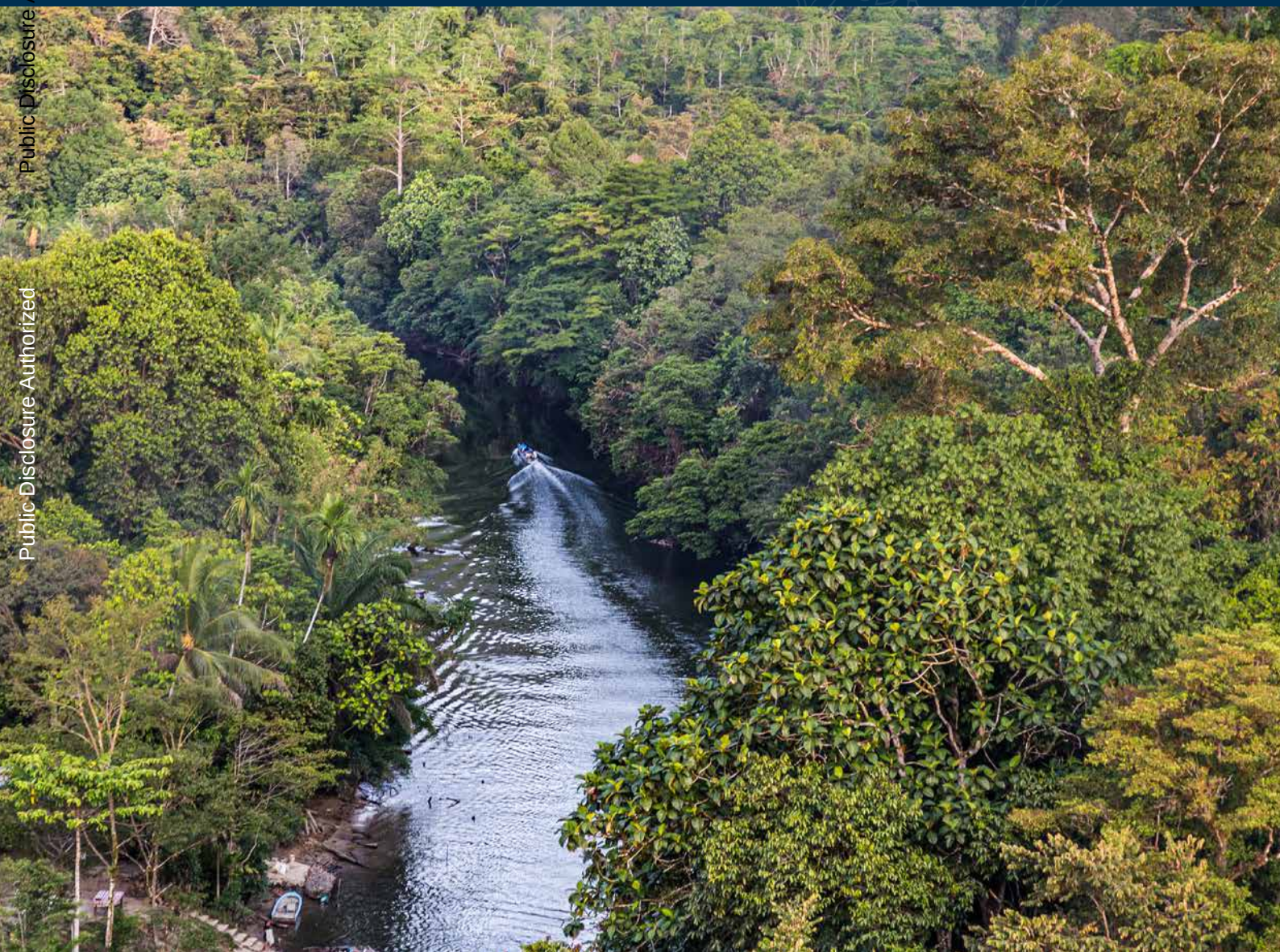
WORLD BANK GROUP
Inclusive Growth & Sustainable Finance Hub in Malaysia

BANK NEGARA MALAYSIA
CENTRAL BANK OF MALAYSIA

An Exploration of Nature-Related Financial Risks in Malaysia

MARCH 2022



CONNECT WITH US

WORLD BANK GROUP
Inclusive Growth & Sustainable Finance Hub in Malaysia

wbg.org/Malaysia

@WorldBankMalaysia

@WB_AsiaPacific

http://bit.ly/WB_blogsMY

BANK NEGARA MALAYSIA
CENTRAL BANK OF MALAYSIA

www.bnm.gov.my

@bnm.official

@BNM_official

@banknegaramalaysia

BNM Official

Bank Negara Malaysia

An Exploration of Nature-Related Financial Risks in Malaysia

MARCH 2022

WORLD BANK GROUP
Inclusive Growth & Sustainable Finance Hub in Malaysia

BANK NEGARA MALAYSIA
CENTRAL BANK OF MALAYSIA

Table of Contents

Acknowledgements

An Exploration of Nature-related Financial Risks in Malaysia was prepared through a joint Bank Negara Malaysia-World Bank collaboration by core team members Nepomuk Dunz, Henk Jan Reinders, Shahira Johan Arief Jothi, Rekha Reddy, Martijn Regelink, Fiona Stewart (World Bank), Mohd Shazwan Shuhaimen, and Thulaja Thessa K. Vasudhevan (BNM), under the supervision of Cecile Thioro Niang (World Bank) and Madelena Mohamed (BNM). Shashank Singh, Samantha Power, Uma Rajoo (World Bank), Keshia Jasmine Ashaari, Nur Izzati Jamal, Nur Zalini Abdul Rahman, and Chow Chin Hwa (BNM) provided key inputs. Pietro Calice, Rafaello Cervigni, Souleymane Coulibaly, Katia D'Hulster, Erik Feyen, Federico Diaz Kalan, Tatiana Didier, Olga Gavryliuk, Giovanni Ruta, Marc Schrijver, Tao Wang (World Bank), Jessica Chew Cheng Lian, Fraziali Ismail, Suraya Sani, Razeen Mohd Rom, Chuah Kue Peng, Katie Lee, Audrey Lim Shu Wen, Nur Syairah Husna (BNM), and Quek Yew Aun of the Ministry of Energy and Natural Resources (KeTSA) provided useful comments on draft versions of this report. Kane Chong and Francis Sim designed the report and its cover. 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.

