Data gatekeeping.* Flood data are considered sensitive in Malaysia, and its publication is perceived to carry some risks associated with the potential backlash from the private sector, and the public more broadly, from resulting changes in property values. Government agencies have reservations about sharing available climate-related data, including flood risk maps. Thus far, there have been strict limitations on data usage by other public or private bodies. Nevertheless, relevant ministries in Malaysia are conscious of the importance of accessibility of such data. They are developing a centralized climate-related database, including flood hazard and projection maps. This information is planned to be made accessible to the public, including financial institutions.<sup>69</sup>

**Financial institutions in Malaysia can overcome, at least in part, the limited availability of information on flood risks, even though the available options are costly.** There is some evidence that some financial institutions have been relying on a broad spectrum of practices in sourcing relevant climate-related data.

*Proprietary flood risk maps.* For example, financial institutions can access proprietary data from (re)

<sup>69</sup> Some data have been made publicly available by the Selangor and Malaysia DID related to hydrology on their website, where information is based on data from telemetry stations. See <http://infobanjirjips.selangor.gov.my/>.

insurance companies, including flood hazard maps and value-added services, such as flood modeling and projection tools. These databases generally offer the most sophisticated data analysis and forecasts on flood risks for the Malaysian financial sector. They typically rely on global in-house flood risk models that integrate flood hazard and exposure data from various sources, such as satellite and hydrological data. Most insurers rely on such databases. However, access to these datasets can be costly and similar concerns on availability and quality of data for Malaysia apply to such datasets. They also rely on limited historical information and infrequent updates. Some third-party flood risk maps are also available only at the postcode level. The estimated flood risk maps are thus subject to a high margin of error. Also, the assumptions and modeling framework are often “black boxes,” with limited transparency to ITOs (or banks) intending to leverage the information.

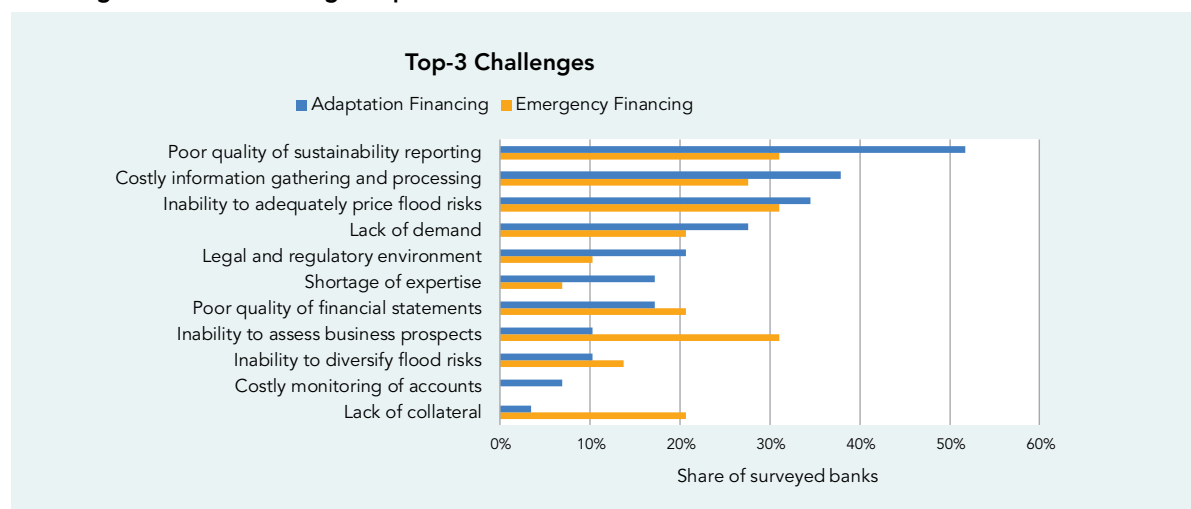
*Enhanced information from clients.* Financial institutions can also collect data based on their clients’ exposures. While there is no standardized practice for data collection from customers, as discussed above, banks are building their data capacities by engaging more proactively with their clients in collecting data points such as insurance claims. ITOs can also leverage their historical claim data. However, such information often lacks sufficient granularity, such as geocoding, to adequately understand the risk profile of customers. Such an approach could enable the management of flood risks in the portfolio of financial institutions. It is arguably not sufficient to allow financial institutions to accurately assess the risks of potential clients (especially those in different geographical locations), and to

diversify flood risks in their portfolios by expanding their client base. This constraint is particularly acute for smaller financial institutions with a smaller client base.

*Open-sourced data.* Technological advancements have increasingly contributed to improved availability and quality of data on flood risks. In recent years, the increasing availability of open-source data, such as satellite data, has allowed greater accuracy in assessing the footprint of past floods and more widespread geographical coverage of flood risks, including for areas where no other mapping or modeling capacity is available. These should facilitate the development of flood risk models. However, few financial institutions in Malaysia have independently used such information.

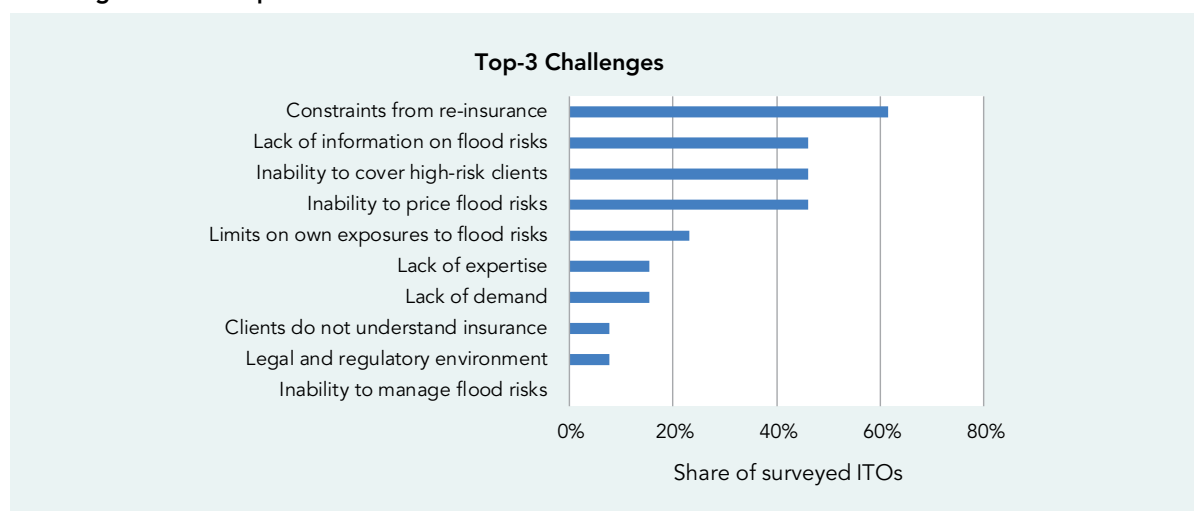
**These data gaps constrain the measuring and monitoring of flood risks, including changes associated with evolving weather patterns, changes in land use, urbanization, and even flood mitigation projects.** This has important implications for flood risk management by financial institutions and the range of product offerings for businesses. It can lead to inaccurate pricing of flood-related financing and insurance, which carry risks for financial institutions. It can also lead to exclusionary or redlining behavior, with financial institutions acting conservatively in offering flood protection coverage or adaptation and emergency financing to perceived high-risk customers. There are also risks of inadequate coverage of financial products—for instance, leaving businesses under-compensated or without access to financing following a severe flood event—that can constrain business adaptation and resilience, hamper recovery efforts, and erode trust in the financial sector.

**FIGURE 4.3**  
Challenges for the Financing Adaptation and Resilience





**FIGURE 4.4**  
Challenges for the Expansion of Flood Insurance



## 4.4.2 Inability to Adequately Price and Diversify Risks and Serve High-Risk Businesses

**Financial institutions in Malaysia face critical challenges in adequately pricing flood risks.** Risk-based pricing lies at the core of financial markets for flood risks, especially for the insurance market. For instance, assessing flood risk exposures and quantifying potential losses is essential to calculating insurance premium amounts, ensuring that ITOs have the financial capacity to pay claims while maintaining financial sustainability, and establishing sufficient reserves and capital. Yet, more than 40 percent of ITOs and more than 30 percent of banks stated that their inability to adequately price flood risks hampers their product offerings to businesses in Malaysia (Figures 4.3 and 4.4). This is partly due to the marked flood risk data gaps discussed above, and limited expertise and capabilities among financial institutions, as discussed below.

**Flood risk diversification is also perceived as a key challenge for financial institutions, especially ITOs in Malaysia.** Flood risks in Malaysia are highly localized, resulting in risk concentration. Insurers arguably face concentrated risks as large losses can occur simultaneously and in geographically clustered areas. For example, businesses located near river basins are prone to more frequent flooding during monsoons, or businesses located in coastal floodplains are generally affected more frequently than businesses located at a distance from (or elevation above) watercourses. A

large and diverse client base is crucial for the ability of financial institutions to diversify away flood risks, especially in the case of ITOs. The non-mandatory nature of flood insurance and the limited depth of the insurance market in Malaysia make it challenging for ITOs to build a sufficiently large pool of uncorrelated risks, as clients within these high-risk areas are more likely to purchase insurance or takaful protection.

**Lack of adequate risk-based pricing and an inability to effectively diversify flood risks can thus hinder the ability of financial institutions, especially ITOs, to serve high-risk clients.** Indeed, the survey shows that limitations to risk diversification are core challenges to ITOs in Malaysia, with a significant share of the surveyed ITOs pointing to either the inability to cover high-risk clients or exposure limits to flood risks. Concerns with risk diversification and outreach to high-risk clients are likely to grow in Malaysia if markets develop on a commercial basis. Interviews with ITOs and re-insurance/re-takaful operators revealed that increases in exposures to high-risk clients would likely raise the pricing of protection products, effectively crowding out potential clients that are of either lower risk or that would be unable to afford the higher premiums. In addition to excluding those needing flood protection the most, this may further hamper ITOs' efforts to diversify risk in their portfolios effectively.

### 4.4.3 Lack of Demand and Other Demand-Side Factors

**Banks highlighted that lack of demand is a challenge for expanding adaptation and emergency financing.**

Almost 30 percent of the surveyed banks stated that lack of demand is a top-3 challenge for adaptation financing, and 20 percent of banks said so for emergency financing (Figure 4.3). The lack of explicit classifications of flood risk adaptation strategies in the data collection practices of banks can exacerbate this perception. However, only a small share of ITOs (15 percent) noted lack of demand as a top challenge (Figure 4.4).

**Banks also noted some other constraints from the demand-side, especially for emergency financing.**

More than 20 percent of the banks mentioned as a top-3 constraint for emergency financing the poor quality of financial statements, inability to assess business prospects, and lack of collateral. In contrast, only a handful of banks noted these other demand factors as top constraints for adaptation financing. These differences can be explained by changes in business prospects in the aftermath of floods when businesses, especially SMEs, may have suffered significant asset losses and damages that formed the collateral basis for debt financing, and their business viability may in fact become uncertain.

### 4.4.4 Lack of Capabilities

**A small share of surveyed banks and ITOs noted limited capabilities as a top challenge hindering their ability to support businesses' adaptation and resilience to flood risks.**

Almost a fifth of financial institutions cited a lack of expertise in assessing and managing flood-related risks in their portfolios. Such assessments can be particularly complicated in the case of flood risks, even though such risks are highly localized in Malaysia. Sophisticated data analytics and modeling are usually required, which tend to be more complex and expensive compared to other risks. In

addition, the high uncertainty around flood risks adds an additional layer of complication. Risk-mitigating factors, such as the availability of adaptation technologies and government policies that impact risk exposures and pricing mechanisms, are challenging to understand and quantify. These challenges are compounded by the marked data gaps discussed above, as the lack of high-quality flood data further limits the understanding of these risks and can exacerbate inaccuracies in estimating and pricing risks.

## 4.5 Conclusions

**Reinforcing the findings from the survey of Malaysian businesses, evidence from financial institutions reveals that banks and ITOs have limited engagement in supporting businesses' adaptation and resilience.**

Financing for flood risk adaptation and resilience, especially emergency financing remains relatively small, with a limited range of financial products available to businesses. Consistent with the business-level survey results, financial institutions also believe that insurance coverage is skewed toward larger businesses, with the uptake of flood insurance among smaller businesses

being less widespread. At the same time, there is a perception among financial institutions of limited business demand for financial products in flood risk management, which, in turn, reduces the incentives for greater engagement by financial institutions. In the case of insurance, low demand may be caused by a "disaster syndrome" in which the low depth of the insurance market pressures the government for ex-post compensation, whereas the expectation of such compensation further reduces demand for insurance.

**Marked gaps in flood-related information are at the core of constraints in financing and insurance for flood risk management for businesses.** There is limited reporting on exposures and vulnerabilities to flood risks from businesses, and the availability and accessibility of information from public sources are also limited. At least in part, due to marked data gaps and the inability to adequately quantify flood risks, financial institutions in Malaysia face challenges in monitoring flood risks. Risk management practices related to floods are not yet widespread, especially among banks. While many banks use screening to assess flood risks for business clients, flood risks are not consistently embedded in credit risk assessments, and such risks are not priced into financial services. There is also limited reporting of banks' exposures to flood risks, which can be partly explained by banks not tracking flood risks among their clients. The inability to accurately assess risk exposures and quantify potential losses constrain risk-based pricing—including for insurance premiums—and limit the scope for risk transfers, for instance, to insurance and re-insurance.

**Furthermore, there are limits to potential flood risk diversification.** To the extent that flood risks are not random—that is, large losses tend to occur simultaneously and in geographically clustered areas—financial institutions face concentrated and correlated risks. A large and diverse client base is crucial for their ability to diversify away flood risks. In the case of ITOs, the non-mandatory nature of flood insurance and the limited depth of the insurance market in Malaysia make it challenging for ITOs to build a sufficiently large pool of uncorrelated risks, as clients within high-risk areas are more likely to purchase insurance protection. For ITOs, these challenges imply that market expansion on a commercial basis can raise concerns about affordability and may lead to further exclusion of some of the most vulnerable businesses, namely high-risk businesses. Limited capabilities to assess and manage flood risks seem to compound these challenges. There is also a perception, especially among banks, of limited demand from businesses for the financing of adaptation and resilience.

**The inability to properly quantify and price flood risks and a lack of flood risk diversification hinder the ability of financial institutions to serve Malaysian businesses, especially high-risk ones, adequately.** Indeed, the evidence in this chapter points toward a *de facto* exclusion of a set of high-risk, vulnerable businesses from access to either finance or insurance (or both). These patterns are aligned with the evidence presented in Chapter 3, which also provided some evidence that high-risk businesses, especially smaller businesses, are being either priced out or outright excluded from the insurance market.

**The results suggest that there might be a vicious cycle between bank financing and insurance, in which limits in access to one source of external funds can further constrain access to other sources of finance.**

On the one hand, certain high-risk businesses affected by floods were asked to retrofit their premises to obtain further insurance coverage. Doing so can be particularly difficult when businesses face constraints in access to finance. Similarly, depending on past exposures to floods of businesses, banks could have requested them to purchase flood insurance or develop and implement adaptation plans as prerequisites for access to financing.

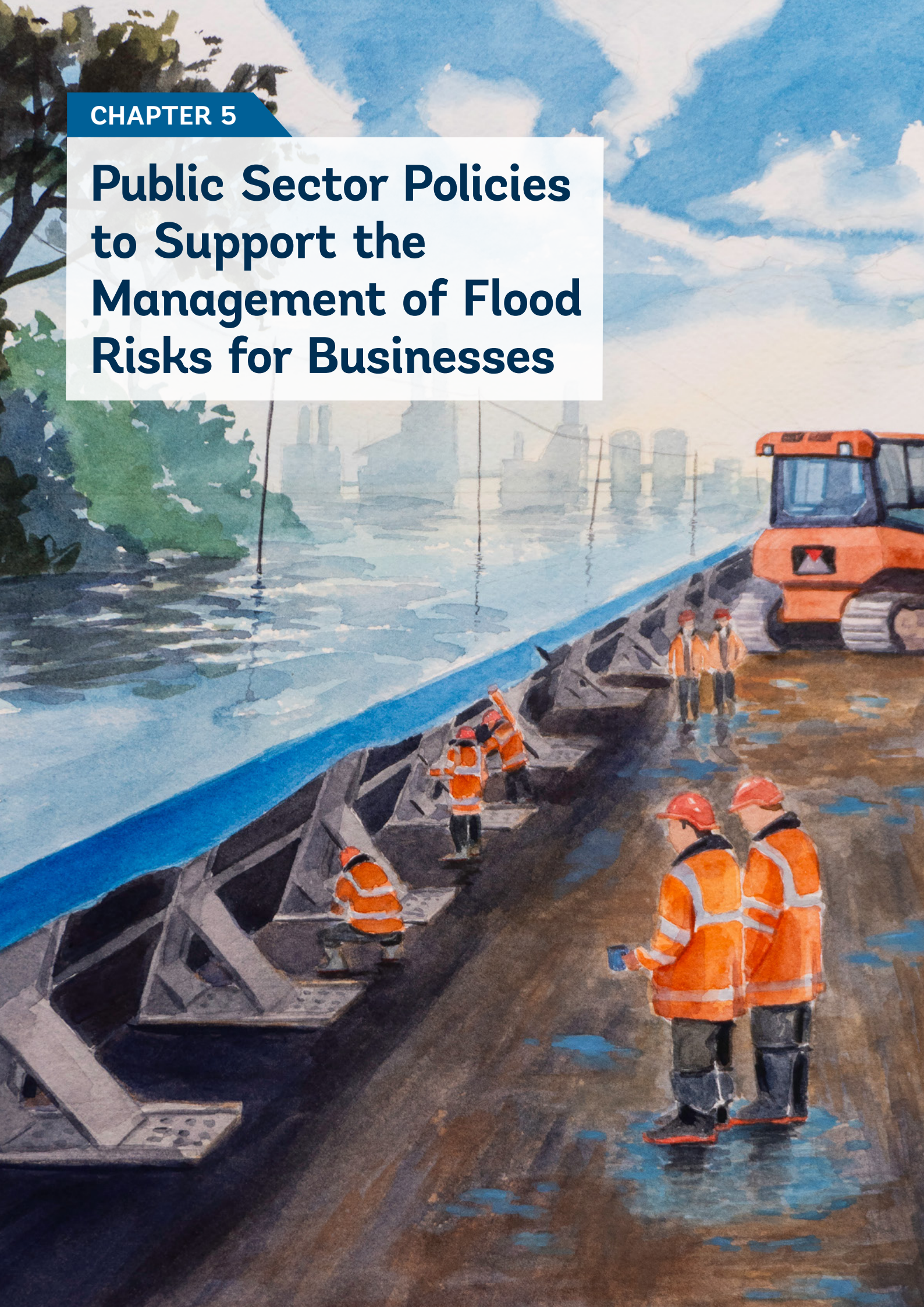
**Finally, there is a role for public sector policies to unlock financing and protection for flood risks.**

Financial institutions face significant challenges in providing these financial services and products in Malaysia. For ITOs, the challenges in providing flood risk protection to a highly concentrated, high-risk segment is exacerbated by a prevailing tariff culture. For banks, the inherent fragility of business in the aftermath of disasters negatively affects their incentives to provide emergency financing and adaptation finance; precisely because these are businesses typically exposed (and vulnerable) to flood risks. The next chapter provides a more in-depth discussion of these issues and how public sector policies can foster financial sector development as an enabler of greater private sector adaptation and resilience.