List of Figures

List of Boxes

Acronyms and Abbreviations

ASEAN	Association of Southeast Asian Nations
BNM	Bank Negara Malaysia
CO2/ CO2e	Carbon Dioxide/Carbon Dioxide Equivalent
CCPT	Climate Change and Principle Based Taxonomy
DFI	Development Finance Institutions
DNB	Dutch Central Bank (*De Nederlandsche Bank*)
ESG	Environmental, Social, and Governance
ENCORE	Exploring Natural Capital Opportunities, Risks and Exposure (biodiversity tool)
EU	European Union
EUR	Euro (currency)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
Gt	Gigaton
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IBAT	Integrated Biodiversity Assessment Tool
KBA	Key Biodiversity Areas
JC3	Joint Committee on Climate Change
MSA	Mean Species Abundance
MSPO	Malaysia Sustainable Palm Oil
MyBIS	Malaysia Biodiversity Information System
NACE	Statistical Classification of Activities in the European Community (*Nomenclature des Activités Économiques dans la Communauté Européenne*)
NGFS	Network for Greening the Financial System
NGO	Non-Governmental Organization
RM	Malaysian ringgit (currency)
TCFD	Task Force for Climate-related Financial Disclosure
TNFD	Task Force for Nature-related Financial Disclosure
UEBT	Union for Ethical Biotrade
UK	United Kingdom
UN	United Nations
USD	United States dollar (currency)
VBI/ VBIAF	Value-Based Intermediation/Value-Based Intermediation Financing and Investment Impact Assessment Framework
WB	World Bank
WEF	World Economic Forum

Executive Summary

ES.1 Introduction

Malaysia is one of the world's megadiverse countries, and many of its economic activities are directly or indirectly dependent on nature and its associated ecosystem services.[1] The COVID-19 pandemic, with its far-reaching economic impacts, is a reminder of the link between human health and planetary health, given that most human infectious diseases are transmitted between species (Taylor et al. 2001). Ecosystem services are broadly defined as the benefits that people obtain from ecosystems and include regulating services (such as regulation of droughts, floods, and land degradation), provisioning services (such as crops, fresh water, aquaculture, and timber), supporting services (such as photosynthesis, nutrient cycle, and water cycle), and cultural services (such as recreational and other non-material benefits). A recent World Bank (WB) study found that, in a worst-case scenario of partial ecosystem collapse, Malaysia could experience a 6 percent gross domestic product (GDP) annual loss by 2030 compared to a baseline scenario (Johnson et al. 2021). In Malaysia, the losses would be driven by a decline in export demand and adverse impacts of the partial collapse of forestry and fishery ecosystem services.

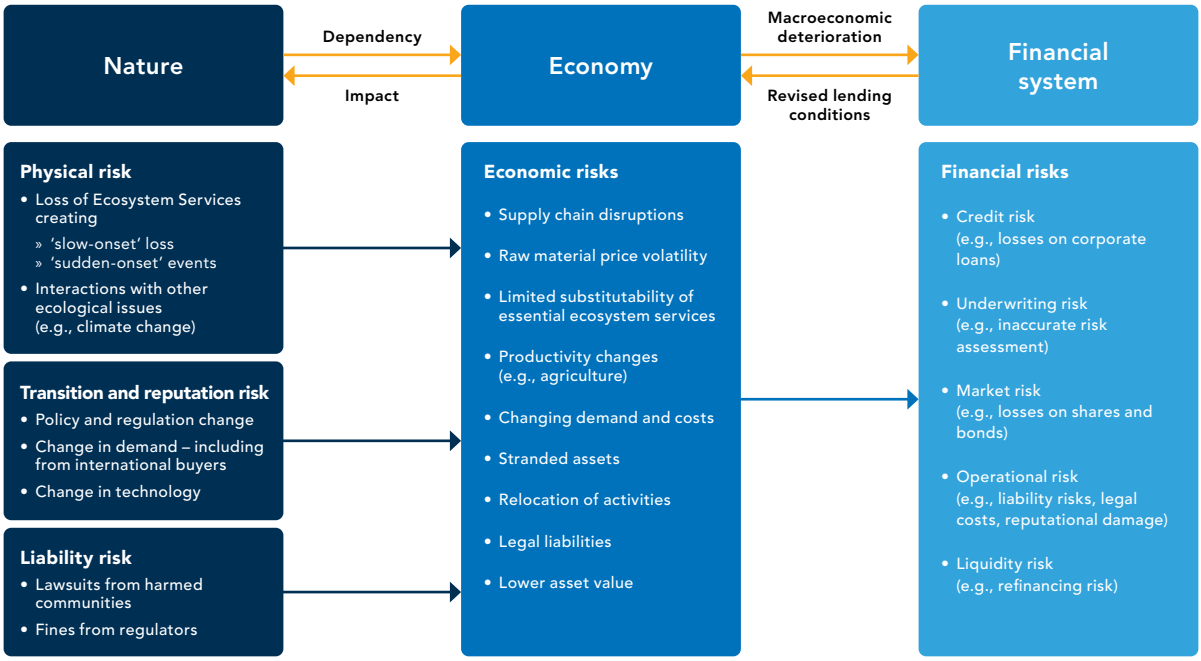
In parallel to climate-related risks, nature-related risks can lead to economic and financial losses. As shown in Figure 1, nature-related risks as defined in this study encompass a broad set of risks that are related to ecosystem services, biodiversity, and natural assets (such as water and forests). Within the environmental risk dimension of the environmental, social, and governance (ESG) framework on sustainability, these risks complement and partly overlap with those risks associated with climate change.[2] *Physical risk* could emerge from the deterioration and loss of ecosystem services that firms depend on. At the same time business operations may have an impact on biodiversity and ecosystem services via *excessive* natural resources extraction, disposal of waste, or land-use change. If firms do not adapt in a timely fashion and banks do not adjust their lending portfolio, nature-related financial *transition risk* could materialize. Transition risk consists of sudden changes in policy, technology, and consumer preferences in response to nature loss and can have a substantial impact on the economic, financial, and reputational position of firms and their financing banks with large impacts on biodiversity and ecosystems.