## CHAPTER 5

# Public Sector Policies to Support the Management of Flood Risks for Businesses







## Key Messages

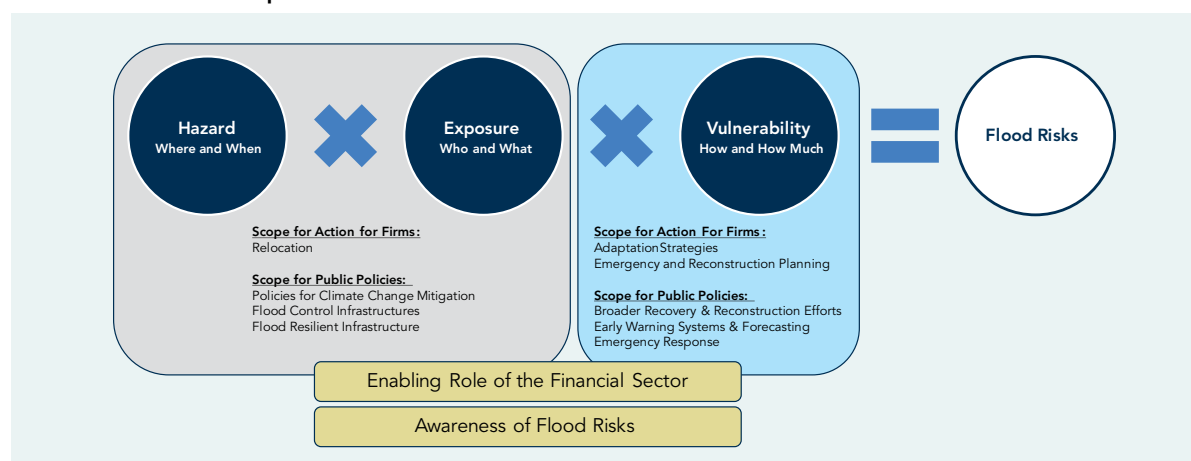
- **An integrated, coherent, and proactive approach by the public sector, the private sector, and the financial sector is paramount in building a flood-resilient economy.**
- **The public sector plays a pivotal role as the primary provider of large-scale flood control infrastructure, simultaneously ensuring the resilience of critical infrastructure and service delivery in the face of flood risks.** The public sector is also responsible for a range of policies softer in nature, such as urban planning and land use restrictions in flood-prone areas, among other responsibilities.
- **The actions by the public sector can significantly change the scale and the type of private sector investments.** They also affect the incentives to undertake such investments by businesses and the financial sector alike by changing their risk-return profiles. But while these actions can markedly reduce the impacts of floods on businesses in Malaysia, residual risks would remain.
- **Ultimately, the ability of businesses to reduce the impact of floods hinges on their capacity to adapt.** But private sector actions should build on and complement those of the public sector, which puts a premium on transparency about public sector policy priorities and strategies.
- **The financial sector can be an important enabler.** Access to financial products can support businesses in coping with floods by financing ex-ante adaptation efforts and enabling ex-post financial resilience. However, the landscape for financing investments to enhance private sector resilience to flood risks is marked by a range of market inefficiencies that call for policy intervention.
- **This chapter outlines a range of complementary policy actions in six key areas, focusing on how policy makers in Malaysia can support and foster private sector resilience to floods.** This chapter discusses at length the following six critical sets of actions, as follows:
  1. **Enhancing data availability, accessibility, and affordability** to support flood risk assessments, which are vital for risk management, informed investment decisions, and the development of financial markets.
  2. **Developing a long-term flood risk adaptation strategy** has first-order importance by establishing the level of risk retention by the public sector, thereby reducing policy uncertainty and facilitating the assessment of flood risks for the private sector.
  3. **Strengthening the enabling environment for the financial sector**, including mainstreaming flood risks to enhance accountability, ensure adequate risk management, and foster financing toward adaptation and resilience.
  4. **Supporting access to finance for adaptation and recovery**, especially targeting the most vulnerable businesses, such as SMEs.
  5. **Deepening the insurance market** to enhance the range of financial instruments that can support the financial resilience of businesses in Malaysia.
  6. **Enhancing flood risk awareness and building capabilities** to foster greater efforts toward adaptation and resilience.



**Effective management of flood risks entails complementary actions by both the public sector and the private sector to reduce hazards, exposures, and vulnerabilities (Figure 5.1).** As discussed earlier in this report, the impact of floods on businesses depends on the likelihood of floods and their physical characteristics (i.e., the hazard); businesses' exposures; and the degree to which businesses and their assets would be adversely affected by floods, taking into account the hazards they face and their exposures (i.e., their vulnerabilities). Actions aimed at reducing hazards are complex, relate to climate change mitigation, and lie beyond the scope of this report. While businesses can reduce their exposure to flood risks, mainly by

relocating away from high-risk locations, the public sector can play a critical role in decreasing exposures more widely by enhancing the resilience of public infrastructure, building flood control infrastructure, and strengthening urban planning and land use restrictions in flood-prone areas, among others. A discussion of such public sector policies is also beyond the scope of this report and is left for future work. This report is focused on supporting businesses to adapt and strengthen their resilience to flood risks. The public sector, working with the private sector, has a critical role in promoting informed private sector actions in this regard.

**FIGURE 5.1**  
**Role of Policies in Adaptation to Flood Risks**



**Constrained access to finance for adaptation and resilience, especially for SMEs, is a key factor hampering the needed investments in climate change adaptation and resilience.** As highlighted in Chapters 3 and 4, businesses often lack access to finance to invest ex-ante in preparedness and risk reduction strategies. They also lack access to ex-post sources of funding for recovery efforts if these risks materialize. In fact, businesses highly exposed to flood risks may face even tighter financing constraints as risk-averse financial service providers retrench from such risks. SMEs, in particular, face more binding constraints than larger businesses. Businesses may not have access to emergency sources of financing when hit by floods as lenders may perceive these businesses as higher risk due to the negative impact of floods on their assets and business prospects. Not only banks but also ITOs may not cater to high-risk businesses. The evidence in Chapter 4 suggests this is currently the case in Malaysia. Improving access to finance for businesses, especially SMEs, can be crucial to enhancing the resilience of the private sector to flood risks.

**This chapter focuses on the range of public sector policy options to strengthen private sector resilience and enhance the management of flood risks for businesses, zooming in on policies for the financial sector.** These policies should address the underlying market failures and frictions that constrain businesses from effectively adopting more resilient business practices while creating an enabling environment that encourages private financing toward appropriate investments in climate adaptation. Policies must also be firmly grounded on a comprehensive understanding of incentives for both businesses and financiers and the risks and uncertainties they face. These guiding principles serve as the foundation for effective adaptation strategies and the design and implementation of appropriate policy support. The rest of this chapter brings together the evidence from the demand and supply assessments discussed in Chapters 3 and 4 to outline the critical challenges hindering private sector adaptation and resilience and to present a range of policy options available to tackle them.

## 5.1 Challenges of Financing Investments in Adaptation to Flood Risks

**The landscape for financing adaptation efforts in response to flood risks is marked by financial frictions and market failures that can lead to underinvestment in adaptation by both businesses (especially SMEs) and financiers.** Chapter 2 provided evidence of the potential benefits of climate adaptation investments for businesses, such as those associated with supply chain resilience. Business-level survey evidence reinforced this assessment by showing that businesses with limited access to finance in Malaysia are less likely to invest adequately in preparedness and have

suffered, on average, greater losses and damages when affected by floods in recent years. Despite the potential benefits, the analyses in this report pointed toward limited investments in flood preparedness characterized by perceived mismatches in supply and demand. Banks argue that there is limited demand for finance from businesses, as shown in Chapter 4. In contrast, businesses argue that the range of financial products is inadequate, and they have limited access to finance, as highlighted in Chapter 3. These challenges can be particularly marked for SMEs.<sup>70</sup>

### 5.1.1 The Lack of Business Case for Investments in Flood Risk Adaptation

**Mismatched time horizons and difficulties in cost-benefit assessments hinder investment in flood risk adaptation and resilience.** Such investments often require significant upfront expenditures but returns tend to have longer and more uncertain payback periods when compared to conventional investments. These benefits may not be material to businesses in the short term, especially for SMEs, a segment of businesses typically characterized by high entry and exit rates. Many SMEs may not be operating when the risks these investments seek to address materialize.

**In addition, the benefits of investments in adaptation and resilience to floods can be particularly hard to quantify, which further weakens the business case for investments.** An important benefit from investments in adaptation and resilience is the mitigation of vulnerabilities to risks, which lowers expected losses associated with floods. Hence, the benefits of such investments are, in practice, avoided losses, which are complex to measure and monetize. This is further compounded by the high uncertainty surrounding not only flood risks, but also the effectiveness of adaptation and resilience strategies. For instance, regional, sectoral, and firm-specific variations in exposures and

vulnerabilities to floods call for tailored adaptation strategies, adding to the complexity of the decision-making process and the cost-benefit assessment.

**The uncertainty about the timing and magnitude of the returns to adaptation and resilience investments can stifle financing.** Lenders tend to favor investments with predictable short-term returns and may not appropriately consider the longer-term benefits (and costs) associated with efforts toward adaptation to flood risks. In fact, developing financial markets for long-term financing is a well-known challenge in many EMDEs.

**Furthermore, externalities and the public good nature of adaptation investments toward flood risks can lead to the mispricing of benefits, costs, and risks.** For example, investments by individual businesses can contribute to sector-wide resilience and stability, partly because many businesses in Malaysia operate within complex supply chains. Investments that strengthen individual businesses' resilience can reduce vulnerabilities in the entire supply chain. Without effective pricing mechanisms for these externalities, individual businesses would undervalue the benefits

70 See also Schaer and Kuruppu (2018).

of investments, thereby reducing their incentives to invest. For the same reasons, lenders may be reluctant to fund these investments, especially when prioritizing

resilience-enhancing investments could compromise short-run profitability.

## 5.1.2 High Uncertainty amidst Limited Capabilities

**For starters, the magnitude and frequency of floods are inherently difficult to assess and marked by uncertainty.** This is due to the need to account for complex and interdependent factors, including hydrological and meteorological processes, natural and non-natural factors (including rainfall patterns, soil moisture, topography, and drainage systems, among others), and mitigating factors (such as flood control infrastructure). Climate change adds an additional layer of uncertainty and complexity to these assessments, as discussed in Chapter 2.

**Information deficiencies exacerbate these uncertainties, rendering adaptation and resilience investments riskier than conventional investments.**

In addition to the marked data gaps related to limited availability, accessibility, and quality of information on flood risks in Malaysia, there is heightened uncertainty stemming from limited knowledge around: (i) technologies (e.g., technical feasibility); (ii) markets; and (iii) policies and regulations, including a lack of consistency in public sector policies.<sup>71</sup>

**In Malaysia, an important source of uncertainty pertains to public sector policies.** Private efforts toward flood risk resilience should complement public sector efforts to achieve efficiency, minimize duplication of efforts, and maximize the impact of investments. Limited information about the government's capital investments in flood adaptation projects (actual or planned) and the extent of government support to recovery efforts after flooding events (see below) constrains effective coordination between private sector and public sector efforts.

**Lack of transparency about the disaster risk management framework at the country level further compounds on uncertainties.** As a result, and as discussed in Chapter 2, disaster risk reduction, response, and recovery projects seem to lack integration and cohesiveness, with limited information about coordination protocols and mechanisms

to address rapidly evolving climate risks. There is also a lack of clarity over responsibilities and often duplication of interventions, which results in confusion and delays among the agencies involved in response and recovery activities. Recent large-scale disasters have revealed areas for improvement in the current institutional structure for disaster response system management, which is summarized in Box 5.1. Evidence from the business-level survey in Chapter 3 reaffirms the perception. Malaysian businesses noted the need for greater coordination and transparency across government agencies.

**Overall, the high uncertainty hinders the willingness of both businesses and financiers to invest in climate adaptation and resilience.**

The high uncertainty often results in indecision and underinvestment. For businesses, there are risks of overadaptation (i.e., undertaking investments that later prove to be unnecessary), underadaptation (i.e., failure to invest toward mitigation of losses), or incorrect adaptation (i.e., undertaking investments that later prove to be ineffective). Even when businesses recognize the need to devise strategies to mitigate losses associated with floods, the high uncertainty and risks of inadequate action amidst costly investments can hinder effective action toward preparedness and adaptation, including financial resilience planning. For lenders, high uncertainty is equivalent to high riskiness, whether real or perceived, which in turn affects risk-return trade-offs and can discourage financing.

**The underdevelopment of the financial infrastructure for climate-related adaptation investments further complicates this already intricate informational environment.**

Taxonomies that define criteria for economic activities aligned with climate-related goals and climate-related disclosure standards are essential elements in building an enabling environment for financing sustainable and climate-resilient projects. The absence of formally agreed-upon objectives and standards can result in a lack of comparability, reliability,

<sup>71</sup> Data gaps are a significant constraint to financial institutions in Malaysia, hindering critical flood risk assessments that underpin the pricing of financial services, including insurance premiums, as argued in Chapter 4. Data gaps also constrain an accurate flood risk management for businesses. When businesses lack access to information, they may not understand the risks they face, and consequently, they are less likely to invest in flood risk mitigation. As discussed in Chapter 3, a significant fraction of SMEs noted that they lack sufficient information about flood risks as a factor constraining investments.

and accountability, leading to higher transaction costs and unnecessary outlays, which can reduce the attractiveness of these investments. Thus far, policies supporting the enabling environment in Malaysia have focused primarily on climate change mitigation efforts rather than adaptation, with an emphasis on managing GHG emissions. There remains a lack of clarity around the standards and definitions for adaptation investments. Also, a standardized reporting framework with well-defined metrics that would allow financial institutions to better monitor and report on flood risks remains to be developed. The underdevelopment of the enabling

environment for climate change adaptation vis-à-vis mitigation is not unique to Malaysia. Indeed, most taxonomies and disclosure and reporting requirements do not explicitly reference how financing can support climate change adaptation and resilience.<sup>72</sup>

**Finally, limited awareness and capabilities intensify the challenges posed by data gaps and high uncertainty and can hinder the adoption of effective risk management practices.** As highlighted in Chapters 3 and 4, there are marked gaps in awareness of flood risks, for both businesses and financial institutions in Malaysia.

72 See, for example, the Policy Note, “Green Finance: A Policy and Advocacy Approach,” by the Inclusive Green Finance Working Group, United Nations Secretary-General’s Special Advocate for Inclusive Finance for Development.

## BOX 5.1

# The Government Response to the 2021-22 Floods

In the aftermath of the large-scale December 2021 - January 2022 floods, the government responded with several measures to aid recovery efforts. The magnitude of the event exposed some shortcomings in the disaster risk management framework in Malaysia and offered valuable lessons for reforms, including:

*Challenges to early warning systems.*<sup>73</sup> On December 16, 2021, MetMalaysia issued an orange alert for severe weather in Kelantan and Terengganu.<sup>74</sup> However, an unexpected shift of Tropical Depression 29W led to unprecedented rainfall also on the west coast of Peninsular Malaysia. MetMalaysia then issued an amber alert, which then swiftly turned to a red alert (the highest level) for the Klang Valley, Selangor and neighboring states. It rained continuously for four days, with total precipitation equivalent to a month’s worth of rainfall in the area. By December 20, floodwaters reached a height of four meters in some places and many roads remained impassable. This episode revealed potential shortcomings in the early warning system’s capacity to accurately predict severe weather patterns and

issue timely warnings, indicating a need for improved forecasting and communication infrastructure. The 2022 Auditor-General’s Report revealed that Phase 1 of the Flood Forecasting and Warning Programme for the three river basins in Kelantan, Terengganu and Pahang was unsatisfactory, with a flood forecasting accuracy rate of 5.6 percent.<sup>75</sup>

*Weak communication and coordination.* Widespread news reports suggest a lack of effective communication and coordination among different government agencies, local authorities, and various stakeholders during this flood episode.<sup>76</sup> In fact, Government of Malaysia officials acknowledged shortfalls in the government response, including in NADMA’s role during this episode, citing insufficient and inadequate staffing that curbed its capabilities to centrally coordinate emergency responses.<sup>77</sup> This lack of coordination resulted in inefficiencies in timely response actions, resource allocation, and dissemination of information to affected communities.

73 See Malay Mail (2022) and Rahman (2022) and references herein.

74 See The Star (2021).

75 See, for example, New Straits Times (2023).

76 See, for example, Free Malaysia Today (2021) and Reuters (2021).

77 See, for example, Astro Awani (2022) and Mohd Yazid (2022).



*Slow and inefficient resource allocation and distribution.*

The government faced difficulties in efficiently allocating and distributing resources such as food, water, medical supplies, and relief aid to affected areas.<sup>78</sup> Often, slow and inefficient official response required local communities, civil society organizations, community groups, non-governmental agencies, as well as individuals and corporates to rally together and fill gaps, which, at times, led to overlaps (and gaps) in disaster relief efforts.<sup>79</sup>

*Post-disaster recovery and reconstruction.* Following the floods, the government faced long-term recovery

and reconstruction challenges, including delays in rebuilding damaged infrastructure, insufficient support for affected communities, and challenges in implementing comprehensive reconstruction plans. In response to the flood events, the federal government announced a flood relief package to support recovery and reconstruction efforts. Most of the public sector support was aimed at individuals and households, but support was limited and marked by difficult application processes.<sup>80</sup> There were only a few initiatives supporting affected businesses, and coverage also seemed limited.<sup>81</sup>

78 See, for example, The Diplomat (2021) and Malay Mail (2021).

79 See, for example, The Diplomat (2021), The Malaysian Reserve (2021), and The Vibes (2021).

80 See, for example, New Strait Times (2021b) and Rahaman (2022).

81 In addition to Bank Negara Malaysia' Disaster Relief Facility, Bank Simpanan Nasional (a development finance institution under the DFIA 2002 Prescribed Institution Act) offered interest free loans of up to RM10,000 for affected businesses. See MOF (2021). Additional deliberations took place within the Economic Action Council (EAC) regarding proposals to provide special grants for MSMEs impacted by the floods—see New Straits Times (2022).

## 5.2 Challenges of Developing the Insurance Markets for the Management of Flood Risks

**Insurance coverage is an important element for the financial resilience of businesses.** Investments in preparedness and adaptation aim to reduce businesses' exposures and vulnerabilities to flood risks. While effective risk mitigation can go a long way, losses and damages caused by floods may not be entirely preventable. Businesses need strategies to ensure they can cope without devastating long-term consequences and quickly recover when floods occur. Indemnity insurance allows businesses to protect against financial losses associated with specific assets or pools of assets by transferring the financial risks they face to financial institutions. In addition, when international

markets absorb a portion of claim payments through re-insurance, there is a transfer of risk away from the local economy.<sup>82</sup> In other words, insurance and takaful markets are primarily about risk transfer and risk sharing, respectively, not risk mitigation. When insurance premiums are reflective of risks (risk-based pricing), insurance can then encourage investments in risk mitigation.

**Insurance can provide timely financial resources for reconstruction efforts when disaster strikes.**<sup>83</sup>

Existing research shows that countries with higher insurance penetration usually recover more quickly

82 For example, the economic impact of the 2011 Canterbury earthquake in New Zealand was minimal despite direct losses approaching 20 percent of GDP (New Zealand Parliamentary Library, 2014).

83 As an illustration of this impact, 80 percent of insured residences were rebuilt after Hurricane Katrina in subsequent years, compared to only 50 percent of uninsured properties. See Turnham et al. (2011).

and have lower economic output losses.<sup>84</sup> In countries with developed insurance markets, insurance claims payments tend to be larger and more quickly disbursed than government assistance.<sup>85</sup> When insurance penetration is sufficiently high, insurance payments can reduce the need for emergency relief from the government, thereby reducing the potential costs of floods to taxpayers.

**International experience has shown that developing the insurance markets for flood risks is challenging.** In Malaysia, challenges from both the demand and supply for flood risk insurance have led to a relative underdevelopment of insurance and takaful markets. From the demand-side, as shown in Chapter 3, there is limited demand for insurance by businesses, especially among SMEs, due to: (i) limited awareness and underestimation of flood risks; (ii) lack of understanding about insurance coverage and claim payment processes; and (iii) expectations of post-disaster government compensation or financial

assistance. There are also several challenges on the supply-side. The classical indemnity insurance is based on the observation of losses, whereby insurance claim payments are triggered once losses occur. For this type of insurance product, if flood risks are to be covered by the private markets, risks need to be “insurable.” This means that for insurance companies to charge actuarially sound premium rates, risks need to be: (i) *quantifiable*—that is, the probability of occurrence of a flood, its severity, and its impact in terms of damage and losses must be measurable; (ii) *random*—that is, the timing and location of insured events must be unpredictable, and not affected by the insured parties; and (iii) *diversifiable*—that is, risk diversification must be possible across a sufficiently large community facing different risk exposures. Flood risks pose particular challenges regarding insurability as these criteria are not always met, pushing up the prices of insurance coverage and leading to shallow markets. We review these individual elements below.

## 5.2.1 Inability to Accurately Quantify Flood Risks

**Private insurance markets tend to develop based on risk-based pricing.** Assessing risk exposures and quantifying potential losses is critical to calculating premium amounts, ensuring that ITOs have the financial capacity to pay claims (and remain profitable), and establishing sufficient reserves and capital. Robust risk assessment analysis, quantifying potential losses, is also essential in facilitating the transfer of risks to re-insurance markets. Scenario-based or fully probabilistic flood catastrophe models, developed in part at the instigation of the re-insurance sector, form the basis of underwriting flood insurance coverage worldwide.<sup>86</sup> Such models can assess both flood risks and potential flood damages. Notably, risk-based pricing provides incentives for insurers to offer coverage. It is also an effective mechanism to incentivize risk reduction as it signals the extent of risk exposures to potential clients. In fact, in the absence of a flood insurance market and risk-based pricing, real estate prices tend to ignore flood risks, raising the risks of maladaptation, in which businesses take actions that increase their exposures and vulnerabilities to risks.

**The marked data gaps in Malaysia pose challenges for the insurance sector.** Classical indemnity insurance requires robust data for the insurer to assess flood risks. As discussed in Chapter 4, the lack of data of sufficient quality limits the adoption of accurate probabilistic models for flood risks in Malaysia by ITOs, which are necessary for risk-based pricing. The de facto tariff-based pricing prevalent in Malaysia and the relatively shallow markets arguably lead to limits or exclusion of coverage for riskier segments. International experience indicates that Malaysia may be trapped in a vicious cycle. OECD (2016) notes that the availability of risk maps suitable for underwriting flood insurance coverage is often driven by demand from the insurance sector needing data for mapping and modeling flood risks. This was the case in the United States and Canada, where the development of flood risk models was led by re-insurance brokers and catastrophe modeling businesses along with the deepening of the private insurance market.

84 See, for example, Melecky and Raddatz (2011), Von Peter et al. (2012), OECD (2018), Cambridge Centre for Risk Studies and AXA XL (2020), and Fache Rousová et al. (2021).

85 For example, Kousky and Shabman (2015) provide evidence that this is the case in Germany, Austria, and Switzerland.

86 Catastrophic risk models use information on the probability of events of varying magnitudes, the location, structural characteristics, and vulnerabilities of assets-at-risk, and the level of insurance coverage of those assets to provide ITOs with estimates of their exposure to different types of disaster events.