Central banks have recently started to investigate biodiversity and other nature-related impacts and dependencies of financial systems. Central banks and supervisors have so far focused mainly on climate-related risks but have recently expanded their efforts to cover a broader set of environmental risks. Studies include France (Svartzman et al. 2021), the Netherlands (van Toor et al. 2020), and Brazil (Calice et al. 2021). Such studies on nature-related risks are nevertheless at a nascent stage and largely exploratory in nature (Network for Greening the Financial System (NGFS) 2021).

1 The term megadiverse country refers to any one of a group of nations that harbor the majority of Earth's species and high numbers of endemic species. The World Conservation Monitoring Centre of the United Nations Environment Program has identified 17 mega-diverse countries, one of which is Malaysia.

2 For example, this study finds that two important nature-related factors Malaysian banks may have exposure to are: (1) the imposition of more stringent climate policies and (2) enhanced efforts to preserve nature's function as a store of carbon-dioxide (C02). It also finds highly relevant risk factors that are connected to climate change – including those related to extensive water use, land use, and pollution other than greenhouse gases (GHGs).

Figure 1: From nature-related risks to financial risks



Source: Based on van Toor et al. 2020 and Svartzman et al. 2021

More comprehensive regulatory and supervisory policy implications are under development. The NGFS, of which Bank Negara Malaysia (BNM) is a member, has recommended several first actions that could be taken by financial sector regulators and supervisors to help build the foundations for more comprehensive measures, namely: (1) capacity building, (2) assessing domestic financial system dependencies and impacts on nature, (3) awareness raising and signaling, and (4) supporting relevant initiatives to the extent possible (NGFS 2021).

BNM, as part of its mandate to promote monetary and financial stability conducive to the sustainable growth of the Malaysian economy, has an interest in understanding nature-related financial risks to the financial sector. A better understanding of nature-related financial risks is important for prudential supervision to identify and address any emerging risks in the loan books and investments of banks and other financial institutions. This work is the result of a collaboration between the WB and BNM to: (1) build capacity to develop the analytical framework through which nature-related financial risks can be analyzed and managed and (2) raise awareness of these issues within BNM and among stakeholders in the government and the financial sector. Sustainable policies for the maintenance of ecosystem services are the main responsibility of the line-ministries within the government. However, adequate pricing of nature-related financial risks is important to align capital allocation, including loan origination, with Malaysia's sustainability goals.[3]

This report assesses the exposure of Malaysian banks to sectors and regions that are highly vulnerable to nature-related risks.[4] Expanding on the work of other central banks, three main types of exposures are examined. These include (1) the exposure of banks to sectors that are highly dependent on ecosystem services and hence pose physical risk, (2) the exposure of banks to sectors that negatively affect ecosystem services

3 One of the main roles of the financial system is to allocate capital (both equity and debt) to productive activities. When risks are not adequately understood and priced in, this could lead to an overallocation of capital to sectors that is not in line with sustainability objectives. Furthermore, it hinders adequate mitigation actions to prevent or limit financial impacts of such risks.

4 Exposure is defined here as the fraction of outstanding loans to highly vulnerable sectors and regions that could potentially be affected by adverse nature-related risk factors and scenarios.

and hence pose transition risk, and (3) the exposure of banks to Key Biodiversity Areas (KBA) that may become protected in the future. In addition, a first set of adverse scenarios are identified that are most relevant to Malaysia and these are mapped to bank's loan exposures.

This study makes use of both Malaysian and global data. The sectoral mapping data is primarily obtained from the Exploring Capital Opportunities, Risks and Exposure (ENCORE) database while the exposure data is obtained from BNM. The spatial analysis uses data on KBA in Malaysia from the World Database of Key Biodiversity Areas, hosted by the Integrated Biodiversity Assessment Tool (IBAT). The sectoral analysis covers approximately 90 percent of the total commercial loan portfolio of Malaysian banks while data for the spatial analysis are far more limited.

Given that the data and methodologies to assess nature-related financial risks are currently limited, this study is exploratory in nature. This report constitutes a first step towards assessing the exposure of Malaysian banks to nature-related financial risks. However, data on economic and financial vulnerability is often incomplete or unavailable. To get a more complete understanding of nature-related financial risks, further research is needed, this may include developing: (1) a comprehensive set of scenarios to be used in assessing nature-related financial risks, (2) a better understanding of how scenarios lead to adverse economic and financial outcomes (e.g., transmission channels), and (3) models to understand the quantitative impact of scenarios and transmission channels on economic sectors and financial institutions, including banks. Key findings are provided in section ES.2 and a list of potential actions in section ES.3.