## 5.2.2 Lack of Risk Randomness and Limits to Risk Diversification

**Flood risks tend not to be random.** The expected losses for the insurance sector depend on the frequency of damaging events and the extent of possible damages. Hazards, exposures, and losses associated with floods in Malaysia are location specific. Businesses located near river basins are prone to more frequent flooding during monsoons, or businesses located in coastal floodplains are generally affected more frequently than businesses located at a distance from (or elevation above) watercourses. Frequent flooding of high-risk areas and extensive potential damages related to each flood event means that risk-based premiums can become very high for high-risk properties. For example, the actuarially-sound premium for properties prone to severe flooding (e.g., more frequently than 1-in-50-year probability of return event) is estimated to exceed 1 percent of the property's value. Precisely because flood risks are not random—that is, significant losses occur simultaneously and in geographically clustered areas—IOTs face concentrated and correlated risks. When insurance covers a small client base or a client base displays some degree of interconnectedness or correlated risks, insurance companies are not able to diversify their risks and tend to charge higher premiums and limit their overall risk exposure by excluding high-risk clients.<sup>87</sup> These two factors imply that high-risk properties could be *effectively* priced out or excluded from private insurance markets.<sup>88</sup> In Malaysia, the survey evidence presented in Chapter 4 suggests that this is indeed the case, with a set of high-risk businesses being unable to obtain coverage.

**Marked informational inefficiencies related to flood risks result in adverse selection in indemnity insurance.** Adverse selection refers to the fact that if the price

of insurance cannot be fully adjusted to the level of risk that clients face—either because the information is unavailable or too costly to collect or because of price controls—then those clients facing more risk are more likely to demand more insurance, posing risks to the sustainability of the insurance market. In other words, those purchasing insurance tend to be precisely those facing higher risks. When the insurance market is voluntary, as in the case of Malaysia, the difficulty in attracting low-risk clients into the pool of clients for flood insurance constrain risk diversification, often leading to higher premiums and the exclusion of high-risk businesses. As discussed in Chapter 4, while currently not a binding constraint, IOTs and re-insurance companies view adverse selection as a potential risk if/when the private flood insurance market were to expand in Malaysia.

**Although moral hazard tends to be a concern for indemnity insurance markets, the business-level survey evidence suggests that this is not currently the case in Malaysia.** Moral hazard exists if there is no reward for risk mitigation behavior built into insurance products. In this case, policyholders tend to rely on insurance alone to offset their financial risks; thus, choosing to do less ex-ante to reduce their vulnerabilities to flood risks, which can lead to potentially higher exposures and losses. The adoption of risk-based pricing could reduce the risk of moral hazard. The survey evidence presented in Chapter 3 indicates that moral hazard does not seem to be a current source of concern for businesses in Malaysia, as there is a positive correlation between flood insurance uptake and the adoption of preparedness plans.

<sup>87</sup> See, for example, Schwarze and Wagner (2007).

<sup>88</sup> According to the OECD (2016), flood-prone areas, particularly outside major urban areas in developed countries, are generally not protected for events beyond a 1-in-100-year return period, which is viewed as a relatively high level of frequency for an insurance loss.

## 5.3 Public Sector Policy Support to Enhance the Role of Financial Markets

**Overall, a range of market failures, frictions, and inefficiencies justify policy interventions to strengthen private sector resilience by supporting the financing of flood risk adaptation and resilience efforts.** Managing climate and environment-related risks in the financial system is a key priority for Malaysia. As described in BNM's Financial Sector Blueprint 2022-2026, one of the five strategic thrusts is to position the financial system to facilitate an orderly transition to a more sustainable and resilient economy. The challenges discussed in this report relating primarily to the development of financial markets for the management of flood risks reaffirm the relevance of continued public sector support and involvement. Specifically, policy makers should support the development of private adaptation and emergency finance and the insurance market into more mature, efficient, and mainstream markets that can support a more resilient economy. The challenges vary depending on whether businesses seek financing or insurance products to reduce their vulnerabilities and enhance their financial resilience. Tackling these challenges will require a deliberate and holistic approach to catalyze private capital while incentivizing businesses to manage flood risks through a range of complementary interventions. Implementation will depend on dedicated involvement and coordination among policy makers, regulators, the financial sector, and the private sector.

### RECOMMENDATION 1

#### **Enhancing Flood Risk Data Availability, Accessibility, and Affordability**

**Governments are critical in building the appropriate climate information infrastructure for flood risks to mobilize private investment in adaptation activities.** Flood risk maps are an invaluable tool, providing information in support of climate change adaptation and resilience decisions. This information is crucial for the financial sector, enabling risk modeling, pricing,

and an accurate assessment of risk exposures, while supporting the needed financing for investments to mitigate risks and minimize losses. For similar reasons, this information is also beneficial for the public sector and the private sector. Because of significant positive externalities associated with sharing credible and timely climate-related information, governments are usually the leading providers of this information.

**Timely and accurate information is also critical for emergency responses.** In many high-income countries, the impact of extreme weather events is often mitigated by their ability to take early action based on meteorological and hydrological warnings. A review of the experience of high-income countries reveals that many have invested in their publicly financed National Meteorological and Hydrological Services, encouraged the development of complementary private services, and invested heavily in research and development. However, the provision of meteorological and hydrological services is complex, and often too much an emphasis is placed on buying observation equipment and not enough on the delivery of services to enhance awareness and foster action.<sup>89</sup> Box 5.2 provides examples of the broader economic benefits of more accurate and timely information.

**Policy makers in Malaysia must ensure that the information needed to manage flood risks for both the private sector and the financial sector is available and widely accessible.**<sup>90</sup> Investments are also needed to improve the quality of information on flood hazards. For instance, as highlighted in Chapter 4, improvements are needed to expand the data coverage to flash floods and ensure timely and up-to-date information reflecting evolving flood risks. Flood maps should also provide information with the necessary spatial granularity—that is, more granular than postal code level—for adequate flood risk assessments by the financial sector. Flood maps should incorporate climate model projections, such as those published by the IPCC reports, to explicitly recognize and signal that a changing climate

89 See, for example, World Bank (2019) for detailed guidance on how to improve meteorological and hydrological services.

90 For example, in a wide range of countries worldwide, governments usually prepare and publish flood hazard maps. See, for example, OECD (2022).



will impact flood risks. The Government of Malaysia also needs to improve access to flood-related data. In this regard, when deciding how to communicate flood risk information to the public, the government must ensure they communicate the considerable uncertainty around the future impact of climate change, and not only the *most likely* scenario. The Government could also consider using interactive platforms to disseminate the information and help increase awareness of flood risks.<sup>91</sup>

**While the Government of Malaysia should be the leading provider of meteorological and hydrological data, public-private arrangements could be developed.**

For example, public-private partnerships could complement and enhance national meteorological and hydrological services, enabling cost-sharing and revenue-generating activities, for instance, through sales of value-added information such as advisory services.<sup>92</sup> The Government could also leverage privately-owned infrastructure to enhance data collection efforts, use the private sector to support service delivery and monitoring systems, and explore collaboration related to ICT systems (including data services and cloud computing). In addition, while the government can develop and publish the risk models for floods needed by the financial sector, the private sector could also undertake this role if the necessary underlying data are available.<sup>93,94</sup> In this regard, there are lessons from the experience of MalaysiaRe, which had built and published its flood risk model in the early 2010s but was recently phased out due to high maintenance costs, inaccuracies in the flood risk maps, and lack of usage by the private sector. The case of MalaysiaRe illustrates the importance of the public sector. Even if the private sector leads efforts to model flood risks, the public sector still has a critical role in data provision with the needed scope and quality.

**An important factor limiting the Malaysian government's willingness to share information on flood risks relates to legal indemnity.** Generally, governments are concerned about potential liabilities emerging from their decisions to publish information or that they are not provided full protection for decisions made in good faith. However, countries worldwide have adopted several strategies to mitigate the legal liabilities associated with the dissemination of flood

risk data to support the development of a better data environment. Box 5.3 discusses some examples of how countries have managed the legal risks associated with the publication of flood risk maps and their impact on insurance provision. Global experience provides some lessons for Malaysia, as follows:

- *Establishing legal and regulatory frameworks to support the collection and dissemination of data*, clearly defining the roles and responsibilities of the various parties and agencies, outlining procedures for updating and disseminating the maps, establishing data qualifications and limitations, and the intended purpose of flood risk data. Some jurisdictions—such as Indonesia, the Netherlands, and the EU flood risk directive—have enacted legal frameworks to make it an obligation for local agencies and governments to collect, monitor, and disseminate flood data.
- *Involving the public while enhancing awareness* to mitigate privacy, property rights, and other legal risks arising from the misinterpretation or misuse of the maps while also creating awareness of the intended role of data. For example, the Australian Flood Risk Information Portal hosts flood risk maps, satellite observations, catalogued flood data, and scientific research. It adopts a crowdsourced approach where the public can contribute to the portal. In addition, countries have deployed robust communication and awareness strategies to effectively communicate the purposes and limitations of flood maps to the public, including providing clear information on the accuracy of the maps, their intended use, and the responsibilities of individuals and organizations in responding to flood risks.
- *Enabling a “challenge process”* to enhance the quality of flood maps and enable corrections. In the United Kingdom and the United States, the public may challenge the information on flood maps by providing relevant evidence to the relevant authorities.
- *Grandfathering of rules with the release of maps*. For instance, in the case of Belgium, constraints to financial product offerings are limited to new constructions after the publication of flood maps.

91 In Indonesia, STRADAA's dashboard displays the exposures and vulnerabilities to floods at the village level and clusters similar villages into “vulnerability profiles.” It also includes information on the extent of adaptation measures in place. The EU also publishes flood risk maps with information on areas with significant exposure to flood risks, along with links to primary information on hazards, exposures, management plans, and adaptation strategies.

92 See, for example, World Bank (2019).

93 For instance, since the 2011 floods in Thailand, several initiatives have been launched to remediate the lack of reliable data/ information on flood risks, including a risk modeling service by Impact Forecasting, a risk mapper for insurers by Munich Re, and a database of industrial parks with associated maps by Guy Carpenter.

94 There are some complexities surrounding the relationships between the public sector and the private sector that fundamentally influence the provision of hydrological and meteorological information and services. Rogers et al. (2021) highlight the importance of legal frameworks, open data policies, and regulation to maximize the benefits of weather enterprise and expand public sector-private sector engagement.

## BOX 5.2

## The Value of Hydro-Meteorological Data and Early Warning Systems<sup>a</sup>

**As highlighted in Chapter 3, businesses mentioned the need for improvements in Malaysia's early warning systems.** For instance, businesses noted the lack of timely forecasts and the limited lead time in early warning systems during past floods events.

**Hydro-meteorological information allows for better early warning systems.** Weather forecasts enable the anticipation of, and preparation for, climate-related events like floods, with benefits in terms of protecting people, businesses, and assets (prevention) and emergency preparation. Early warnings enable businesses to move vehicles and other movable assets out of flood zones. They also enable the implementation of other mitigation measures (e.g., sandbagging). Machines, equipment, and inventories can also be moved to avoid damage. Significant savings are possible in the transport sector by moving transport equipment, including trains and buses, out of dangerous areas. In other words, early warning systems enable preparation, which can reduce physical damages and economic losses.

**The more lead time early warning systems give and the greater the population's trust, the more effective they are, and the greater the benefits.** This warning timing is critical. The more time businesses have to prepare themselves ahead of flooding, the more they can do to minimize their losses. Accurate and timely forecasts also allow the preparation of emergency services before an event occurs. During the few hours before an intense weather event, much can be done to increase the efficiency of emergency services. Forecasting floods, however, is particularly complex, and building trust is difficult. If it were possible to predict flash floods with a high degree of accuracy, including their location, it would be possible to evacuate the at-risk areas, and reduce losses significantly without expensive investments in flood protection. But the decision to evacuate cannot be made if the probability of false alarm is too high or the warning area is too large. With every false alarm, the trust in the early warning system diminishes. This problem was illustrated in New Orleans, which had been previously unnecessarily evacuated twice (for Hurricane George in 1998 and Ivan in 2004),

making it more difficult to convince inhabitants to leave before Hurricane Katrina, which resulted in devastating losses in the area. If the risk of false alarms becomes low enough to create and maintain trust and allow for significant prevention measures before disasters, a limited improvement in forecast accuracy can lead to a significant increase in economic and financial benefits. Communication is essential to raise awareness about the limitations of forecasts.

**Improvements in weather forecasting could also lead to broader economic benefits.** In agriculture, weather forecasts are used for planning purposes, such as guiding decisions on fertilizer application or crop timing. A few studies assessed the productivity gains from weather forecasts. For instance, Wills and Wolfe (1998) investigated the use of forecasts to optimize lettuce production in the state of New York, and they found a 10 percent increase in productivity from more accurate forecasts. In the energy sector, weather forecasts can be used to anticipate electricity demand, allowing more efficient management of energy production to maximize the use of lower-cost but slowly-adjusting production units. Roulston et al. (2003) estimated the value of weather information to optimize wind power production; they found a doubling in profits thanks to one and two-day forecasts. In the tourism sector, weather is a predictor of future activities and helpful in resource planning, like anticipating the number of visitors to a tourist site, hotel occupancy rates, or the number of restaurant customers.

**Long historical data series are helpful to infrastructure design and urban planning while enabling the monitoring of the environment over the long term.** Measures can be taken to prevent the private sector from taking on new risks, such as improving building and construction codes that promote growth into low-hazard areas. In many countries, new constructions are tightly regulated, or even prohibited, in flood-prone areas. Without accurate historical data, identifying such zones can be challenging, and curtails the adoption of such preventive measures. Accurate historical data also enable the identification of long-term trends that can help guide the design of adaptation efforts.

<sup>a</sup> Source: Hallegatte (2012).

## BOX 5.3

# Managing the Legal Risks of the Publication of Flood Maps around the World

**The publication of flood maps involves certain legal risks.** Among chief risks are concerns about: (i) liability, in case the maps contain inaccuracies; (ii) privacy, in case maps reveal sensitive information about individuals and their properties; (iii) intellectual property rights, in case maps are created based on proprietary or copyrighted materials and are published without proper authorization; and (iv) misinterpretation, in case of actions solely based on maps that lead to subsequent losses.

**Below are some examples of how countries have managed the legal risks of disseminating flood-related data.** It is important to note that while these examples can provide relevant insights into the challenges of publishing flood-related data in Malaysia, specific approaches have varied depending on each country's legal system and their unique circumstances.

- *United States:* the Federal Emergency Management Agency (FEMA) provides flood risk maps through its National Flood Insurance Program, which has established regulations and guidelines for floodplain management and flood risk mapping. These maps are used to determine flood insurance requirements and are publicly accessible. However, FEMA provides disclaimers stating that the maps are not perfect and may not account for all possible flood risks. In addition, in the case of inaccuracies, such as the erroneous inclusion of a location into a high-flood risk area, landowners may file a "flood map challenge" to have their land re-classified by demonstrating that their land is not subject to flooding.<sup>95</sup>
- *United Kingdom:* the relevant environment agencies provide flood risk maps identifying areas at risk. The agencies acknowledge that the maps are imperfect and should be used with local

knowledge and expert advice. They also encourage the public to report back on discrepancies, providing relevant data or methodologies if they would like to change or review information on flood risk maps.<sup>96</sup> Some agencies even provide a detailed checklist of the steps required to challenge the information on flood maps.<sup>97</sup>

- *Australia:* the Australian Government, through Geoscience Australia, maintains the Australian Flood Risk Information Portal (AFRIP)<sup>98</sup> which hosts flood risk maps, satellite observations, and a wealth of catalogued flood data compiled from various sources, including local, state, and territory governments. The AFRIP also adopts a crowdsourced approach, where the public may contribute to the portal. They emphasize that while the information is based on the best available data, it may not account for all possible flood risk scenarios, and users should exercise caution and seek additional advice when making decisions based on the maps.
- *Germany:* The government provides guidance on how to interpret and use the maps responsibly. As an awareness tool, EU-level flood risk maps are published in a centralized platform alongside flood management plans.<sup>99</sup>
- *Netherlands:* Risicokaart.nl publishes street-level flood hazard maps, intended as a public awareness tool to inform citizens about their living environment and support crisis preparedness planning for the public sector authorities. Under local legislation, provincial authorities are obliged to produce and manage publicly accessible risk maps<sup>100</sup> compliant with the associated provincial risk map regulations.<sup>101</sup>

<sup>95</sup> See, for example, Kusler, J. (2016).

<sup>96</sup> See <https://www.sepa.org.uk/flood-map-help-pages/help/>.

<sup>97</sup> See <https://naturalresources.wales/flooding/challenging-our-flood-maps/?lang=en>.

<sup>98</sup> For more information on AFRIP, see <https://www.community-safety.ga.gov.au/data-and-products/afrip>.

<sup>99</sup> EU's flood risk map is available at <https://discomap.eea.europa.eu/floodsviewer/>.

<sup>100</sup> For further information on Risicokaart, see <https://www.risicokaart.nl/aanleiding>.

<sup>101</sup> For further information on provincial risk map regulations in the Netherlands, see <https://www.risicokaart.nl/algemene-informatie/regeling-provinciale-risicokaart>.

- *Bangladesh*: The government has invested in flood risk mapping and early warning systems. These maps are used to identify vulnerable areas and plan evacuation strategies. Legal frameworks have been established to support the dissemination of this information.
- *Vietnam*: The government has developed flood risk maps, which are used for disaster preparedness and planning. Legal frameworks exist to ensure the responsible use of this information.
- *India*: The government has established agencies like the Central Water Commission (CWC) and the India Meteorological Department (IMD) that provide flood forecasting, early warning services, and flood risk maps. Legal provisions are in place to govern the dissemination of this information.
- *Indonesia*: The government has developed a two-stage process for publishing flood risk maps identifying vulnerable areas. First, local agencies are responsible for preparing and publishing maps of disaster-prone areas. Second, after disseminating maps to government bodies, it becomes the responsibility of the Indonesian government to revoke or reduce property rights in such areas and provide compensation to property holders under the legislation.<sup>102</sup> Indonesia's "Law Concerning Meteorology, Climatology and Geophysics" further obliges the government to enhance awareness and participation of people in climate change adaptation activities by fostering data collection, analysis, and monitoring of climate change and public dissemination of information.
- *Japan*: The Japanese government, through agencies like the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), provides flood risk maps and early warnings. The Japan Meteorological Agency publishes "Real-time Risk Maps"<sup>103</sup> showing the levels of risk of inundation, floods, and landslides three hours in advance of an event.<sup>104</sup> Legal frameworks are in place to regulate the use and dissemination of this information.
- *Singapore*: The Public Utilities Board (PUB) of Singapore provides flood risk information and early warnings. Information covering over 300 water level sensors around Singapore's canals and drains alongside images from a network of 48 CCTVs (updated every five minutes) are published on an interactive map on the PUB's website.<sup>105</sup> The public may also subscribe to the PUB's SMS alert system for timely updates on potential flash floods. Legal provisions guide the responsible use of this information.

**After publishing flood risk maps, several countries have adopted measures to encourage investments in adaptation and mitigate moral hazard concerns associated with specific public sector supported insurance schemes.** Here are some examples:

- *United States*: In some flood-prone regions, private insurance companies may refuse coverage or charge higher premiums for properties located in high-risk zones. FEMA designates Special Flood Hazard Areas based on flood risk assessments, and properties in these areas may face challenges obtaining flood insurance coverage.
- *Belgium*: Insurers may not extend coverage to high-risk properties built after the completion of risk maps.
- *Australia*: In flood-prone regions, insurance companies may impose exclusions or limitations on coverage for properties located in high-risk areas.
- *India*: In flood-prone areas, insurance companies may refuse coverage or charge higher premiums for properties located in high-risk zones.
- *United Kingdom*: Flood risk maps help determine the insurance category and class for land areas, considering the probability of floods and potential losses. Insurance companies use this information to assess the risk and provide coverage.

102 See Mehryar and Surminski (2020).

103 See [https://www.jma.go.jp/bosai/en\\_risk/#zoom:5/lat:33.998027/lon:135.000000/colordepth:normal/elements](https://www.jma.go.jp/bosai/en_risk/#zoom:5/lat:33.998027/lon:135.000000/colordepth:normal/elements).

104 See [https://www.gov-online.go.jp/eng/publicity/book/hlj/html/201803/201803\\_03\\_en.html](https://www.gov-online.go.jp/eng/publicity/book/hlj/html/201803/201803_03_en.html).

105 See <https://app.pub.gov.sg/waterlevel/pages/WaterLevelSensors.aspx>.



## RECOMMENDATION 2

**Developing a Long-Term Flood Risk Adaptation Strategy**

**Governments can play a crucial role in reducing businesses' uncertainty by informing the public about the extent of flood risk protection, which is (or will be) the public sector's responsibility.**<sup>106</sup> In doing so, governments can improve the decision-making processes of a broad spectrum of stakeholders. As discussed earlier in this chapter, governments are the primary providers of large-scale risk mitigation infrastructure. They are also responsible for ensuring that infrastructure and service delivery are resilient to flood risks, among other responsibilities. Private sector actions should build on and complement those of the public sector. But without a clear definition of responsibilities of the public sector and lack of transparency (or high uncertainty) about policy priorities, as is the case in Malaysia, private efforts can be haphazard and may not necessarily address the critical needs of the private sector and the country more broadly. Therefore, policy makers should signal and commit to the direction of future policies to the largest extent possible, to enhance transparency and provide crucial information for the private sector and financiers alike.