ES.2 **Key Findings**

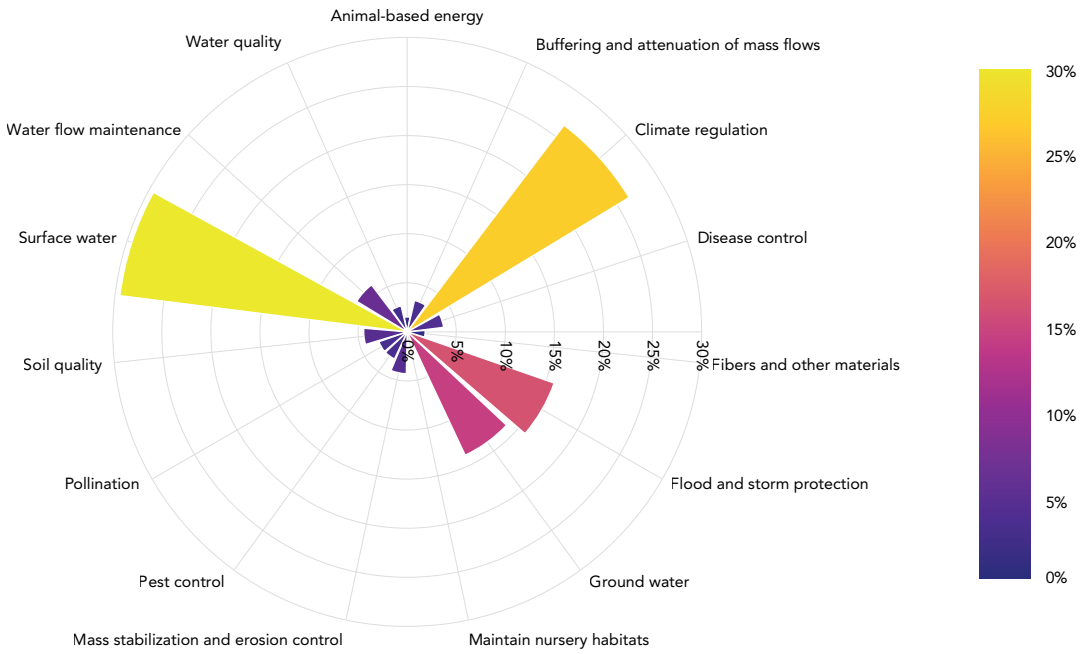
Based on loans to economic sectors, Malaysian banks are exposed to a broad range of nature-related physical and transition risks. Of the commercial loans portfolio analyzed, 54 percent is exposed to sectors that depend to a high extent on ecosystem services. This high dependency exposes Malaysian banks to physical risk from ecosystem deterioration, particularly related to deterioration in surface water[5] (29 percent), climate regulation such as carbon storage (26 percent), and flood and storm protection (16 percent) (Figure 2, panel a). Of the commercial loans portfolio, 87 percent is also exposed to sectors that strongly impact ecosystem services (thus potentially facing a higher level of transition risk from changes in regulations and policies), particularly related to greenhouse gas (GHG) emissions (61 percent), water use (55 percent), and terrestrial ecosystem use[6] (43 percent) among others (Figure 2, panel b).

There are wide differences between individual banks and bank types in their exposure to physical risk arising from lending to sectors that depend highly on ecosystem services and transition risk, and arising from lending to sectors that have significant impact on nature. The differences are linked to the target sector of lending that those banks predominantly serve. For example, construction lending is strongly dependent on surface water[6],climate regulation, and flood and storm protection, and strongly impacts nature via terrestrial ecosystem use, freshwater use, and GHG emissions, among others.

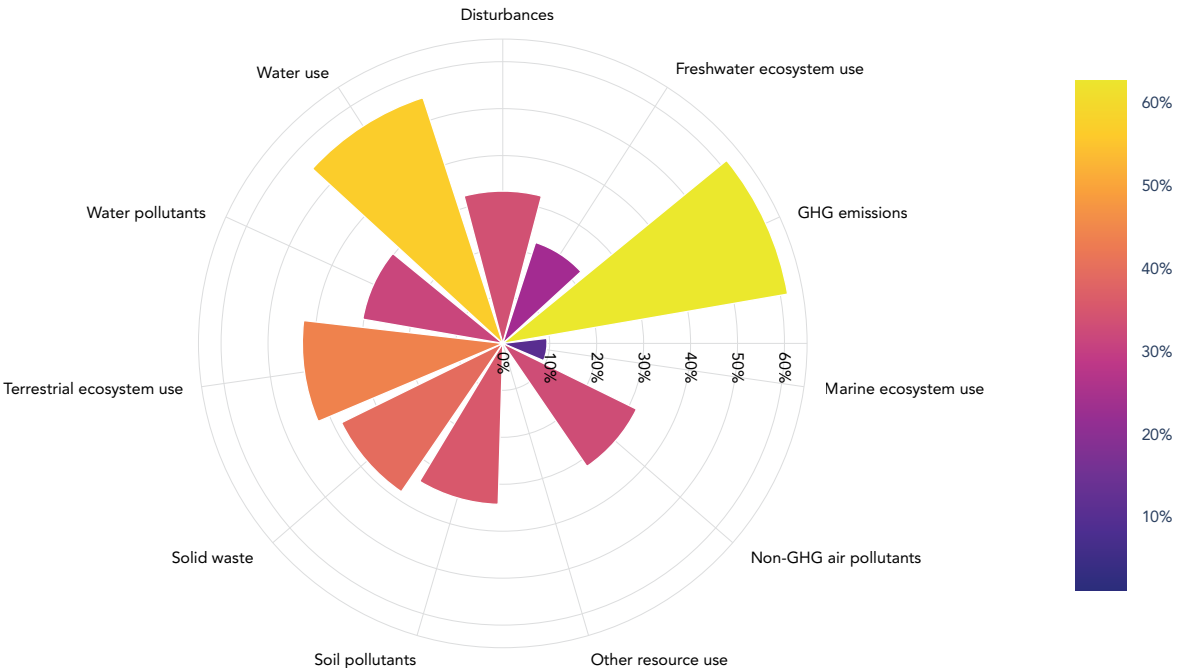
5 This terminology refers to the provision of clean water from rain and water flow from natural sources.
6 This terminology refers to *unsustainable* land use change or resource use, which reduces the extent of natural ecosystems, or over exploits them beyond their ability to replenish, which in turn affects continuous provision of ecosystem services.