**In many countries, governments establish legal responsibilities and liabilities and communicate these to all relevant stakeholders.**<sup>107</sup> In the Netherlands, the level of flood protection the government must provide to the population is legally defined. The government is responsible for flood risk protection, but only up to a prescribed level. It publishes maps outlining residual flooding risks despite the public flood defenses. These maps help all private actors decide where to buy a house or build a factory, the construction standards they should implement, and the levels of financial preparedness they will need. When private businesses provide public services—such as electricity supply—regulation is used to define risk management responsibilities, including the disaster risks associated with flooding, in a way that aligns private actors' incentives with public interest. Allocating responsibilities may require significant institutional and legal reforms. In addition, there could be effects on the development of financial markets. For example, improved zoning, land use, and building standards can reduce economic losses and as a result, insurance claims more generally, which could allow

insurers to increase coverage in more vulnerable areas that need it the most while maintaining affordability.

**One important foundational step for policy makers in Malaysia is the articulation of a national adaptation strategy with a prioritized action plan.** Developing clear adaptation goals toward flood risks would allow the country to leverage actions taken by different ministries and agencies of government and across the national and sub-national levels of government. Importantly, the proposed national adaptation strategy should be closely aligned with the country's infrastructure development plans. To ensure effective implementation of policy priorities, policy makers could consider embedding climate risk assessments in public capital investments and infrastructure planning processes.

**In addition, national and sub-national policy makers could issue complementary detailed adaptation investment plans, outlining portfolios of high-priority projects, to support the achievement of the national adaptation goals.** Prioritization would allow policy makers to identify a subset of interventions most likely to deliver significant net benefits, especially those that prevent irreversible impacts (such as “building right” to prevent sizable retrofit costs a few decades later). Providing more information about specific public sector investments would facilitate the identification of residual risks associated with floods for the private sector and of the complementary needed adaptation and resilience efforts to mitigate vulnerabilities to flood risks. Doing so would also facilitate the alignment of financial sector policies, regulations, and especially the adoption of incentives and targeted approaches consistent with national adaptation goals. Global experiences indicate that the ministry of finance usually plays a central role in setting up a multi-sector, multi-stakeholder, iterative process to translate needs and opportunities identified at the local level into a national list of priority investments.<sup>108</sup> Robust governance principles should underlie these processes to ensure transparency and accountability in public sector policies.

**An integrated, whole-of-government approach, with strong cooperation among different ministries and agencies, is also essential to reduce uncertainty about long-term government policies and foster coordinated action.**<sup>109</sup> The national adaptation strategy could outline such an approach. The public sector in Malaysia is actively involved in the management of flood risks, including

106 See, for example, Fatas and Fuhrer (2004), Bloom and Van Reenen (2009), and Hendrickson (2017).

107 For more details, see Hallegatte et al. (2020).

108 See, for example, World Bank (2021).

109 See, for example, Bloom and Van Reenen (2009) and Hendrickson (2017).

through investments in ex-ante risk reduction, ex-post emergency response, reconstruction efforts, and the provision of emergency financial assistance. But there is a need for a more integrated approach, with effective coordination of all these different levers of policy action across the various layers of government. Such a holistic approach is crucial for coherent and robust policy making and also to address coordination failures that may hinder effective action and outcomes. It could also minimize governance failures associated with poorly designed regulations and ineffective or inefficient institutions. Developing a coordinated approach may require adjustments in institutional and legal frameworks, including adjusting the mandate of ministries, agencies, or institutions, creating new agencies when needed, or even establishing an overarching coordinating body.<sup>110</sup>

**Furthermore, policy makers could foster partnerships between the public sector and the private sector.**

Partnerships could enable increased financial capacity as public sector resources are scarce. They could also facilitate risk sharing and transfer mechanisms through risk pooling or other financial instruments that help distribute the financial burden of disasters more equitably. Moreover, partnerships can facilitate the coordination of public sector and private sector efforts to reduce hazards, exposures, and vulnerabilities to flood risks while ensuring a holistic approach to risk assessment, financing, and risk reduction to promote efficiency and maximize the impact of public sector interventions.

**The government could reduce uncertainty related to post-flood emergency and recovery by setting out its strategic priorities for financing disaster response; for instance, through a disaster risk finance (DRF) framework.** The adoption of a DRF is a critical component of a comprehensive approach to disaster risk management that complements risk reduction and preparedness. Such a framework would outline comprehensive financial protection strategies to manage costs associated with disasters like floods, aimed at limiting their impact on public sector finances. For example, the DRF could highlight the segments of society whose support the government would prioritize during future shocks, the current (and potentially new) financing instruments upon which it intends to draw to support vulnerable segments, and the delivery mechanisms through which it intends to disburse funds. Strengthening the financial resilience of the government can be particularly important when there is an expectation that the state will act as the insurer or

relief provider of last resort, as is the case in Malaysia. Currently, flood-related disaster costs are funded from fiscal budgets (federal and sub-national) allocated every year, and Malaysia's Ministry of Finance can make additional funds available ex-post in case of significant damages. While historical costs of disasters have not been very large, as discussed in Chapter 2, they are expected to rise due to the increased frequency of floods.

**The government should consider the adoption of a risk-layered approach.** Risk layering to improve financial resilience against disasters involves diversifying and stacking multiple layers of risk management tools and strategies to mitigate the financial impact of disasters. This approach ensures that cheaper sources of funds are used first and that more expensive instruments are used only for extreme events. The specific combination and design of risk layers depend on factors such as the nature and frequency of risks and the overall risk management strategy. The first layer typically comprises risk retention financial instruments. One relevant financial instrument for Malaysia is contingent financing, which can be useful for both the public sector and the private sector. At the national level, such instrument can provide immediate liquidity following a natural disaster and can be particularly useful for emergency assistance. For example, a catastrophe-deferred drawdown option (Cat DDO) is a pre-approved contingent credit line that can disburse quickly once disaster strikes. Cat DDOs have strengthened DRF frameworks in more than 20 countries globally. Cat DDOs can also spur the adoption of additional financial instruments. For example, as part of its Cat DDO, the Government of Madagascar committed to the development of a sovereign insurance solution against the risks associated with tropical cyclones. The other layers typically involve risk transfer financial instruments, such as insurance and insurance-linked securities (such as catastrophe bonds). The adoption of these solutions for flood risks in Malaysia is discussed below.

### RECOMMENDATION 3

#### **Strengthening the Enabling Environment for the Financial Sector**

**Strengthening the financial sector's capacity to manage flood risks is vital to enhance accountability, ensure adequate risk management and financial stability, and foster financing toward adaptation**

<sup>110</sup> See, for example, Hallegatte et al. (2020).

**and resilience. Harnessing investment opportunities should go closely together with risk management.**

The financial sector can only mobilize finance to adaptation and resilience if financial institutions can effectively manage flood risks in their portfolios. Since the perceived level of risk directly impacts on investment decisions, managing such risks can directly impact financial behavior and support capital toward flood risk adaptation and resilience. Also, adequate flood risk management is important to preserving financial stability, especially if financial institutions are to play a more significant role in funding climate adaptation.

**Prudential regulators' mandates to create an enabling environment for the financial sector include the design of a robust climate information architecture.**

Taxonomies and climate-related disclosure standards are essential elements in this regard for both private capital mobilization and risk management. Taxonomies focus on setting standards that enable businesses, lenders, investors, and other stakeholders to identify systematically, consistently, and transparently flood-resilient investments, assets, and entities, to facilitate the flow of financing toward them. Disclosure standards also support financial institution's decision-making processes by improving the information flow. They provide investors, lenders, and insurance underwriters with the necessary information to assess and price flood risks, thereby supporting risk management. Disclosure requirements allow businesses to monitor impact and outcomes better, and course correct when needed. However, the financing of adaptation investments is marked by distinct challenges, such as the lack of clear, standardized metrics for assessing adaptation results and outcomes.<sup>111</sup>

**Malaysian financial sector regulators have developed a comprehensive strategy to prepare the Malaysian financial system to be more sustainable and climate resilient, with emphasis on the development of the informational enabling environment.** Bank Negara Malaysia and Securities Commission Malaysia have taken

a phased approach in establishing the building blocks for a strong foundation in climate risk management for the financial sector, working collaboratively with industry participants through the Joint Committee on Climate Change (or JC3).<sup>112,113,114</sup> Bank Negara Malaysia introduced climate-related risk considerations into regulatory and supervisory expectations as well as into macroeconomic and financial stability assessments in 2021. Specifically, Bank Negara Malaysia issued in April 2021 its Climate Change and Principle-based Taxonomy (CCPT) to facilitate the assessment of climate-related risks and encourage financial flows towards environmentally sustainable economic activities. Several use cases have been published since then and an updated implementation guidance, including a standardized due diligence questionnaire for mandatory adoption by financial institutions, was published in January 2024 to facilitate financial institutions' effective implementation of the CCPT.<sup>115,116</sup> Securities Commission Malaysia issued its principles-based Sustainable and Responsible Investment Taxonomy for the Malaysian Capital Market (the "SRI Taxonomy") in December 2022, outlining the guiding principles for the identification and classification of sustainable economic activities.<sup>117</sup> In June 2022, the JC3 published the Task Force on Climate-related Financial Disclosures (TCFD) Application Guide for Malaysian Financial Institutions, which outlines key recommendations and provides practical resources to facilitate the adoption of TCFD Recommendations by the Malaysian financial industry. TCFD-aligned disclosures for licensed financial institutions will be mandatory for the financial year commencing in January 2024. To foster climate risk management, Bank Negara Malaysia also issued in June 2022 a discussion paper for the upcoming 2024 Climate Risk Stress Testing Exercise, followed by a policy document on Climate Risk Management and Scenario Analysis, and in February 2024, a climate risk stress testing methodology paper.<sup>118</sup> These documents set out the principles and requirements on climate risk management and scenario analysis for financial

111 Outcomes on risk reduction from climate adaptation investments are typically expressed in specific ways to the respective sector or context of these investments (e.g., agricultural yields, health benefits, or reduced water stress). This highlights that "adaptation has no common reference metrics in the same way that tonnes of GHGs or radiative forcing values are for mitigation" (IPCC, 2014).

112 In April 2019, BNM pledged to undertake the six recommendations published in the "NGFS First Comprehensive Report on A Call for Action: Climate Change as a Source of Financial Risk." See <https://www.bnm.gov.my/climatechange/bnm-pledge-ngfs-glasgow-declaration>. In January 2022, BNM outlined "finance for sustainability" as one of the three broad themes in its Financial Sector Blueprint 2022-2026, setting a target of more than 50 percent of new financing for green and transitioning activities.

113 The SC articulated its commitment to developing the SRI ecosystem in Malaysia in its 2019 Sustainable and Responsible Investment Roadmap for the Malaysian Capital Market (SRI Roadmap). See <https://www.sc.com.my/upload/sri-roadmap-2019/book/sri-roadmap-2019.pdf>.

114 See <https://www.jc3malaysia.com/about-jc3>.

115 See for example the sectoral guides under the Value-based Intermediation Financing and Investment Impact Assessment Framework (VBIAF). See <https://www.bnm.gov.my/-/value-based-intermediation-financing-and-investment-impact-assessment-framework-guidance-document>.

116 The JC3 updated several documents for the implementation of CCPT classification by financial institutions. See <https://www.bnm.gov.my/-/jc3-sc1-ccpt-docs>.

117 See <https://www.sc.com.my/resources/media/media-release/sc-unveils-principles-based-sustainable-and-responsible-investment-taxonomy-for-the-malaysian-capital-market>.

118 See <https://www.bnm.gov.my/-/climate-risk-stress-testing>.

institutions.<sup>119</sup> Meanwhile, the Securities Commission Malaysia launched in December 2023 a voluntary Sustainable and Responsible Investment Guide for Private Markets, outlining guidance on sustainability considerations for investment and due diligence processes.<sup>120</sup> In addition, the JC3 has worked to bridge critical data needs to support the management of climate- and environment-related risks within the financial sector, for example through the issuance of its Climate Data Catalogue to serve as a reference by the financial sector.<sup>121</sup> The Securities Commission Malaysia, through its affiliate Capital Markets Malaysia, issued in October 2023 the Simplified ESG Disclosure Guide for SMEs, aimed at guiding the development of a standardized national dataset of SME ESG disclosures aligned with international standards.<sup>122</sup>

**Thus far, supporting enabling environment for the financial sector regarding adaptation investments has lagged behind that for mitigation investments in Malaysia and globally.** Policies, such as those described above, have predominantly highlighted climate mitigation efforts rather than adaptation to enhance resilience. Globally, existing standards have focused primarily on climate change mitigation efforts rather than adaptation, with an emphasis on managing GHG emissions. For example, existing taxonomies tend to focus on defining sectors and activities that can be classified as “green” to make them more attractive to lenders and investors. As noted above, many taxonomies do not explicitly reference how financing can support climate change adaptation or resilience in the face of climate shocks. Similar observations can be made in the case of disclosure and reporting requirements. For example, while the TCFD recognizes the importance of reporting on physical risks associated with climate change, it places greater emphasis on the disclosure of financial risks and opportunities related to the transition to a low-carbon economy. Similar trends are observed in Malaysia. Overall, this is a fast-evolving area, and global standard-setting bodies are increasingly recognizing the need for more extensive adaptation efforts. Yet, the evidence remains limited on whether such efforts have translated into adaptation investments at scale.

**Accounting for the impact of flood risks on the safety and soundness of financial institutions is an integral component of prudential supervision.**<sup>123</sup> Flood risks manifest themselves in the form of credit, operational, and liquidity risks, threatening the profitability and solvency of banks and the overall stability of the financial system. Hence, they belong to the core mandate of supervisory authorities. Among the regulatory measures at the disposal of prudential authorities are flood risk assessments, which, depending on capacity and data availability, could range from empirical analysis of risk exposures to model-driven stress testing. They can provide a fact base for dialogue between the various stakeholders. Insights into these risks can help (macro- and micro-) prudential supervisors focus on the most relevant risks. It also supports the improvement of flood risk management practices among financial institutions.

**Although heatedly debated in policy and academic circles and not widely used across countries, prudential policies could also be used to stimulate adaptation financing.** One example is through differentiated capital requirements.<sup>124</sup> Capital adequacy frameworks could be updated to account for climate change, and capital adequacy parameters may be linked to investments in flood risk mitigation and adaptation, freeing up capital to be invested in risk reduction projects.<sup>125</sup> Supervisory authorities can also set quantitative targets, for example, the share of a bank’s portfolio that must target vulnerable segments—for example, Bangladesh has adopted analogous policies targeting green sectors.

**Also widely debated is the use of monetary policy tools, such as collateral policies, to foster financial flows to adaptation.** Specifically, central banks can adjust their collateral frameworks and give favorable status to green bonds and securities linked to adaptation finance. Central banks could also purchase sovereign or private-sector debt instruments linked to adaptation or emergency financing. Such measures would increase the demand for such instruments, thus lowering the financing costs for such projects.

119 See [https://www.bnm.gov.my/-/dp\\_2024\\_crst](https://www.bnm.gov.my/-/dp_2024_crst) and <https://www.bnm.gov.my/-/pd-crmsa-2022>.

120 See <https://www.sc.com.my/api/documentms/download.ashx?id=f04c3b23-0aae-4024-94af-235b0b573e94>.

121 The Climate Data Catalogue identifies and maps available climate data sources to support the critical data needs for specific identified use cases, including investment and lending decisions, macroeconomic modelling, stress testing, scenario analysis and product development. See <https://www.jc3malaysia.com/data-catalogue>.

122 See <https://www.capitalmarketsmalaysia.com/wp-content/uploads/2023/07/Public-Consultation-Simplified-ESG-Disclosure-Guide-for-SMEs.pdf>.

123 SMEs account for the vast majority of businesses in Malaysia and are among the most vulnerable businesses to flood risks, as shown in Chapter 3. Because banks are an essential source of external financing for SMEs, their regulation remains a critical element of the enabling environment for adaptation financing.

124 See for example World Bank (2022).

125 The Hungarian National Bank has incorporated environmental issues proactively in its policy objectives, actions, and frameworks, including lowering the risk weights for green assets so banks can hold less regulatory capital against them. Such measures are relatively easy to implement.



**While efforts are needed to develop the enabling environment for the financial sector to foster financing toward investments in flood risk adaptation and resilience, policy makers should also pay close attention to unintended consequences.** Although the empirical evidence remains limited, policy makers should carefully monitor the implementation of new frameworks—such as, stress testing, disclosure requirements, prudential requirements, and supervisory tools accounting for physical risks like floods—to avoid and mitigate potential unintended consequences. A key concern is that once banks monitor flood risks more closely, they may reallocate their loans away from clients in high-risk areas. As recent World Bank research has shown, even proportional implementation of policies can have unintended implications for such high-risk clients.<sup>126</sup> SMEs tend to face marked financial constraints, which can become even more acute. To the extent that SMEs may be highly vulnerable to such risks, they may face more significant barriers to access to finance if banks need to comply with climate risk-related regulatory policies.

**It is also important to consider the operational feasibility of these new policy levers, given concerns raised by financial institutions about their capabilities and the prevailing deficiencies in the data environment.** The implementation and operationalization of policies are highly dependent on capabilities and data availability, which are a constraint in Malaysia. The financial sector regulators should assess the extent to which data gaps related to flood risks could compromise the adoption of specific tools discussed here. As data availability and capabilities develop over time, supervisors should periodically reassess their menu of feasible policy tools.

#### RECOMMENDATION 4

##### **Supporting Access to Finance for Adaptation and Recovery**

**Financial sector policies that support business financing should place greater emphasis on climate-resilient adaptation efforts, ensuring outreach to a broad set of businesses.** Flood risks impact a wide range of Malaysian businesses, exposing them to potentially extensive losses from extreme events. As discussed in Chapter 3, such risks are particularly acute for SMEs,

which tend to be more vulnerable, partly because of more constrained access to finance and lower capacity to develop and adopt resilience strategies that can help them avoid, absorb, and adapt to floods. Yet, vulnerabilities to flood risks depend, to a large extent, on businesses' geographical location and their risk management strategies. Effective support requires solutions to reflect geographic-specific challenges but with widespread outreach across businesses and specifically designed to support access to finance for the most vulnerable businesses with limited access to finance, such as SMEs.<sup>127</sup>

**Interventions to address constraints in access to finance for ex-post recovery efforts also require a widespread outreach.** Government support programs in Malaysia for flood-related losses largely leave out SMEs from their coverage. Given the limited access to private sources of emergency financing, there is a strong case for public sector support to enhance access to emergency financing to ensure business continuity and allow businesses, especially SMEs, to make the needed expenditures and investments for their recovery. Policy targeting is important in this context. When floods hit, there is some urgency in getting funds to businesses struggling with liquidity constraints that hinder their capacity to withstand the shock and minimize their losses. Unless a framework is already in place that enables governments to deliver financial support to affected businesses rapidly, targeting of emergency support will be challenging. At the speed with which decisions must be made, policy makers will face the tough decision of either setting simplified targets and disbursing quickly, but likely providing support to businesses that do not need it, or setting more strict targets (e.g., based on proof of flood damages) with greater outreach for businesses in need of support, but disbursing at a slower pace. Policy makers faced a similar trade-off in the aftermath of the COVID-19 pandemic.

**Effective policies supporting access to finance for ex-ante and ex-post financing related to flood risks require careful design and adoption of robust monitoring and evaluation (M&E) frameworks.** High-quality data on businesses' vulnerabilities to flood risks is vital in this regard, enabling the identification of vulnerable and affected businesses, thus reinforcing Recommendation 1 on closing data gaps. Robust and independent M&E frameworks are critical for accountability, transparency,

<sup>126</sup> For example, Miguel, Pedraza, and Ruiz-Ortega (2022) show that a micro-prudential policy in Brazil requiring banks to incorporate environmental risks into capital assessments induced large banks to reallocate their lending portfolio away from exposed sectors.

<sup>127</sup> While financing adaptation requires localized solutions, financing mitigation is more standardized. The response mechanisms to improve energy efficiency and adopt renewable energy sources tend to be similar across a wide range of country contexts.

and fine-tuning of interventions. Systematic monitoring and frequent evaluations of the impacts of support measures could inform an effective policy toolkit for the next crisis through positive feedback loops. For instance, M&E frameworks would not only reveal the impact of past support policies but also identify lessons that could form the basis of future revisions to the design and implementation of these programs. M&E frameworks would allow for evidence-based course correction of public sector support programs, which could be particularly helpful due to evolving flood risks in Malaysia.

**Externalities justify the use of concessional finance for flood risk adaptation investments.** The “public good” feature underlying some of the needed investments in adaptation justifies using public sector funds for concessional finance—that is, financing at more favorable terms when compared to commercial sources (for example, lower interest rates, longer maturities, and more favorable debt repayment schedules). Moreover, the challenges associated with the high upfront costs and long return periods could be addressed through concessionality. Such support should not aim at providing liquidity to financial institutions but rather at providing incentives to businesses (especially SMEs), fostering greater access to funding, thereby enhancing the business case for these investments.

**Concessional financing may also be used for ex-post recovery financing.** Access to market-based post-disaster financing can be particularly challenging, especially for SMEs that may have lost assets that formed the collateral basis for debt financing, and, as a result, their business viability may come into question. In addition, there are externalities in such support. Emergency financing may contribute to economic and financial stability by mitigating the adverse effects of natural disasters on businesses. In some cases, the government can go beyond concessionality in financing, e.g., through subsidized loans or emergency assistance in the form of grants (See Box 5.4). Once again, policy makers should be careful in the design of policies to avoid providing the private sector with disincentives for adaptation investments. Research has emphasized these risks, often referred to as maladaptation risks, in the context of government-supported insurance to flood risks (see more below). To mitigate such risks, emergency financing could be used alongside adaptation investments.

**However, policy makers should deploy concessional financing sparingly as it carries risks.** Concessionality

carries the risk of reducing the incentives for financial intermediaries or investors to commit their funding, depending on who bears credit risks. There are also risks that financial institutions are unable to compete with support programs, which can lead to crowding out effects. Governments should: (i) determine clear objectives to be achieved with the use of concessionality, with emphasis on private capital mobilization and market creation; (ii) assess the extent of potential market distortions, including crowding-out effects and changes in competitive dynamics; and (iii) deploy mechanisms to mitigate such risks. Such interventions should also embed an exit strategy and clear graduation targets for both businesses and financial institutions. To this end, at the instrument design stage, policy makers should assess how to ensure that concessionality expands the universe of businesses with access to finance for adaptation investments, and whether there may be additional policy actions needed to support the removal of concessional financing at a later stage, including actions strengthening the enabling environment.

**The higher risks of flood-related investments highlight the importance of risk-sharing support, for instance, through public credit guarantees (PCGs).**<sup>128</sup> This high riskiness, perceived and actual, of investments is explained not only by the high exposure of businesses to flood risks but also in part by the marked uncertainties about these risks, mismatched time horizons for investments (upfront costs alongside uncertain future payoffs), and inefficiencies in the informational environment. The main objective of de-risking interventions, such as PCGs, is to change the risk-return profile of investments for lenders, thereby fostering capital mobilization.<sup>129</sup> PCGs can be mobilized at scale to reduce the net losses financial institutions may incur if borrowers default, especially when such risks can materialize in clusters. PCGs can also be important in reducing information asymmetries through demonstration effects for financial institutions, helping financial intermediaries learn to engage in this segment.

**Furthermore, PCGs can be leveraged to provide emergency finance to viable businesses affected by floods.** For example, PCGs can incorporate “automatic” shock absorbers, for example, through disaster-related windows, that can support not only ex-post financing but also ex-ante access to finance by lowering the credit risks borne by financial intermediaries for potentially

<sup>128</sup> For more details on this recommendation, see World Bank (2022).

<sup>129</sup> Dalhuijsen et al. (2023) suggest that DFIs can play a role in reducing regulatory and policy risks. For instance, DFIs could act as a bridge between local governments and the market to address key concerns and uncertainties about the policy and regulatory environment for green investments and drive necessary reforms to improve the enabling environment, in addition to offering de-risking instruments such as political risk guarantee, first loss provisions, and loan loss reserves.

impacted businesses. In this context, PCGs would have to adopt robust M&E frameworks aligned with the goals of improved absorption of flood-related risks. Some EMDEs have started to explore PCGs to support adaptation activities, especially post-disaster financial support through disaster-triggered guarantee programs. For example, Morocco's Central Guarantee Fund and portfolio credit guarantee schemes in Burkina Faso and Rwanda provide a capital injection to the financing institutions that may experience liquidity constraints post-disaster, enabling banks to continue lending to MSMEs affected by climate shocks. However, such initiatives are still at a nascent stage of development.

**Policy makers can also leverage developmental financial institutions (DFIs) to play an important catalytic role in fostering change in the financial sector.**<sup>130</sup> In Malaysia, DFIs have the scale and the necessary tools to provide long-term funding and support riskier projects, and they could also catalyze private capital, all essential features appropriate to

financing flood adaptation investments. For instance, DFIs can support private capital mobilization by designing innovative financial instruments, acting as first movers, setting standards, and demonstration effects, among others. Moreover, DFIs can support capacity building efforts, for example, by providing technical assistance to businesses and lenders in managing flood risks. DFIs can also lead by example, for instance, by developing flood-related risk management frameworks and sharing the lessons from these practices with private financial institutions. Nonetheless, these are complex endeavors. Evidence from DFIs worldwide, which are leading players in climate finance in EMDEs, shows that DFIs strongly favor mitigation investments, with limited evidence that they have supported climate-resilient investments at scale (Dalhuijsen et al., 2023).<sup>131</sup> For instance, DFIs often focus on projects such as those promoting improved energy efficiency or the adoption of renewable energy sources. In fact, some DFIs provide financing exclusively for mitigation purposes.

<sup>130</sup> See, for example, Dalhuijsen et al. (2023) for a review of the lessons learned from greening DFIs.

<sup>131</sup> The bias toward mitigation investments is further evidenced in other studies, such as the International Development Finance Club (IDFC), which suggests that \$146 billion of the \$185 billion green finance provided by IDFC members in 2020 is dedicated to climate mitigation. See IDFC (2021). Similarly, CPI (2023) shows that about 90 percent of climate finance from public actors—largely comprised of DFIs—is dedicated to climate mitigation.

## BOX 5.4

# Emergency Relief

**Governments may consider the provision of post-disaster assistance for businesses.** Where flood damages are considered uninsurable, national governments may provide (partial) compensation for flood damages. Some countries provide grants to businesses affected by flooding to support business survival and, therefore, employment. When such assistance is provided, the costs of flooding shift away from the private sector to the public sector, at least in part, depending upon the extent of the assistance programs. This type of public sector support disincentivizes ex-ante adaptation investments or insurance uptake. Moreover, a lack of clarity on the level of financial assistance that may be available for businesses can lead to misunderstandings in terms of the amount of assistance that will be available and room for political discretion in terms of the amount of assistance eventually granted, which is likely a factor

in the increasing levels of government assistance seen in many countries over time (OECD, 2016). It can also induce moral hazard in insurance uptake. The greater the expectations of ex-post relief are, the smaller the incentives are for ex-ante investments in adaptation and insurance uptake.

**Defining the scope and eligibility for ex-post financial assistance can reduce misunderstandings and mitigate potential adverse impacts,** especially when such criteria are applied consistently over time and across flooding events, especially when criteria are narrowly focused on providing immediate needs. To reduce the impact of emergency compensation on insurance demand, several countries do not provide compensation for damages that would otherwise have been insurable (rather than what was actually insured).

**Policy makers can also strengthen the role of capital markets in financing flood mitigation investments for Malaysian businesses through innovative instruments.**

One potential solution is the securitization of loans for small-scale flood mitigation projects, allowing lenders to transfer some of the risks of these investments to capital market investors and giving capital market investors the option to invest in adaptation investments at scale. For SMEs, pooling solutions could be helpful, for example, through instruments with the scale to justify issuance and measurement, reporting, and verification (MRV) costs and attracting institutional investors while mitigating idiosyncratic risks among issuers. Policy makers could support such an approach by establishing a dedicated fund to finance flood adaptation efforts by businesses (or leveraging existing ones). Given the need to assemble a sufficiently large pool of assets to cover the costs of securitization (as noted in Chapter 4), and the SME sector's limited access to collateral, another option would be to target funding to a revolving pool of receivables of those SMEs investing in climate adaptation. Malaysia Securities Commission could also support the introduction of innovative instruments directed at investment in climate resilience.

**Malaysia has a deep pool of domestic institutional investors that could be leveraged as cornerstone investors in such initiatives.** Given the externalities associated with climate adaptation investments, Securities Commission Malaysia, working with institutional investors, should consider fostering financing for climate adaptation investments. As mentioned above, this could be facilitated, for example, through requirements for investment allocation equivalent to a certain percentage of assets under management.

**Policy makers could also enhance support for adaptation financing through alternative financing platforms, such as equity crowdfunding and peer-to-peer lending platforms.** The Securities Commission Malaysia has supported SME financing through these platforms, for example, through a co-investment scheme such as the Malaysia Co-Investment Fund (MyCIF).<sup>132</sup> Such an approach fosters private capital mobilization and could be leveraged to support adaptation and resilience investments of SMEs, for instance, by the adoption of targeted allocations for flood preparedness and adaptation investments.

## RECOMMENDATION 5

### Deepening the Insurance Markets

**The increasing prevalence of flooding in Malaysia and its associated costs suggests the public sector should engage more actively to develop the insurance market.** While the government is considered an insurer of last resort and is expected to step in to cover losses and fund recovery efforts in Malaysia, given the increased frequency of flooding, this approach is likely not sustainable. Efforts are needed to develop financial markets that can support the financial resilience of businesses to flood risks. Insurance is a core financial market segment in this regard. However, it seems unlikely that the private insurance market will be able to unlock the challenges hindering greater penetration. This would be the case even if flood risk maps become widely available. While more information would provide ITOs with the needed data to more adequately price risks, it would not help resolve the various causes of misalignment of incentives that hinder the uptake of private insurance. Global experience suggests that high-risk clients could still effectively be excluded from the market.

**Malaysia seems trapped in a vicious cycle that stunts the development of the private insurance market.**

Several market failures and financial market frictions play a role in limiting the depth of the private insurance market, placing the segment in a “disaster syndrome.” A low level of flood insurance penetration pressures the government for ex-post compensation, and the expectation of such compensation further reduces demand for insurance coverage.<sup>133</sup> Moreover, ITOs seem to place restrictions on providing insurance to some high-risk businesses, especially those in the agriculture sector. Although flood insurance has been provided through *de facto* tariff pricing, as indicated in Chapter 4, market-based pricing dynamics would only reinforce the tendency to exclude high-risk businesses. On the demand-side, an increase in insurance take-up would likely come from high-risk businesses (due to adverse selection), likely pushing premiums up as aggregate risks for ITOs would increase, further curbing demand. Malaysia's key challenge is expanding flood insurance penetration, while ensuring affordability and providing incentives for risk reduction and adaptation.

**Countries worldwide have adopted a wide range of approaches to tackle these complex challenges, but specific trade-offs mark each solution.** Such trade-offs

<sup>132</sup> MyCIF was set up as part of Belanjawan 2019 to co-invest in micro, small and medium enterprises (MSMEs) and social enterprises alongside private investors via equity crowdfunding and peer-to-peer financing (P2P) platforms. See <https://www.sc.com.my/mycif>.

<sup>133</sup> In some contexts, this has also been called the “charity hazard,” in which businesses and households expect government compensation for uninsured damage. Hence, they purposely do not purchase insurance coverage.



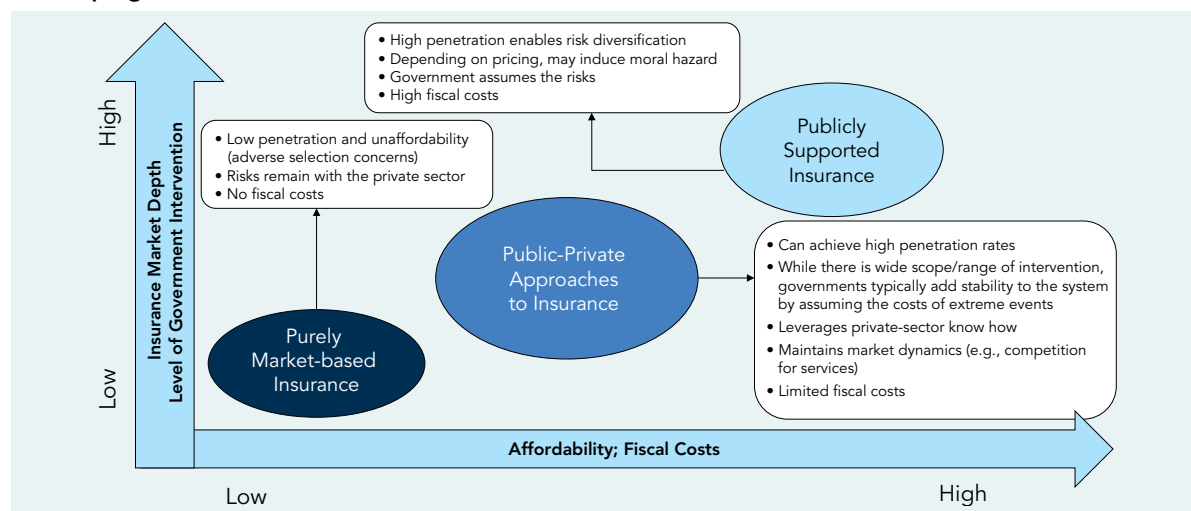
reflect the tensions associated with who will ultimately bear the financial costs associated with floods. In Malaysia's status quo, these costs are assumed mostly by vulnerable businesses, and to a lesser extent by the public sector in as much as reliance is placed on government support schemes for businesses affected by floods. In the solutions discussed below, greater insurance market depth and affordability are achieved by either the transfer of financial risks to the public sector or by cross-subsidizing financial risks across a wider pool of insured assets (Figure 5.2). The solutions seek to address the externalities associated with insurance provision, as summarized by the "disaster syndrome," and therefore affect incentives for businesses, ITOs, and the public sector, with consequences for market dynamics. All these solutions have distributional impacts, whereby some stakeholders would gain, while others would lose. Ultimately, the level of protection in the marketplace should reflect Malaysian policy makers' decision on the distribution of the costs associated with floods across the private and the public sectors.

**While the supply-side survey indicates that flood risks are perceived as insurable in Malaysia, international experience suggests some role for public sector support.** The evidence in Chapter 4 shows that the perception among insurance and re-insurance companies active in Malaysia is that flood risks are currently diversifiable and can be shouldered by the industry. If this were indeed the case, there would be no need for the public sector to absorb losses associated with flooding. However, in several countries with risk profiles similar to Malaysia's, the public sector has absorbed some of the losses associated with flooding and has also intervened to develop the insurance market (Figure 5.3).<sup>134</sup> For

example, in Hungary and the United Kingdom, public sector support for flood insurance is offered for high-risk properties and coverage for lower-risk properties is available from private insurance companies. The public sector also plays an active role (through various types of interventions) in countries like Malaysia with relatively more frequent but similarly severe flooding events (such as in Belgium and Costa Rica) or in countries with similar frequency but more severe flooding events (such as in Austria, Switzerland, and Thailand). Other broad-based public sector support examples include Iceland, France, the Republic of Korea, and Spain. In contrast, government intervention is much more limited in Italy, which faces challenges very similar to Malaysia in developing flood insurance market. More broadly, government intervention is less prevalent in countries with less frequent and less costly flooding events, and even in such cases, adverse selection has led to the unavailability of flood insurance for high-risk clients.

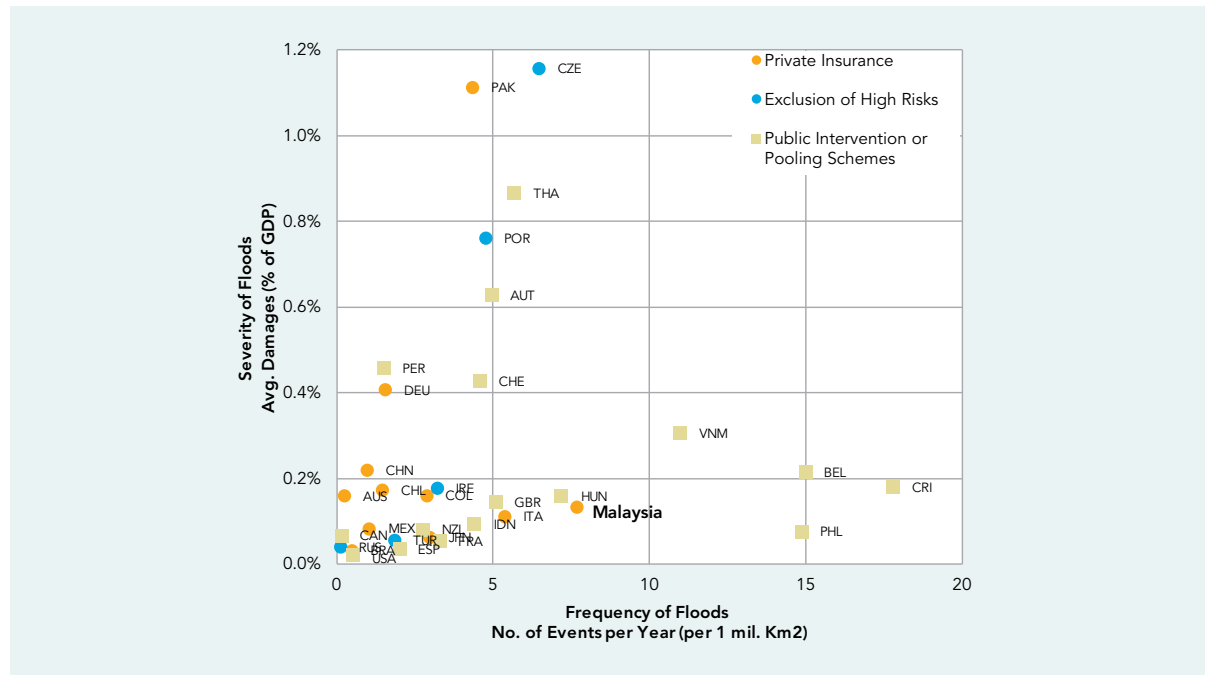
**The specific solution for public sector support, however, is a policy decision.** The set of possible arrangements is broad, and there is no predefined approach to be prescribed; each country should identify the solution that best suits its specific needs. In choosing the specific solution to deploy for flood risks in Malaysia, policy makers should consider the various distributional impacts of different schemes, the effectiveness of solutions in addressing the current barriers in the marketplace, their expected impact in terms of coverage expansion, especially to highly vulnerable segments, and affordability, while considering their overall fiscal costs. The pros and cons of different solutions are outlined below, with examples from other countries.

**FIGURE 5.2**  
Developing Insurance Markets



Source: Adapted from World Bank (2023).

<sup>134</sup> In certain countries, flood risks are considered uninsurable; the public sector typically absorbs a significant share of the risks associated with floods. This is the case of the Netherlands, for example.

**FIGURE 5.3****Countries' Flood Risk Profile and Government Intervention**

Source: Calculations based on EM-DAT database.

### Private Insurance Markets

**The challenges in the Malaysian marketplace are similar to those of many countries worldwide that have the insurance market based on private providers.** This market structure is typically characterized by adverse selection (which often leads to the exclusion of high-risk clients from the market), lack of affordability, high premiums, especially for high-risk clients, and limited market depth. Although insurance penetration varies substantially, countries with a private insurance market generally have low penetration rates—this is the case of Bulgaria, Germany, Greece, Italy, Luxembourg, and Turkey.<sup>135</sup> Risk-based pricing raises awareness about flood risks and incentivizes investments in adaptation to flood risks, thereby reducing moral hazard concerns (e.g., Japan).<sup>136</sup> In some countries (e.g., Germany), insurance companies provide premium discounts when businesses invest in risk reduction (e.g., such as, flood-proofing buildings).<sup>137</sup> However, oversight of investment design and implementation lies beyond the capacity of

most ITOs. Assessment of the financial viability of such investments and performance monitoring are tasks usually performed by banks for investments funded with bank loans. Closer collaboration between banks and ITOs could further support adaptation investments.

**In Malaysia, flood insurance is typically provided as an optional add-on.** In some countries, it is offered bundled with coverage for other perils. Under bundling, flood coverage is combined with coverage for other perils such as fire and windstorms, thereby spreading the risk of flood losses across a large geographical area and significantly increasing the percentage of the population covered for flood damage. When flood peril is automatically included in standard building and contents insurance for businesses, penetration rates of flood insurance are generally higher.<sup>138</sup> Such bundling accounts for relatively higher penetration rates in Israel, Latvia, and the United Kingdom. Higher take-up rates are also observed in countries where mortgage holders are mandated to take insurance against flood

<sup>135</sup> See OECD (2016).

<sup>136</sup> The benefits of risk-based pricing have been documented at length. There is, however, limited evidence demonstrating that risk-based pricing has actually led to significant investments in risk reduction or adaptation. See Cummins and Mahul (2009), OECD (2023), and references herein.

<sup>137</sup> Insurance discounts affect the decision to invest in risk reduction and adaptation by bringing down the costs of such investments. Such incentives can be relevant when policyholders underestimate the benefits of such investments. There is, however, limited empirical evidence. See Hudson et al. (2016).

<sup>138</sup> Insurance penetration rates tend to be higher, for instance, when there are requirements for flood insurance coverage attached to mortgages (e.g., Ireland and Sweden). However, penetration rates remain relatively low in other countries with mortgage-related requirements for flood insurance, such as the Czech Republic and Portugal (and would likely be even lower without the mortgage-related requirements).

risks. The drawback of this approach is that insurance coverage would likely expire with the mortgage.<sup>139</sup> While bundling more broadly could lead to higher penetration rates vis-à-vis add-on policies, flood risks tend to be underpriced. Bundling can also mask the extent of losses associated with flooding. These risks would be particularly high in the case of Malaysia, in light of the various data gaps. Insurers may still exclude high-risk clients, and the lack of explicit premiums for flood risks would remove the incentives for investments in adaptation.