Figure 2. Percentage of Malaysian banks' commercial loans to sectors with high and very high scores on nature-related risk dimensions

(a) Dependency on ecosystem services (physical risk)



(b) Impacts on ecosystem services induced by firms' business activities (transition risk)



Source: ENCORE, BNM, WB calculations

For physical risk, individual banks' exposure to one or more sectors that are highly or very highly dependent on ecosystem services range between 5 and 83 percent of the total commercial loan portfolio. The average exposure according to bank type ranges from 40 percent (investment banks) to 55 percent (Islamic banks). As for transition risk, the individual banks' exposures to sectors that highly or very highly impact nature range between 28 and 100 percent. The average exposure according to bank type ranges from 70 percent (investment banks) to 95 percent (development finance institutions (DFIs). The largest variance in exposures to both physical and transition risks according to bank type is observed in investment banks.

Based on the spatial distribution of loans, Malaysian banks have limited direct exposure to KBA that may be increasingly protected in the future. KBA are sites that contribute significantly to maintaining global biodiversity and are hence important candidates for future protective regulation (i.e., transition risk).[7] The states Perak and Kedah currently have more than a quarter of their territory designated as non-protected KBA. However, the majority of the commercial loans analyzed are channeled to Kuala Lumpur and Selangor, areas that are already well developed. Less than one percent of Malaysian banks' lending portfolio (RM 329 million, USD 78 million) is estimated to go to firms in currently non-protected KBA.

Due to data limitations, however, it is possible that exposures are higher.[8] It would be important to monitor new loan origination practices towards both currently protected areas and areas that may become protected in the future, especially as there are ongoing discussions for an increased target on protected areas under the Convention on Biological Diversity, to which Malaysia is a signatory. There may also be an important role to monitor more indirect exposures through, for example, supply chain linkages between firms in and outside protected areas.

An explorative set of nature-related events shows that there is a wide range of adverse physical risk and transition risk scenarios that could affect Malaysian banks. Based on ENCORE and interviews with stakeholders, 21 possible scenarios of nature-related financial physical risk and 7 nature-related financial transition risk scenarios were identified. These scenarios were not projections of a business-as-usual scenario, but rather state the current financial exposure if affected ecosystem services of identified scenarios defaulted.

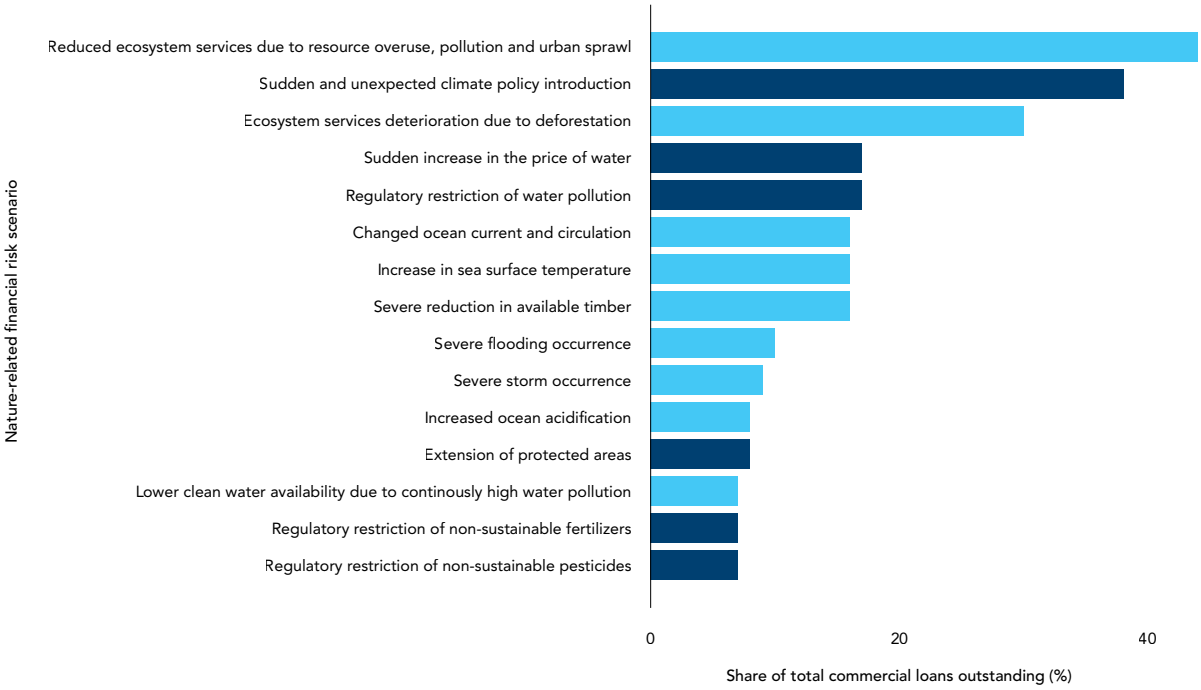
Scenarios with the highest banking sector exposure are those that affect a wide range of sectors. These include: reduced ecosystem services due to continued high resource use, pollution, and urban sprawl (44 percent of the commercial loans portfolio), sudden and unexpected introduction of new climate policy (38 percent), and deterioration of ecosystem services due to continued high rates of deforestation (30 percent), as shown in Figure 3.