### **Parametric Insurance Solutions**

**A few countries have explored using parametric or index-based insurance for floods.** Parametric insurance is a type of insurance that does not indemnify actual losses incurred. Instead of paying for damages that occur after a flooding event, such solutions pay out if certain agreed-upon conditions are met. Payment is triggered and quickly disbursed, regardless of damage. Parametric solutions cover risks without the complexity of assessing damages after an event. They typically address challenges associated with slow and complex claim payout processes since they do not require inspections and verification. Nonetheless, parametric insurance can be more expensive than indemnity-based insurance as the premium is generally priced at two to five percent of the policy limit.<sup>140</sup> Parametric insurance has grown in popularity globally and has been used in several industries.<sup>141</sup> It has been more widely used in agriculture, providing coverage against droughts and other weather-related events that can damage crops. A few countries have adopted parametric solutions for flood risks (see Box 5.5).

**The most significant drawback of parametric solutions is basis risk, which is the difference between payments contract holders receive and the losses they**

**suffer.** Such a deviation can occur in either direction—calculated payouts can be below the sustained losses to the insured (negative basis risk) or above them (positive basis risk). Accurately structuring and pricing the parametric insurance products requires an in-depth assessment of exposures and vulnerabilities. Basis risk is also highly dependent on selecting an adequate trigger. High-quality and timely data are critical for such schemes, which would be particularly challenging in the case of Malaysia due to data gaps. Importantly, this type of insurance does not address the concerns with adverse selection, as ITOs may still limit their exposure to high-risk clients, especially if payouts are frequently triggered. Parametric insurance also does not directly tackle the challenges of shallow markets and unaffordability. Depending on its design, it may exacerbate moral hazard concerns as the ease of payouts may disincentivize investments in flood risk mitigation.

**Payout triggers are the key to minimizing basis risks in parametric insurance solutions.** They are usually related to the intensity of disasters and can take two forms: “pure” parametric trigger or modeled loss trigger. In the former, payouts are based on physical characteristics of disasters, such as the amount of rainfall occurring in a particular location. For the latter, the payout trigger is based on estimated losses for a given event as calculated by a catastrophe model. Parametric solutions can have multiple triggers, resulting in different payouts levels. The main requirements for a parametric trigger are: (i) that the measure is objective and can be modeled; (ii) that the measure is independently verifiable by a third party immediately after a disaster; and (iii) that the measure is tightly correlated with the actual losses incurred following a disaster to minimize basis risk. Neither the insured nor the risk-taker should be able to influence the trigger (or its calculation or reporting).

<sup>139</sup> Such requirements exist, for example, in the United States, the United Kingdom, Ireland, and Sweden. In the United States, federally licensed mortgage lenders are legally required to ensure that borrowers with properties in flood-prone areas are protected by flood insurance. It is estimated that approximately 50 percent of all residential properties in the Special Flood Hazard Area (SFHA) are covered by flood insurance (where mortgage requirements are in place), while less than one percent of homes in the 500-year flood zone are covered.

<sup>140</sup> See Angier (2019).

<sup>141</sup> See Swiss Re (2022).

## BOX 5.5

## Examples of Parametric Insurance for Flood Risks

**Bangladesh's Parametric Flood Insurance.**<sup>142</sup> In June 2020, a pilot project based on index-based flood insurance was introduced by Oxfam Bangladesh with the support of the United Nations World Food Programme and funded by the Korea International Cooperation Agency (KOICA). The pilot project's objective was to enhance household resilience in flood-prone areas while strengthening food security. Insurance payout was triggered quickly after the program's launch when Bangladesh experienced the most severe and long-lasting flooding event in 20 years during the 2020 monsoon season. Each enrolled household received a payout of \$32 through their mobile money platform. The scheme uses satellite data, including water levels and rainfall data, collected over 19 years.

**China's Heilongjiang Provincial Government Multi-Peril Parametric Disaster Relief Coverage.**<sup>143</sup> The program was launched in 2016 to insure China's Heilongjiang provincial government against fiscal contingent liabilities related to disaster relief for 28 counties classified as "less poverty resilient." The scheme covered not only floods but also excess rain, droughts, and high temperatures. The parametric triggers were designed to reflect significant yield losses of crops based on the satellite flood footprint index, precipitation index, drought (based on temperature and precipitation), and low temperature. When triggered, payouts are typically used for disaster relief and post-disaster reconstructions of properties and infrastructure. The insurer, Sunlight Agro Mutual Insurance, with SwissRe as the re-insurer, provides an insured sum of \$360 million and uses satellite and meteorological data to identify trigger events.

142 See Eram (2021).

143 See Pagniez (2016).

### **Public Sector Support through Subsidized Premiums**

**To foster the uptake of insurance and improve affordability, one solution is to subsidize insurance premiums for flood risks directly.** But this can lead to perverse incentives for risk management as policyholders are not necessarily aware of their risks. Countries have adopted this solution with variations in coverage and pricing. For example, subsidies can be targeted at only high-risk clients or can embed cross-subsidization through flat or tariff-based pricing (i.e., not risk-based pricing). Certain pricing policies may be adopted due to difficulties in accurately modeling flood risks, thus pricing them,<sup>144</sup> or as a deliberate government policy.<sup>145</sup> Independent of their specific design, such subsidies partly shift the financial costs associated with floods to the public sector. While

the public sector absorbs some of the costs, it does not absorb the ex-post risks and costs associated with floods. In other words, although the provision of subsidies may impact the insurance pool's size and risk profile, the risks associated with floods remain primarily with ITOs and businesses. Depending on their design, subsidized premiums may not address adverse selection concerns, and private insurers may still have incentives to exclude high-risk clients because they ultimately bear the risk of such clients. In some countries, schemes may target precisely high-risk clients. This type of public sector support has a limited impact in fostering investments in adaptation to flood risks as it tends to remove the signaling effects of pricing for vulnerable clients. Such solutions can

144 For example, in Japan and Chile.

145 For example, in France, Spain, and Switzerland.



be expensive for the public sector, and they may be politically challenging to remove ex-post. For instance, while the use of subsidies is widespread for agriculture insurance in high- and middle-income countries (for example, in Brazil, Canada, China, India, Japan, Mexico, Portugal, South Korea, Spain, Turkey, and the United States), it is rarely used in low-income countries, largely because of fiscal budget constraints.

### **Public Sector Support through Mandatory Insurance Schemes**

**Many countries have adopted some form of mandatory scheme.** Sometimes mandatory coverage is linked to other financial products (e.g., mortgages, loans, and even ex-post government relief); sometimes, countries impose mandatory bundling with other insurance products (e.g., fire insurance); and sometimes, they have adopted universal coverage.<sup>146</sup> Mandatory schemes aim to improve affordability and increase insurance penetration by expanding the client base, thereby enabling effective diversification of risks. Mandatory schemes tend to eliminate adverse selection concerns as they expand coverage independent of the riskiness of clients.

**To counter moral hazard concerns, mandatory schemes often embed measures to incentivize investments in adaptation to flood risks.** Moral hazard can be significant if insurance policies cover the majority of actual losses. In fact, this can lead to an increase in aggregate losses associated with floods, raising concerns about the effectiveness and sustainability of insurance schemes. One solution adopted by France and the United States, has been to design schemes to pool funds from the collected premium and earmark them to claim payouts and investments in adaptation. Doing so secures funding for adaptation investments without burdening public sector finances. Schemes can also build incentives through their pricing policies. Some countries charge higher premiums (e.g., the United States) or impose higher deductibles (e.g., France) for higher-risk customers, and in some cases, to geographical areas without up-to-date flood maps and risk prevention plans, respectively. Other countries embed incentives to minimize moral hazard concerns via premium pricing. For instance, pricing can depend on whether the policyholder undertakes risk reduction and mitigation activities.

**Achieving equilibrium pricing in mandatory schemes is not straightforward, especially in markets where the quantification of risks is not well developed, as in the case of Malaysia.** When mandatory schemes are adopted, premiums are often flat; they do not reflect the riskiness of individual policyholders, clearly signaling the cross-subsidization built into such schemes. Such an approach puts less emphasis on location-based risk assessments and is particularly well suited for countries with marked deficiencies in the information environment, such as Malaysia. However, implementing a mandatory flood insurance scheme warrants close collaboration between the public sector and the private sector, especially regarding pricing policies to ensure adequate profitability and stability of the private insurance market. Specifically, relatively high premiums can lead to a significant increase in the profitability of the insurance industry (at the expense of the private sector). Alternatively, if premiums are priced too low, mandatory flood insurance could threaten the stability of the insurance sector. Mechanisms can be designed to minimize such risks. For instance, processes could be established in which the financial sector regulators regularly review outcomes for the insurance and takaful industry in collaboration with the sector, considering the severity and costs associated with the actual incidence of flood events. Adjustments to the flat mandatory premium for flood insurance would be discussed and approved within such a framework.

**Malaysia could also consider establishing a national insurance fund under the joint oversight of the public sector and the financial sector.** Such a fund could be a mechanism to relieve pressures on the insurance industry and stabilize premiums (that is, so they remain relatively stable from year to year despite variations in the incidence and severity of flooding). In other words, it would act as a stabilizer, absorbing “excess” premiums in periods of lower outlays while covering for larger outlays in other periods. This mechanism would have the advantage of further reducing recourse to public sector funding except in the case of extreme events. Given that investments in climate adaptation are associated with considerable externalities, consideration could also be given to using resources pooled by the insurance fund to finance some of the needed investments (see more below).

**Mandatory schemes are usually established through regulations and are self-funded.** While they do not necessarily entail direct costs for the public sector, implementation can still be politically difficult. The

<sup>146</sup> In some countries, offering flood insurance is mandatory to address the potential exclusion of high-risk clients from insurance markets. However, because uptake is not mandatory, such a solution is still prone to adverse selection and may lead to higher premiums. It also does not address the challenges with limited demand for insurance. Such solution has been deployed in Norway, where private insurers are mandated to offer flood insurance, and Spain, where the responsibility lies with the public sector. In both cases, the purchase of flood insurance remains voluntary.

cross-subsidization embedded in such schemes implies that the costs associated with floods are distributed widely, regardless of whether policyholders face flood risks. This setup implies additional costs to many who would prefer not to pay for insurance (for example, those in low-risk locations). Enforcement among some segments, such as informal enterprises, can be challenging. Despite this, premiums would still be relatively low given the larger pool of participants in such an insurance scheme. A positive spillover effect is that mandatory schemes provide the basis for quickly enhancing data availability, as data can be easily collected for flood events occurring after its adoption.

### **Provision of Insurance by the Public Sector**

**The public sector can financially back the insurance coverage of flood risks, often as the insurer of last resort.** Once again, there are many forms of support across countries. The public sector can directly be an insurer or re-insurer for all or a subset of higher-risk clients. For example, public sector coverage for flood insurance is only available for high-risk properties in Hungary. In many countries, mandatory flood insurance coverage is combined with the option for insurance companies to transfer risks to a public re-insurer.<sup>147</sup> Another example is through public sector guarantees. Private insurers provide flood risk coverage, and the government guarantees private insurers to cover losses for extreme events above a specific threshold. For example, in Belgium, the government provides a backstop on losses to private insurance companies, which are not allowed to insure high-risk properties.

**Insurance schemes backed by the public sector could also entail the transfer of risks to global markets.** When the government takes on risk through such schemes, one option is to transfer risks to private re-insurance companies. Another option is to transfer risks through capital market instruments, such as catastrophe bonds. Catastrophe bonds are insurance-linked securities that transfer the risk of a catastrophic event from the bond issuer, usually an insurance or re-insurance company, to the bond investors. Catastrophe bonds typically cover high-cost extreme events occurring with a very low probability. Issuances have usually covered events such as typhoons, hurricanes, or earthquakes. Catastrophe bonds for flood risks have been less prevalent, partly due to the complexity of flood modeling.

### **Pooling Schemes**

**These schemes provide cross-subsidization across selected segments of households and businesses, depending on the reach of individual schemes.** In some countries, they are country-wide schemes; in others, they cover specific geographical areas or segments.<sup>148</sup> In some cases, such schemes emerge in the context of mandatory insurance solutions. In most cases, the goal of pooling schemes is to enable the diversification of risks through a broader client base comprised of both high-risk and low-risk clients. Depending on the specific design of the scheme, it can eliminate adverse selection concerns akin to mandatory insurance solutions. There are variations in the funding structure of pooling schemes: some are funded through specific surcharges, fees, or taxes, and when mandatory, a portion of the premiums could fund the reserve pool. Pooling schemes can be designed to foster investments in risk mitigation, for example, by earmarking funds in the pool. Schemes that embed preparedness and risk reduction incentives as a condition for coverage are being tested in some developing countries. For example, the African Risk Capacity combines drought risk insurance with contingency planning services, improved risk forecasting systems, and access to international funding.

**Pooling schemes have been developed by the public sector, the private insurance sector, or through partnerships between them.** In some countries, pooling schemes are developed by the public sector, typically combined with government guarantees. That is the case of the French and Spanish insurance systems, in which a state guarantee is triggered when disasters occur, thereby addressing insolvency concerns for private insurance companies. Another example is community-based flood insurance, where a single policy is issued with widespread coverage within the community and, the local government pays premiums. In other countries, private insurance companies have independently established such pooling schemes. By spreading the flood risks across the entire industry, such schemes minimize incentives for individual insurance companies to decline protection for high-risk clients. In some countries, pooling is a joint initiative between the government and private insurers, such as the scheme covering high-risk properties in the United Kingdom; however, no such scheme is available to businesses.

<sup>147</sup> In France, *Caisse central de réassurance* can assume 50 percent of exposure to disaster. In Spain, insurance companies can pass on disaster risks to *Compensación de Seguros*.

<sup>148</sup> For example, some countries have supported agricultural insurance pools and supporting agencies or technical support units, such as China, Malawi, Mongolia, Spain, Thailand, and Turkey.

**Another range of solutions entails sharing risks across countries through catastrophe pools.** Such pooling arrangements have been adopted by several small countries across Africa, the Pacific, the Caribbean, and Central America through sovereign catastrophe risk pools providing parametric catastrophe risk insurance. In Southeast Asia, Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, Singapore, Japan, and Vietnam have joined the Southeast Asia Disaster Risk Insurance Facility (SEADRIF), which offers parametric insurance products to participating countries. It also offers access to a flood risk assessment model. These pooling schemes aim to improve access to international re-insurance and capital markets based on the diversification of correlated risks.

#### RECOMMENDATION 6

##### **Building Capabilities and Enhancing Awareness**

**Raising flood risk awareness is critical.** Lack of awareness and understanding of flood risks as well as about the effectiveness of adaptation and resilience strategies can lead to inaction. As discussed in Chapter 3, there are marked flood risk awareness gaps in Malaysia, particularly among SMEs. Public sector interventions should focus on closing such gaps, concentrating on businesses with lower capabilities and those prone to greater information asymmetries, such as SMEs. Chapter 3 also highlighted a positive correlation between history of floods and increased flood risk awareness. Consistent with this view, global experience indicates that awareness tends to be high in regions where floods are frequent compared to areas where floods occur infrequently. As flood risks evolve due to climate change, public sector interventions should also target businesses in areas where the frequency of flooding is not historically high but might be on the rise. A specific form of policy intervention is through public awareness campaigns to strengthen the management of flood risks among businesses, especially among vulnerable segments, including mainstreaming of flood risks into business operations, risk management practices, and investment decisions. Messages should be targeted and tailored to each stakeholder's capabilities (including financial literacy), while encouraging preventive action. World Bank (2012)

provides a detailed discussion of recommendations for the design of awareness campaigns.<sup>149</sup>

**Policy makers should also prioritize capacity building as an integral element of the policy agenda to enhance private sector resilience to flood risks, possibly undertaken alongside directed financial support.** As highlighted in both the business-level survey and the financial institution survey, there are concerns about the lack of capabilities for flood risk management across the board in Malaysia. Even if flood risk data were to become widely available, businesses may face difficulties using this information to assess risks and their impacts on their operations. Interventions aimed to enhance businesses' capabilities and strengthen their ability to manage flood risks can span a wide range of activities. Such interventions can foster the capacity for integrated enterprise risk management and business continuity planning that mainstream prevention and better connects risk analysis and reduction.<sup>150</sup> Preparing business continuity plans can ensure that management and workers know what to do in case of flooding to maintain or restore production as quickly as possible. Interventions can also strengthen the capacity of businesses to incorporate strategic foresight and scenario planning to identify multiple and intersecting hazards (that may interact with flood risks) and their cumulative impact.

**As indicated in Chapter 3, businesses may also need support in understanding the range of adequate adaptation strategies, including the cost-effectiveness of adaptation and resilience strategies.** Support programs can enhance business-level capacity to identify and implement adaptation strategies. For example, capacity building efforts could promulgate the range of flood protection measures, their cost-effectiveness, associated technical standards, and minimum requirements for adoption. Close coordination with the financial sector to promote access to finance for such investments could enhance the overall effectiveness of the approach. Another important element in this agenda is the need to support business capabilities to enhance supply chain resilience, particularly for SMEs, as discussed in Box 5.6. Programs can also enhance capacities that allow businesses to build back better. For example, businesses can replace old production technologies with new ones—for instance, computer-based management files instead

149 See Chapter 4 of World Bank (2012), which focuses on flood awareness campaigns.

150 Patnaik and Fabrizio (2023) outline a managerial "climate risk planning" framework, which conceptualizes how businesses in various sectors can assess and respond to climate risks.

of paper-based systems that may be destroyed during floods.

**Policy makers can also support building the capabilities of financial institutions.** For instance, policy makers could engage in broad-based efforts to foster learning and knowledge sharing of best practices among financial intermediaries regarding the relatively new concepts and tools needed to incorporate flood risks into their business operations. Policy schemes could

also aim to have demonstration effects, to educate investors and lenders, and to increase their confidence in adaptation investments. In addition, efforts should go beyond capacity building efforts for financial institutions and businesses; they should reach policy makers themselves. Capacity building based on best practices can help countries leapfrog through market development with faster learning facilitated by the experience of other countries.

## BOX 5.6

# Fostering Supply Chain Resilience

**More resilient supply chains can help businesses reduce their exposure and vulnerabilities to floods.**

As argued in Chapter 2, knock-on effects through supply chains (upstream and downstream) can directly contribute to the adverse impacts of floods, at least for less severe floods. While empirical evidence about businesses' specific behavior in the face of floods (and disasters in general) remains limited, a recent survey in Tanzania shed some light on strategies used to mitigate exposure to direct risks (on-site flooding) and indirect risks (through supply chains and damaged infrastructure/utilities).<sup>151</sup> The results suggest that businesses facing higher direct impacts tend to focus on loss-avoidance strategies (e.g., smaller inventories, lower generator ownership), while those facing more indirect risks seek to bridge disruptions (e.g., holding larger inventories, maintaining more extensive supply networks). However, the survey also suggests that businesses tend to stick with their existing suppliers even when such suppliers cannot meet their demand; in other words, businesses cannot easily switch suppliers in response to disruptions.

**Policy makers in Malaysia can support businesses to enhance supply chain resilience, particularly for SMEs.**

In line with the support to strengthen business capabilities outlined in Recommendation 6, targeted training programs can build the capacity of businesses to map and stress-test their value chains. This can help identify suppliers or inputs most vulnerable to disaster risk for which preventive action may be essential (for example, creating supply chain redundancy, holding inventory, identifying alternative input), particularly for critical or time-dependent inputs. They can also encourage collaboration among stakeholders within value chains and across sectors to reduce their vulnerability to flood risks. The government can work with industry associations to provide businesses in different sectors with information and support to find new suppliers and clients, including abroad. It can also facilitate the establishment of new business linkages, by developing access to trade finance for instance.

<sup>151</sup> See Rentschler et al. (2021).



## 5.4 Conclusions

**This study is a first attempt to assess the macroeconomic and financial sector impact of flood events, despite the limited availability of granular data on many fronts.** Yet, the original findings in this report are useful in surfacing gaps and areas where immediate attention by policy makers in Malaysia are much needed. Indeed, there is significant scope to strengthen a set of public sector policies to further support private sector adaptation and resilience to flood risks, which ultimately would lead to more sustainable and resilient economic development for Malaysia.

**This report outlines a range of complementary policy actions in six key areas, focusing on how policy makers in Malaysia can support and foster private sector resilience to floods, with emphasis on policies to enhance the role of the financial sector.** Specifically, the six critical sets of actions are as follows: (1) Enhancing data availability, accessibility, and affordability; (2) Developing a long-term flood risk adaptation strategy; (3) Strengthening the enabling environment for the financial sector; (4) Supporting access to finance for adaptation and recovery; (5) Deepening the insurance market; and (6) Enhancing flood risk awareness and building capabilities. This report leaves the more in-depth assessment of the range of actions that businesses can undertake and their effectiveness for future research.

**There is also a need for a complementary top-down approach.** In addition to public sector support through

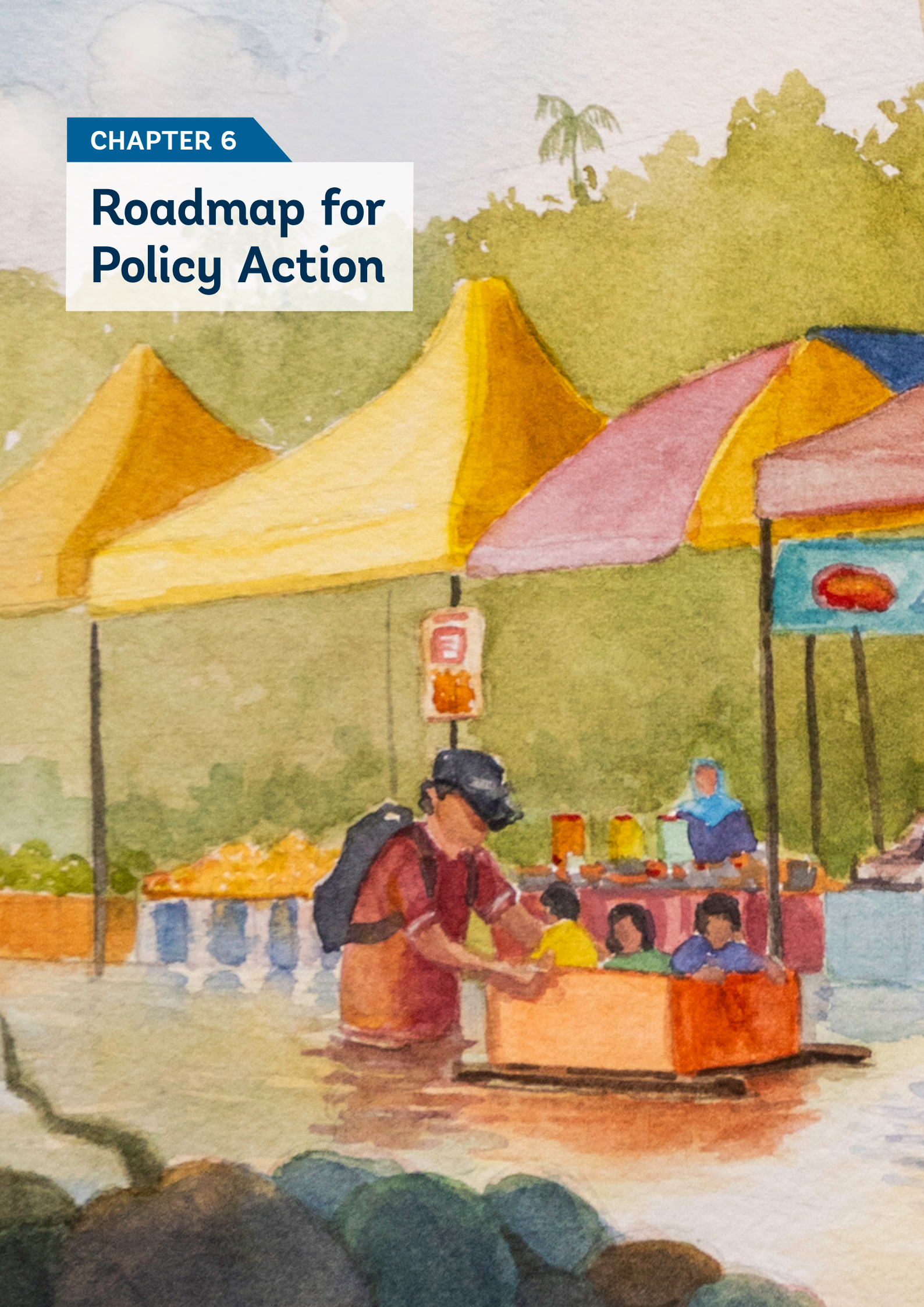
the six recommendations discussed in this chapter, governments can play a vital role in reducing exposures and vulnerabilities to flood risks, thus minimizing private sector losses, as highlighted in Chapter 2. Such actions can significantly change not only the scale and the type of private sector investments, but also the incentives to undertake such investments by businesses and the financial sector alike by changing their risk-return profiles. The types of public sector investments can be grouped into three categories: (i) land use planning and land use restrictions aimed at reducing the level of assets exposed to flood risk; (ii) flood-control infrastructures—including flood defenses such as levees, dams, flood walls and drainage systems, and nature-based solutions (e.g., wetlands, mangroves) aimed at protecting particular areas against inundation; and (iii) risk reduction through forest and wetland protection and water resource management. In addition, the government has a role in reducing vulnerabilities through the development of forecasting capacity and early warning systems and the development and implementation of effective emergency response systems, as discussed in this chapter. All these areas for public sector intervention are not mutually exclusive and should be considered part of a comprehensive approach to flood prevention and mitigation. Therefore, the recommendations outlined in this chapter should not be viewed in isolation but rather as part of an integrated approach to flood risk management.





## CHAPTER 6

# Roadmap for Policy Action





## Key Messages

- **This chapter outlines a roadmap for policy action around the six broad recommendations developed in Chapter 5, highlighting the need for collaboration across a wide range of policy makers in Malaysia.**
- **Enhance data availability, accessibility, and affordability.** In the short term, the Government of Malaysia should publish flood hazard maps to expand public access to information. In the medium term, the Government should improve the quality of the primary data on flood hazard risks to address concerns with limited time horizons, frequency of updates, limited coverage, and geographical comparability.
- **Develop a long-term national adaptation strategy.** In the short term, an immediate, important foundational step for Malaysia is the articulation of a national adaptation strategy with a prioritized action plan that outlines clear adaptation goals toward flood risks. The strategy should also strengthen institutional structure and arrangements for disaster risk management and establish effective cooperation and coordination mechanisms across the various stakeholders.
- **Strengthen the enabling environment for the financial sector.** In the short term, financial sector regulators should rebalance the focus of the climate information architecture (e.g., taxonomies and disclosure and reporting frameworks) by placing greater emphasis on climate change adaptation. In the medium term, the regulators should undertake flood risk assessments for the financial sector to inform other prudential policy actions to preserve financial stability. The regulators should also carefully monitor the implementation of new policy tools and financial sector responses to guard against unintended consequences for financial inclusion and financial stability.
- **Deploy targeted interventions to support access to finance for adaptation and recovery efforts.** In the short term, such interventions should focus on the most vulnerable businesses, especially SMEs. Policy makers must adopt an evidence-driven approach to design and implement targeted policy support as well as the adoption of M&E frameworks to enhance the effectiveness of policy support. In the medium term, the Government of Malaysia with the financial sector regulators should consider developing a policy framework outlining priorities in supporting access to finance for adaptation and recovery.
- **Deepen the insurance market.** In the short term, the authorities should conduct a more in-depth and granular assessment to identify critical vulnerabilities among businesses and gaps in insurance and takaful coverage, and consider the adoption of temporary, targeted policies. In the medium term, the Government of Malaysia and the financial sector regulators should assess alternative arrangements for public sector support for the insurance market, with explicit consideration to defining the scope for public sector funding support.
- **Building capabilities and enhancing awareness.** In the short term, the Government of Malaysia could leverage the possible publication of flood risk maps with awareness raising, for example, by using interactive platforms. In the medium term, the Government of Malaysia should deploy programs to strengthen the capacity of businesses to map and assess their resilience (including their supply chains). Interventions supporting capacity building for both businesses and financial intermediaries can be deployed alongside directed financial support to improve the likelihood of impactful outcomes.



**This report has shown that there is further scope to strengthen public sector policies to support private sector adaptation and resilience to flood risks, ultimately leading to more sustainable and resilient economic development for Malaysia.** Discussions around the need to adapt and mitigate flood risks have gained prominence in recent years, reflecting relatively large-scale episodes. Policy makers in Malaysia have been shifting their approach from reactive to proactive flood risk management, focusing on preparedness and resilience. However, comprehensive and coordinated policy action still remains at a nascent stage, and such impetus must also be nurtured in the private sector.

**The findings point to several areas where policy makers in Malaysia can undertake concrete actions in the short and medium term in tandem with other climate change initiatives to manage climate-related risks more broadly and effectively.** This chapter outlines a roadmap for policy action around the six broad recommendations in Chapter 5, highlighting the need for collaboration across a wide range of policy makers in Malaysia (see also Table 6.1). The Roadmap recognizes and leverages the responsibilities of the national and sub-national governments to address the challenges posed by climate change, including physical risks such as floods, in an collaborative manner with the financial sector regulators and supervisors, among others.

- 1. Enhance data availability, accessibility, and affordability to support flood risk assessments, which are essential for risk management, informed investment decisions, and the development of financial markets.** In the short term, the Government of Malaysia should publish flood hazard maps to expand public access to information and develop legal and regulatory frameworks to support the collection and dissemination of data to manage the legal risks. In the medium term, the Government should improve the quality of the primary data on flood hazard risks to address concerns with limited time horizons, frequency of updates, limited coverage, and geographical comparability by investing in hydro-met services and exploiting new technologies. The Government should also promote the development of technologies and expertise in monitoring and assessing flood risks not only in the public sector, but also in the private sector and the scientific and academic communities. Moreover, the Government could consider establishing partnerships with private stakeholders to complement and enhance public

sector initiatives by leveraging private sector capabilities and expertise in the development of risk models, while reducing fiscal costs.

- 2. Develop a long-term national adaptation strategy, clearly outlining and communicating the priorities for the Government of Malaysia and defining the scope of action for the public sector.** In the short term, an immediate, important foundational step for Malaysia is the articulation of a national adaptation strategy with a prioritized action plan that outlines clear adaptation goals toward flood risks. The strategy should also: (i) strengthen institutional structure and arrangements for disaster risk management; (ii) establish effective cooperation and coordination mechanisms across the various stakeholders; (iii) establish in the legal framework the responsibilities and liabilities of national, regional, and local government authorities and other relevant stakeholders about flood risk management in its entirety, encompassing the periods before, during, and after floods; and (iv) encompass robust governance arrangements to promote transparency and accountability in public sector policy action—for example, by conducting an effective public consultation process and establishing regular monitoring and reporting against set targets. In the medium term, complementing these, the national and sub-national governments should issue detailed adaptation investment plans, outlining their portfolio of high-priority projects, thereby facilitating the identification of residual risks associated with floods for the private sector. By recognizing that climate change poses a significant threat to the long-term sustainability of public sector finances, the Government should also consider developing a disaster risk finance framework to institutionalize disaster response and recovery systems while leveraging innovative contingent financing instruments. Such a framework would outline comprehensive ex-ante financial protection strategies for managing the costs associated with disasters like floods, aiming at limiting their impact on public sector finances.<sup>152</sup>
- 3. Strengthen the enabling environment for the financial sector to foster adaptation and emergency financing.** In the short term, financial sector regulators should rebalance the focus of the climate information architecture by placing greater emphasis on climate change adaptation, for instance, by (i) raising awareness and strengthening the policy discourse and advocacy for adaptation and emergency financing related

<sup>152</sup> The framework should assess and outline the appropriate level of risk retention and risk transfer for the public sector in alignment with their responsibilities and accountabilities for the financial impact of floods in Malaysia.

to flood risks, and (ii) publishing implementation guidance for taxonomies and climate-related disclosure frameworks focused on investments and activities related to adaptation and resilience to flood risks. In the medium term, as data availability and quality improve, the regulators should undertake flood risk assessments for the financial sector to inform other prudential policy actions to preserve financial stability. The frequency of such assessments should improve as information on flood risks and capabilities develop. The regulators should also carefully monitor the implementation of new policy tools and financial sector responses to guard against unintended consequences for financial inclusion and financial stability.

**4. Deploy targeted interventions to support access to finance for adaptation and recovery efforts, especially targeting the most vulnerable businesses, such as SMEs.**

While support to the enabling environment is necessary, it is not sufficient to foster adaptation and emergency financing related to flood risks; targeted financial interventions are still needed. Such interventions should focus on the most vulnerable businesses, especially SMEs, and policy makers must adopt an evidence-driven approach to design and implement targeted policy support to ensure effective outreach. The Government of Malaysia with the financial sector regulators should consider developing a policy framework outlining priorities in supporting access to finance for adaptation and recovery. Greater efforts are needed to strengthen the coordination of public sector policies to enhance the effectiveness and impact of interventions and prevent duplication of efforts. The policy framework could establish priorities and specific strategies (including specific policy instruments) to address the financing gaps for the most vulnerable businesses (especially SMEs), drawing from the principles discussed in this report about the use of concessionality, de-risking instruments (such as credit guarantees), and the adoption of robust M&E frameworks. To enhance the effectiveness of policy support, policy makers should adopt M&E frameworks across the range of targeted support currently available to businesses, including existing financial relief mechanisms provided by financial regulators. The deployment of targeted support should leverage public entities, such as development financial institutions, and existing financial support schemes for businesses.

**5. Deepen the insurance market to enhance the range of financial instruments that can support the financial resilience of businesses in Malaysia.** Doing so will involve consideration of a

range of potential pathways for policy support to expand the insurance market depth while ensuring affordability. The different solutions will affect incentives for businesses, ITOs, and the public sector, with consequences for market dynamics and significant distributional impacts. Therefore, the Government of Malaysia and the financial sector regulators should conduct an in-depth assessment of arrangements for public sector support for the insurance market, examining the relevant trade-offs of specific solutions in light of the challenges faced by Malaysian businesses and Malaysia's climate risk profile. These authorities should also consider establishing a framework for collaboration between the public sector and the insurance industry and defining the scope for public sector funding and other policy support. Because this assessment will take time, in the short term, the authorities should conduct a more in-depth and granular diagnostics assessment to identify critical vulnerabilities among businesses and gaps in insurance coverage, especially among vulnerable SMEs, and consider adopting temporary, targeted public sector policies to support financial resilience for vulnerable businesses.

**6. Strengthen public sector policy efforts to enhance flood risk awareness and build capabilities to foster greater efforts toward adaptation and resilience.**

Public sector intervention should focus on closing awareness gaps, particularly for businesses with lower capabilities and those prone to greater information asymmetries, such as SMEs. In the short term, the Government of Malaysia could leverage the possible publication of flood risk maps with awareness raising, for example, by using interactive platforms with information on flood hazards, exposures, and adaptation efforts. The Government could also develop well-targeted public awareness campaigns to mainstream flood risk management for businesses, especially among vulnerable segments. In the medium term, the Government of Malaysia should also deploy programs specifically designed to strengthen the capacity of businesses to map and assess the resilience of their supply chains, providing guidance in identifying vulnerable links for which preventive action may be warranted. Interventions supporting capacity building for both businesses and financial intermediaries can be deployed alongside directed financial support to improve the likelihood of impactful outcomes. Financial sector regulators can also enhance their capacity building efforts to foster the mainstreaming of flood risks into business operations, risk management practices, and investment decisions of financial institutions.

Roadmap for Policy Action	Time Frame*
<i>Enhancing Flood Risk Data Availability, Accessibility, and Affordability</i>	
Enhance accessibility by publishing flood hazard maps	ST
Develop legal and regulatory frameworks to support the collection and dissemination of data while managing the legal risks	ST
Improve the quality of flood hazard data by investing in hydro-met services	MT
Consider public sector and private sector partnerships to enhance data availability and accessibility	MT
<i>Developing a Long-term Adaptation Strategy</i>	
Develop a national adaptation strategy, outlining the government priorities and the scope of action for the public sector	ST
Strengthen the institutional structure and arrangements for disaster risk management	ST
Establish effective cooperation and coordination mechanisms and establish in the legal framework the responsibilities and liabilities of national, regional, and local government authorities and other stakeholders about flood risk management	ST-MT
Consider issuing detailed adaptation investment plans, outlining the public sector portfolio of high-priority projects	MT
Consider developing a disaster risk finance framework, based on risk-layering principles, to institutionalize disaster response and recovery systems	MT
<i>Strengthening the Enabling Environment for the Financial Sector</i>	
Rebalance the focus of the climate information architecture by placing greater emphasis on climate change adaptation rather than climate change mitigation	ST
Undertake flood risk assessments for the financial sector to inform other prudential policy actions, and reassess frequently as information and capabilities develop	MT
Monitor the implementation of new policy tools and financial sector responses to guard against unintended consequences for financial inclusion and financial stability	LT
<i>Supporting Access to Finance for Adaptation and Recovery</i>	
Develop a policy framework to support access to finance for adaptation and recovery	ST-MT
Consider the use of concessionality in access to adaptation and emergency financing to address critical financing gaps for vulnerable segments, such as SMEs	MT
Consider the deployment of de-risking instruments, such as credit guarantees	MT
Adopt robust monitoring and evaluation frameworks in policy interventions	MT
Consider the development of innovative capital market solutions to support adaptation financing	MT-LT
<i>Deepening the Insurance Market</i>	
Identify critical gaps in insurance and takaful coverage among vulnerable segments and consider the adoption of targeted policies for short-term support	ST
Conduct an in-depth assessment of alternative insurance arrangements, with explicit consideration to establishing a framework for collaboration between the public sector and the insurance industry and to defining the scope for public sector funding support	MT
<i>Building Capabilities and Enhancing Awareness</i>	
Consider the use of interactive platforms with information on flood hazards, exposures, and adaptation efforts to increase awareness	ST
Undertake public awareness campaigns to mainstream flood risk management	ST
Strengthen capabilities for flood risk management in the financial sector and the private sector	ST-MT
Deploy programs specifically designed to strengthen the capacity of businesses to map and assess the resilience of their supply chains	MT

\* Short term (ST): 6 to 12 months; Medium term (MT): 12 to 36 months; Long term (LT): 3 years and beyond.

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# Annex 1

## Sample for Business for the Assessment in Chapter 3

Business Size	Survey Sample		2015 Census Weights	
	Share of Firms	No. of Firms	Share of Firms	No. of Firms
Large	30.0	450	0.9	13
SMEs	70.0	1,050	99.1	1,487
Total		1,500		1,500

Business Sector	Survey Sample		2015 Census Weights	
	Share of Firms	No. of Firms	Share of Firms	No. of Firms
Agriculture	3.4	51	1.1	17
Manufacturing	41.8	627	5.4	81
Services	50.7	760	89.1	1,337
Construction	4.1	62	4.3	65
Total		1,500		1,500

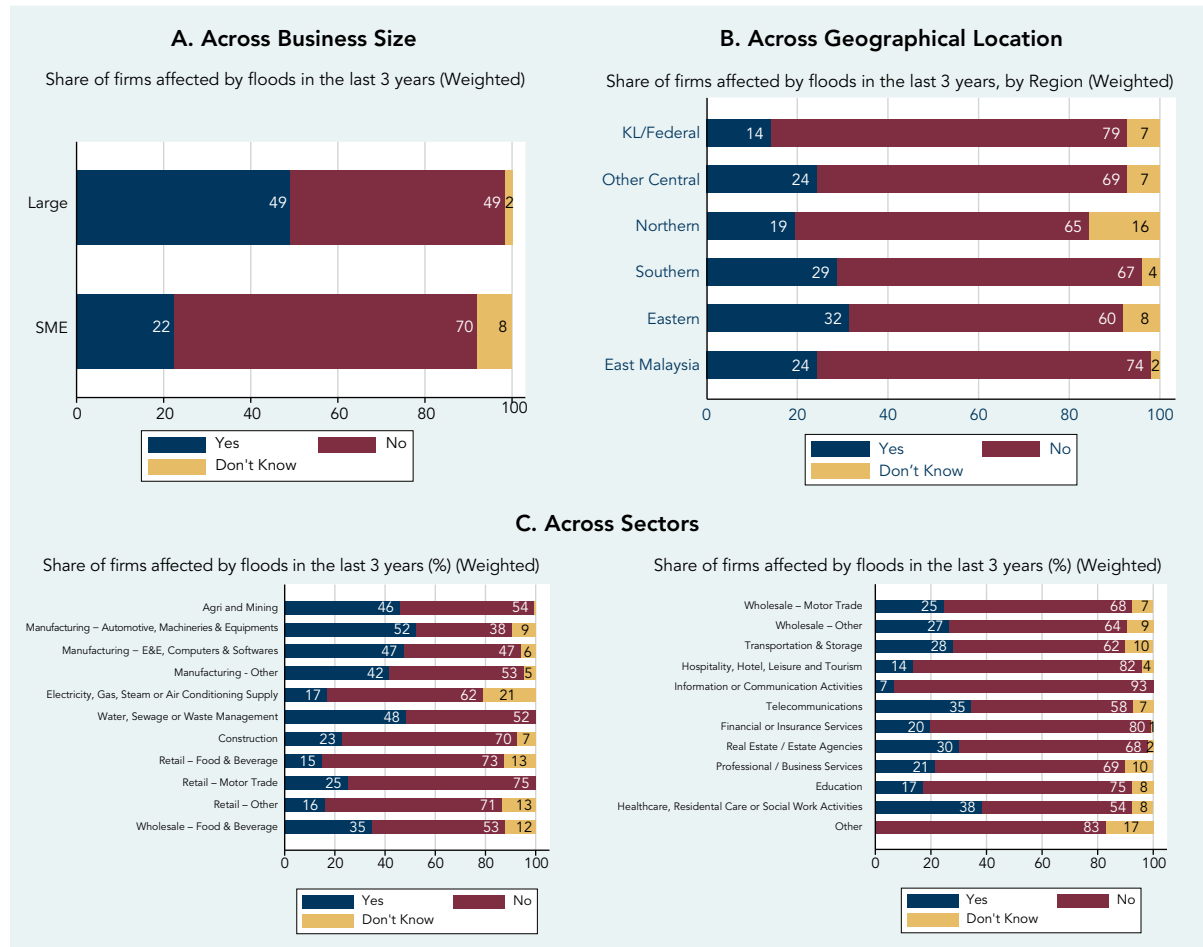
Business Geographical Location	Survey Sample		2015 Census Weights	
	Share of Firms	No. of Firms	Share of Firms	No. of Firms
Central (net)	58.5	878	38.9	584
Northern	17.7	266	21.7	325
Southern	11.3	169	14.2	213
Eastern	5.7	86	12.4	186
East Malaysia	6.7	101	12.8	192
		1,500		1,500