Sectors including agriculture, forestry, fisheries, and tourism are affected by many different financial physical and transition risk scenarios. Other sectors, such as real estate, construction, and wholesale, are large sectors within the Malaysian banking sector's loan books but have a more limited number of relevant scenarios connected to them. These sectors are specifically exposed to scenarios that limit water availability and scenarios that affect a wide range of ecosystem services (such as deforestation-induced ecosystem service deterioration).

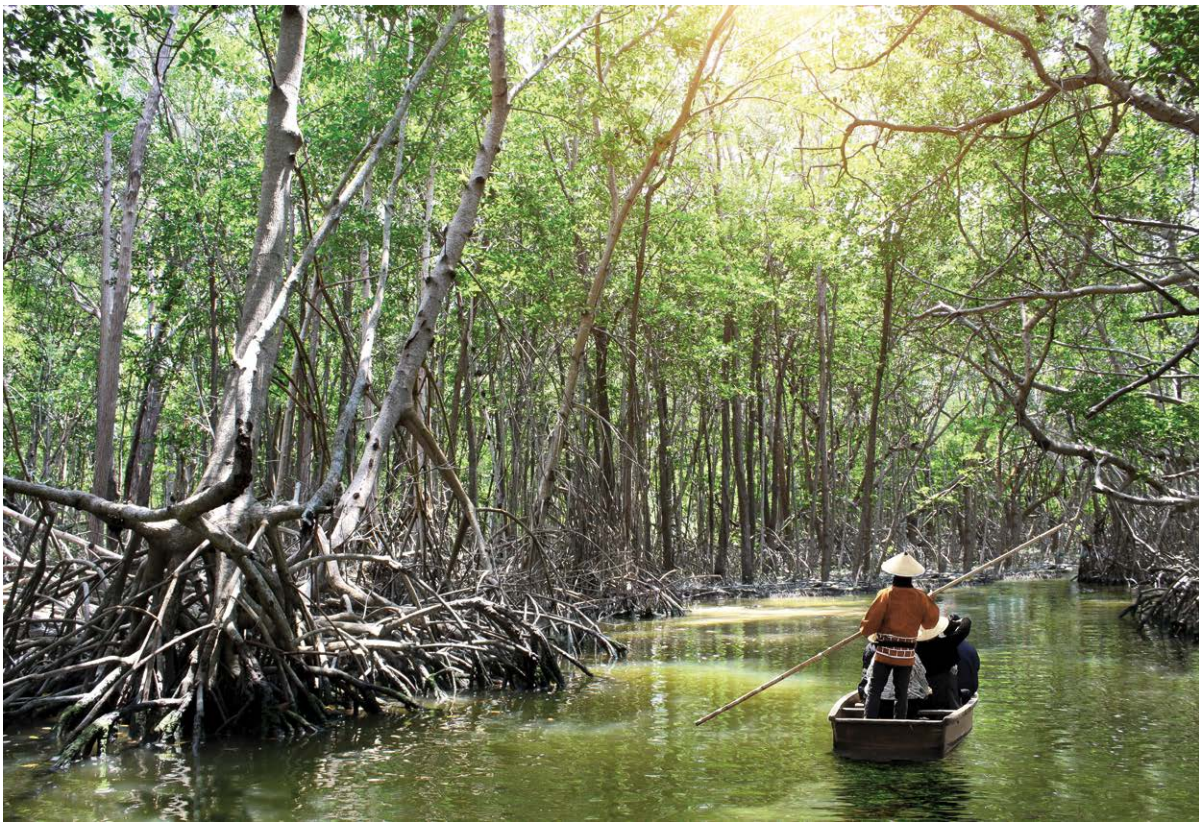
7 The Integrated Biodiversity Assessment Tool website (IBAT) utilizes two subsets of KBA in virtually all countries: Important Bird and Biodiversity Areas (IBA) and Alliance for Zero Extinction Sites (AZE). For Malaysia, KBA data is primarily based on IBA data, capturing bird population and diversity. IBAT data show that IBAs make up 55 of 60 terrestrial KBA in Malaysia. Other areas could be important for biodiversity and at risk as well, where currently no data is available.

8 See Appendix Section A1 for details on data limitations.

Figure 3: Top-15 identified nature-related financial risk scenarios by banking sector commercial loans exposure



Source: ENCORE, BNM, interviews, WB calculations.
Note: Dark blue scenarios are nature-related financial transition risk scenarios, light blue scenarios are nature-related financial physical risk scenarios. Exposure amounts are based on the share of corporate loans to economic sectors that could be directly affected in the scenario under consideration.



ES.3 **Potential Actions to Address Challenges of Nature-Related Financial Risks**

Based on this initial assessment, the findings of this report may support further policy discussions to understand the potential impacts of nature-related financial risks on the financial sector and the economy. Like climate change, addressing the nature-related agenda demands a multistakeholder approach driven by the federal government as part of an integrated national strategy in which financial regulators can act as a central coordinator for a relevant financial sector action plan. Financial regulators, as advisors to the government, have an important role in providing a feedback loop to the government to highlight the potential impacts of nature-related financial losses to the financial sector and the economy. Thus, this report can be a catalyst to initiate discussions and synchronize existing efforts by relevant government agencies to better model and quantify the value of ecosystem services in Malaysia.

Malaysia's financial sector regulators could build on their ongoing climate change initiatives to deepen the understanding of nature-related financial risks, aiming to address them in a more comprehensive manner. While the discussion on nature-related financial risks is still at a nascent stage, efforts to address such risks are within the existing mandate of BNM to the extent that they pose a threat to its ability to preserve Malaysia's financial stability. Although this report is exploratory and its analyses have limitations, the risks presented in its findings, Malaysia's status as a megadiverse country, and the impact of the recent flood event,[9] provide motivation for BNM to continue building its internal capacity for analysis and facilitate wider awareness of these issues as initial steps. Moreover, BNM could help contribute towards knowledge development and regulatory discourse on nature-related financial risks in the region and globally, bringing the valuable perspective of a megadiverse developing country.

Subsequently, BNM could develop further actions related to nature-related financial risks that are cohesive and integrated within its existing climate change strategy. These might include: (1) national policy discussion and direction on nature-related risks, (2) further development of nature-related financial risks methodologies and analyses, (3) progress of ongoing climate change initiatives and determined linkages with nature-related financial risks, and (4) incorporation of evolving practices and standards from the global financial regulatory and supervisory community.

Key areas for actions to manage nature-related financial risks include, (1) raising awareness and policy discourse, (2) enhancing capacity building of relevant stakeholders, (3) enhancing macroeconomic surveillance capacity and risk identification, and (4) developing regulatory and supervisory requirements. Figure 4 depicts recommended actions that could be considered by BNM (and relevant stakeholders such as ministries with responsibility for environmental issues, state-level agencies, and financial institutions) and the level of policy intervention intensity, recognizing the need for prioritization in this challenging pandemic period.

9 The December 2021 flood event, which displaced around 125,000 people across ten states, was linked to extreme weather patterns that became more likely with climate change. Public opinion in one state suggests deforestation worsened flood conditions. As at 2 January 2022, the government had allocated RM1.2 billion (USD335 million) in financial aid and other forms of relief for the flood victims.

Figure 4: Possible actions to address challenges of nature-related financial risks

Policy intervention

Less intensive ← → ***More intensive***

Public awareness/ Policy discourse	**Raising awareness, stakeholder engagement and policy discourse on understanding nature-related financial risks**	• Disseminate report findings with relevant governmental and non-governmental stakeholders, relevant regulators and supervised financial institutions. • Contribute to knowledge programs that raise awareness on nature-related financial risks.	• Advocate and work closely with government to include considerations of nature-related financial risks in relevant policies and investment decisions.	• Encourage and support the government towards developing a cohesive national strategy to address nature-related risks alongside climate change.
Capacity building	**Enhancing capacity building of relevant stakeholders**	• Expand existing capacity building and stakeholder engagement programs under the Joint Committee on Climate Change (JC3) to include nature-related financial risks. • Collaborate with key knowledge partners to build understanding and tools for nature-related financial risks.	• Support development of incentives and instruments to mobilize private finance for the protection and management of biodiversity and ecosystem services.	• Provide financial sector perspectives to government to expand existing government grants/funds related to climate change to encompass goals relevant to protection of biodiversity and ecosystem services.
	Enhancing macroeconomic surveillance capacity and risk identification	• Enhance technical capacity in understanding nature-related financial risks by identifying transmission channels and interacting factors between climate and nature-related risks. • Incorporate a basic concept of nature-related financial risks in existing plans for a surveillance framework on climate risks where both risks have strong synergies (ex: deforestation, disaster resilience).	• Improving existing data collection relevant to nature-related risks at a granular level, including for non-credit products (e.g., insurance) and leveraging ongoing work under the JC3.	• Consider nature-related financial risks as part of high-level reference scenarios for Malaysia, towards developing stress testing plans for nature-related risks alongside climate change. • Consider supervisory deep dives at select banks that are deemed at higher risk, for example due to their financing activities in (future) protected areas.
Policy adoption	**Developing regulatory and supervisory requirements**	• Enhance existing guidance on nature-related risks in relevant taxonomies and frameworks (CCPT, VBIAF, ASEAN taxonomy) by synthesizing relevant findings of this report.	• Signal expectations for supervised institutions to understand the most relevant nature-related financial risks faced by their institution. • Enhance climate-related regulatory guidance on risk management, governance, and disclosures with specific aspects of nature-related financial risks.	• Communicate regulatory and supervisory expectations on managing and disclosing nature-related financial risks along with risks of climate change for supervised institutions. • Develop a monitoring system for new credit to be compliant with climate and nature-related regulations, including checking whether business activities will take place in (future) protected areas.

Source: WB. Note: CCPT = Climate Change and Principle-based Taxonomy; VBIAF = Value-based Intermediation Financing and Investment Impact Assessment Framework; ASEAN = Association of Southeast Asian Nations.

CHAPTER 1

Biodiversity, Nature, and Banking in Malaysia

Globally, ecosystem health and biodiversity are gaining increasing attention as key challenges for environmental sustainability.[10] Biodiversity is declining faster than at any time in human history, with one-quarter of species globally threatened and around one million species facing extinction (Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES)[11] 2019). The World Economic Forum (WEF), in its Global Risks Report 2021, cited biodiversity loss as one of top global risks society faces (WEF 2021). Biodiversity - the diversity among living organisms - strongly contributes to the generation of ecosystem services and ensures ecosystem functioning.[12]

Other threats such as land and sea-use change, pollution, direct exploitation of organisms, climate change, and invasive alien species also put ecosystems at risk and these drivers of nature loss are largely the result of human economic activities (IPBES 2019). This is an essential issue as ecosystem services make human life possible by providing essential benefits from ecosystems such as regulating services (such as regulation of floods, droughts, and land degradation), provisioning services (such as crops, fresh water, aquaculture, and timber), supporting services (such as photosynthesis, nutrient cycle, water cycle), and cultural services (such as recreational and other non-material benefits).[13]