# Annex 2

## Census Weight Results of the Business Survey

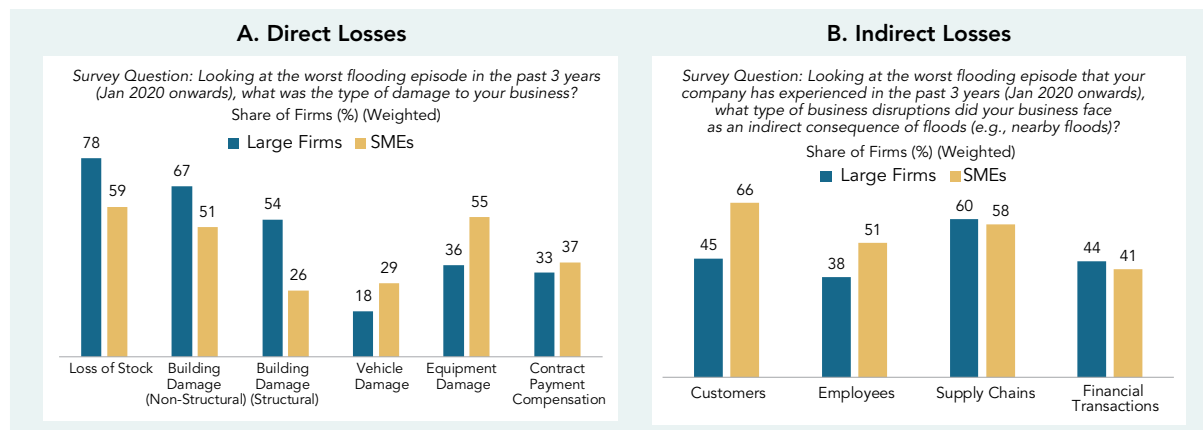
**FIGURE A2.1**

Profile of Businesses Affected by Floods in the Last Three Years



**FIGURE A2.2**

Losses and Disruptions Associated with Floods

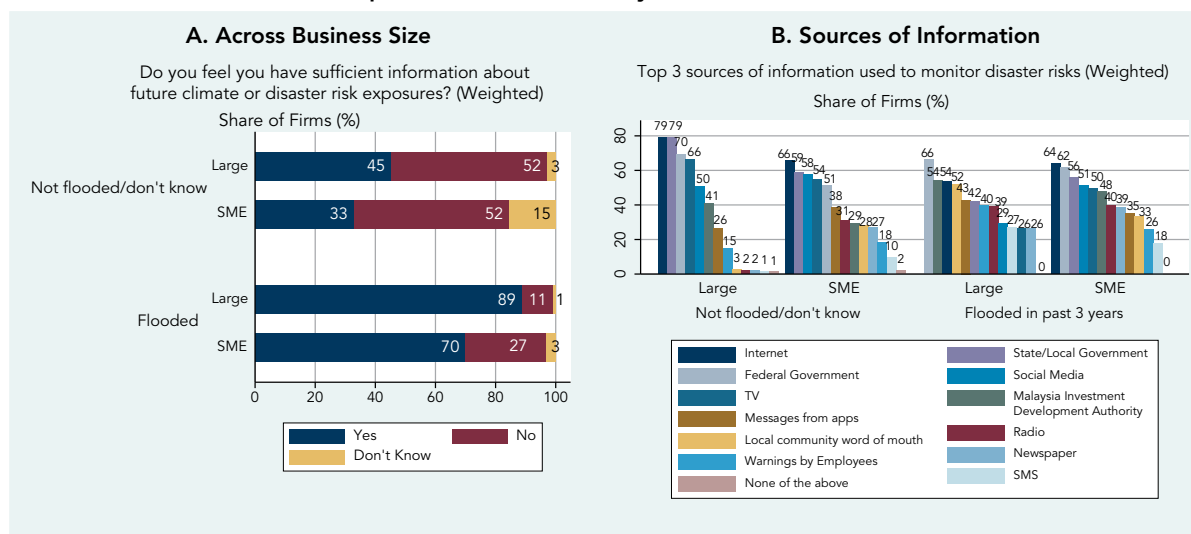


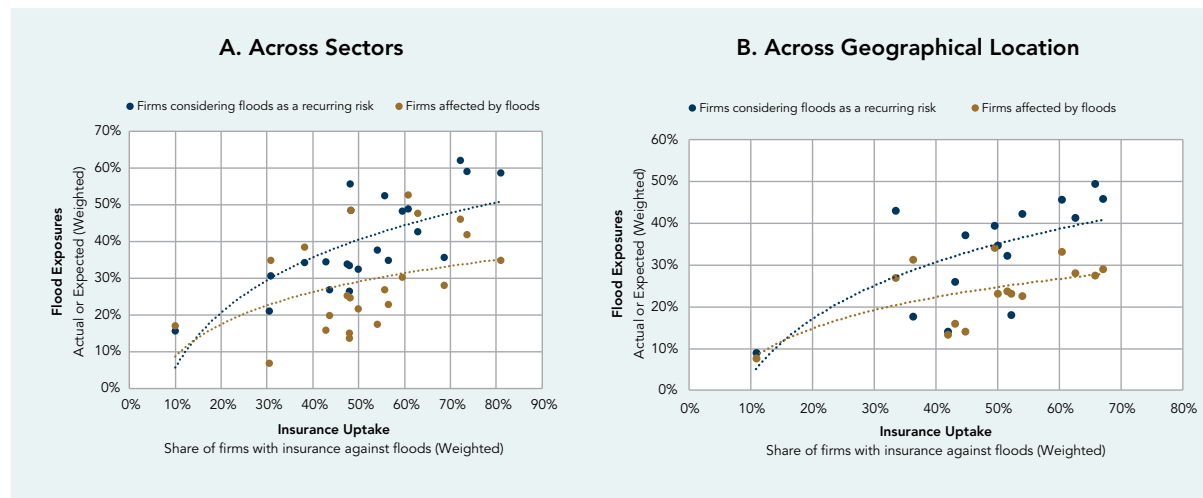


**FIGURE A2.3**  
Flood-Hit Businesses and Flood Risk Awareness

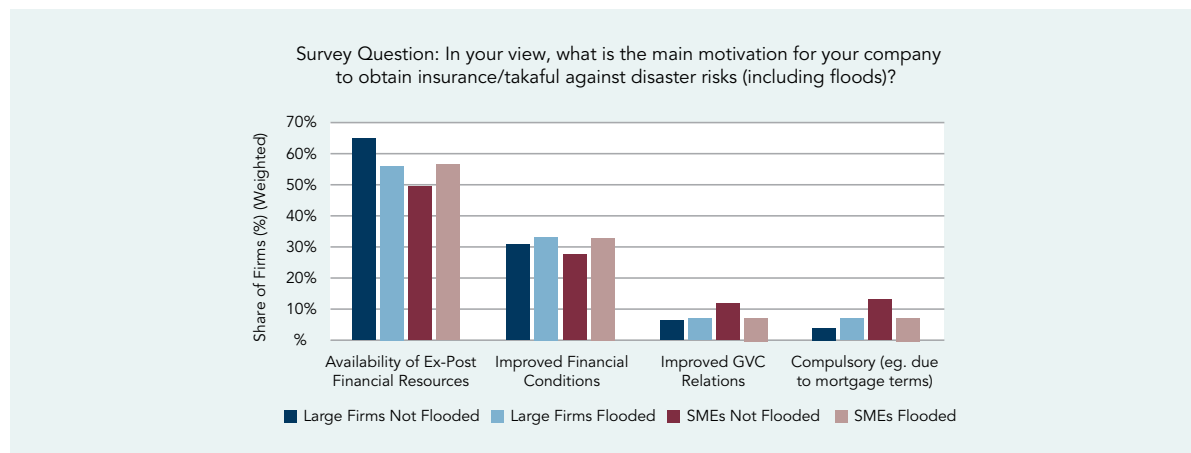


**FIGURE A2.4**  
Flood-Hit Businesses and Perceptions about Availability of Information

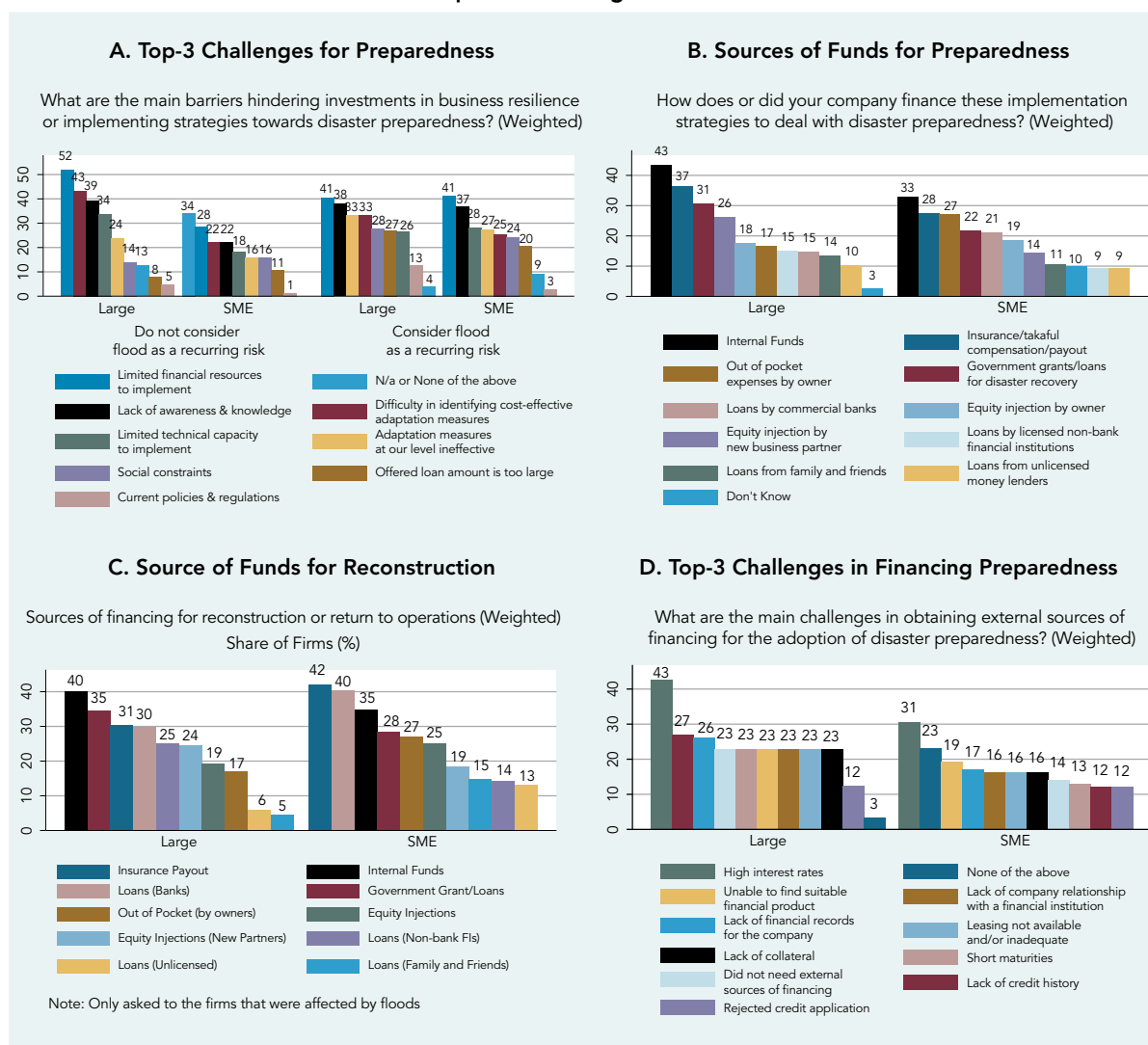


**FIGURE A2.5****Flood Risk Awareness and Adoption of Disaster Preparedness Strategies****FIGURE A2.6****Flood Insurance Uptake**

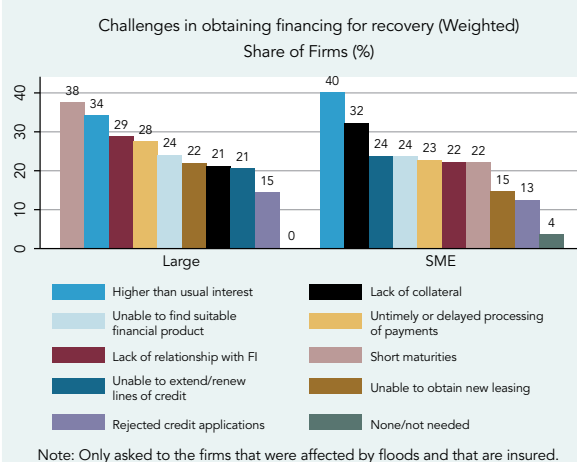
**FIGURE A2.7**  
Motivation to Purchase Flood Insurance



**FIGURE A2.8**  
Constraints in Access to Finance for Adaptation Strategies

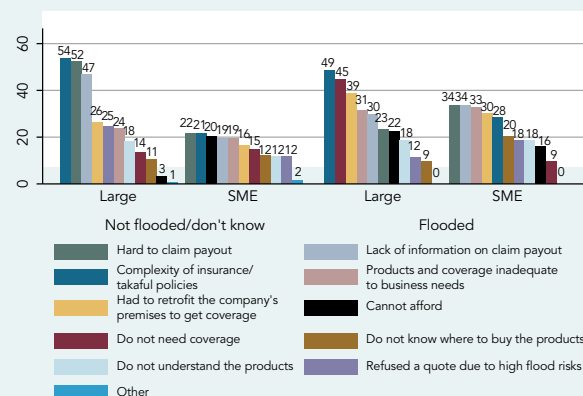


### E. Top-3 Challenges in Financing Recovery and Reconstruction Expenses



### F. Top-3 Challenges to Obtain Insurance

What are the main obstacles to get insurance for your business against special perils, specifically floods? (Weighted)

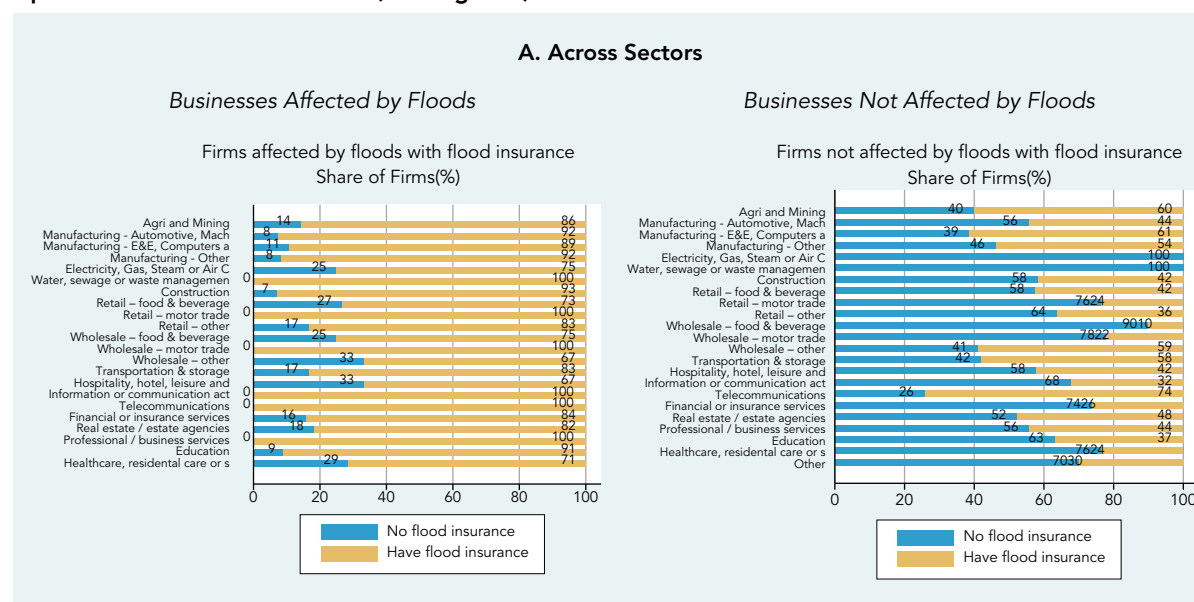


## Annex 3

### Flood Insurance across Sectors and Regions

FIGURE A3.1

Uptake of Flood Risk Insurance (Unweighted)

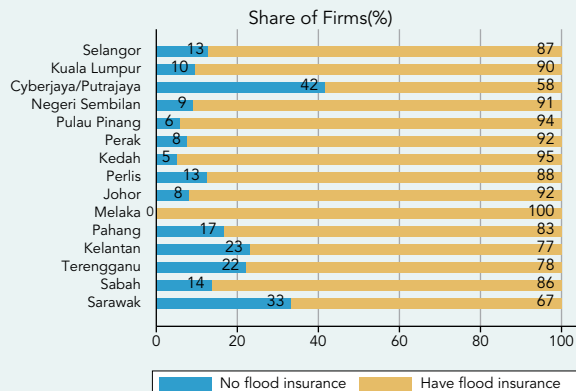




## B. Across Regions

### Businesses Affected by Floods

Firms affected by floods with flood insurance



### Businesses Not Affected by Floods

Firms not affected by floods with flood insurance

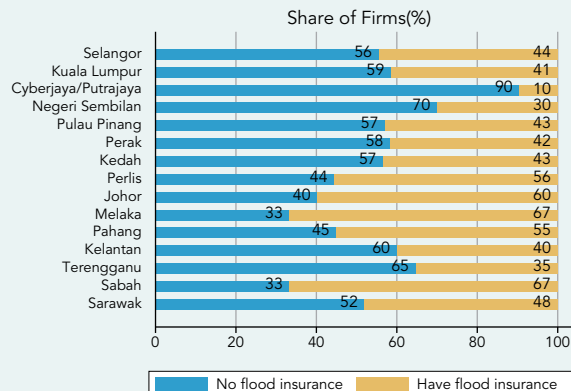


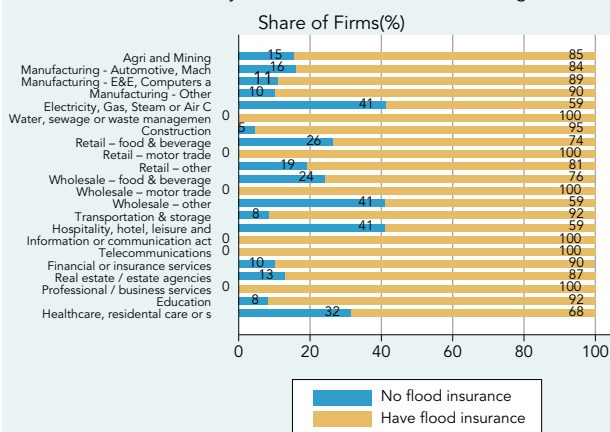
FIGURE A3.2

## Uptake of Flood Risk Insurance (Weighted)

### A. Across Sectors

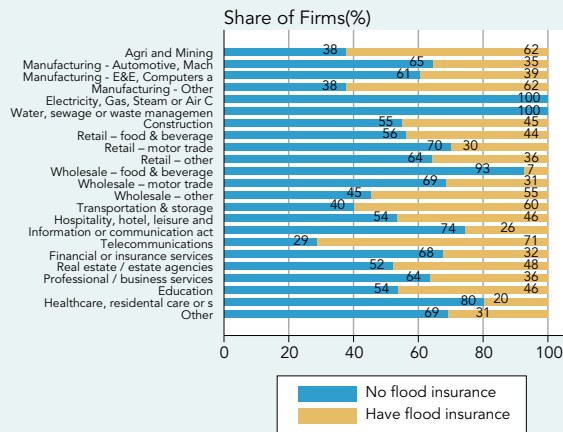
#### Businesses Affected by Floods

Firms affected by floods with flood insurance (Weighted)



#### Businesses Not Affected by Floods

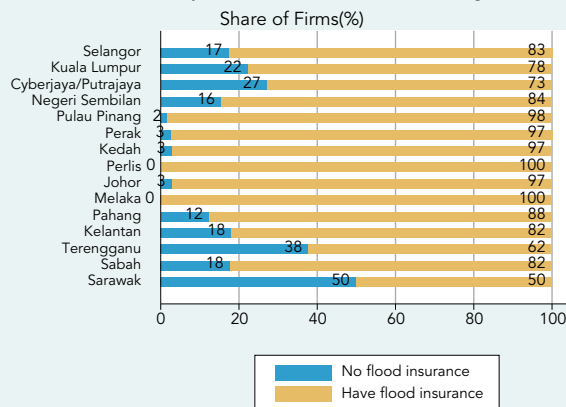
Firms not affected by floods with flood insurance (Weighted)



### B. Across Regions

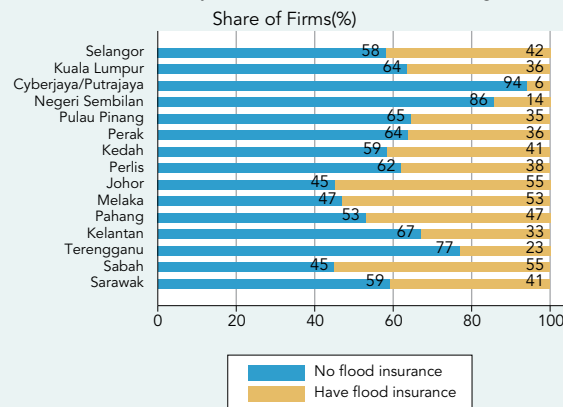
#### Businesses Affected by Floods

Firms affected by floods with flood insurance (Weighted)



#### Businesses Not Affected by Floods

Firms not affected by floods with flood insurance (Weighted)



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