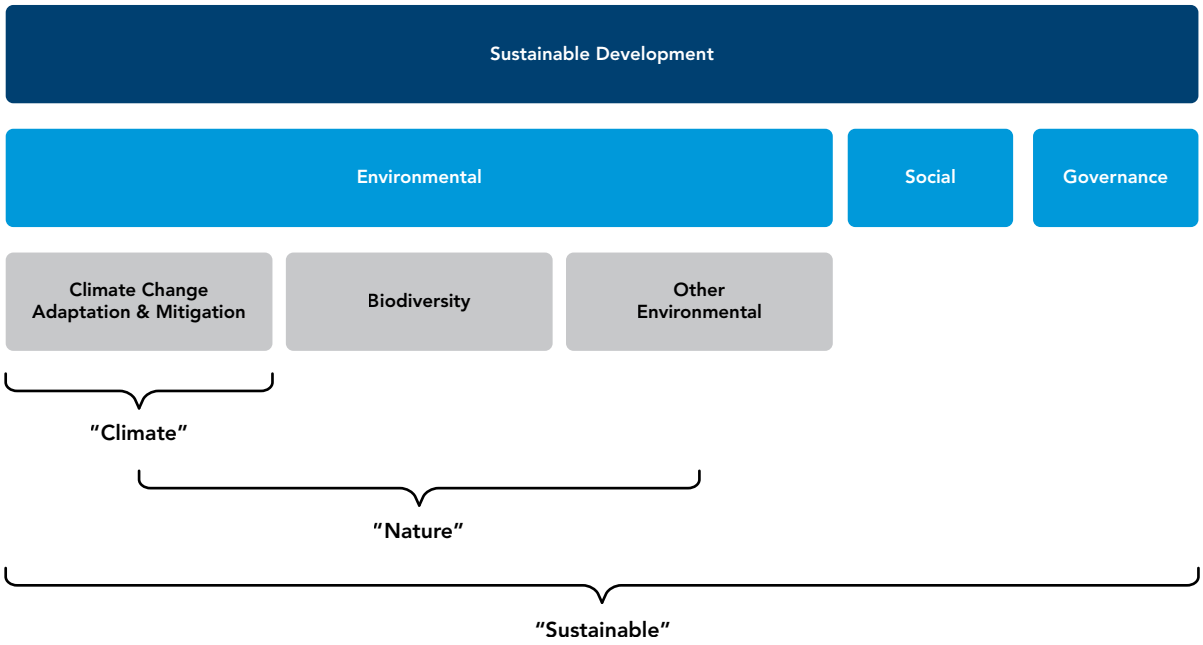
The decline in global wildlife populations coupled with the massive degradation of oceans, forests, freshwater bodies, and other ecosystems undermines nature's productivity, resilience, and adaptability. Fourteen of the 18 ecosystem services categories that the IPBES defines have declined since 1970 (IPBES 2019). This underpins broad consensus that humanity overstretches its pressure on nature (Steffen et al. 2015; IPBES 2019; Dasgupta 2021). Estimates show that 1.6 earths would be required to maintain the world's current living standards with the current economic systems (Dasgupta 2021).

A continuous excessive use of ecosystems beyond their regenerative rate could trigger abrupt, nonlinear, and systemic change in the health of entire ecosystems, if certain ecological thresholds are passed (Lenton 2013; Dasgupta 2021). This has a direct bearing on future economic performance; furthermore, socio-economic impacts can be particularly severe if ecosystems collapse. To illustrate this point: more than half the world's total GDP is moderately or highly dependent on nature and its services; with construction, agriculture, and food and beverages being the three sectors that depend most on nature (WEF, 2020). Recently, the devastating effects of the COVID-19 pandemic have provided an important example of what could become a more frequent event due to deforestation, land-use change, and species exploitation (Platto et al. 2021; IPBES 2020). As such, biodiversity and nature loss fuel risks and uncertainties for our economies and wellbeing (Dasgupta 2021; Folke et al. 2021).

This report investigates the exposure of the banking sector to a broad range of nature-related risks to the financial sector. Exposure is defined here as the fraction of outstanding loans to highly vulnerable sectors (i.e., highly dependent or highly impacting sectors on nature) in the economy, or in other words the maximum possible loss in those sectors. Nature-related risks encompass risks that relate to ecosystem services, natural assets (such as water and forests), and biodiversity. It thereby covers a large share of the environmental risk dimension in the ESG framework for sustainable development. Thus, the scope of risks that are covered in this report are termed "nature-related risks", as outlined in Figure 5.

10 Biodiversity is defined in the United Nations Convention on Biological Diversity (1992) as the "variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems".
11 The IPBES is an independent intergovernmental body established by States to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being, and sustainable development (https://ipbes.net/about).
12 https://www.fao.org/ecosystem-services-biodiversity/en/
13 To emphasize the interconnectedness of biodiversity and ecosystem services this report applies a more holistic terminology of 'nature' and 'nature-related risks.'

Figure 5: Scope of nature-related financial risks within the environmental, social, and governance framework



Source: WB

Nature-related risks are sometimes interrelated with climate-related risks, sharing common drivers through human activities. Climate- and nature-related risks are interconnected (Lade et al. 2021) as for instance, climate-induced flooding, wildfires, and cyclones accelerate habitat and biodiversity loss. At the same time, forests, mangroves, and peatlands are natural carbon sinks, capturing and storing carbon dioxide (CO_2) while also providing protection from extreme weather events. Protecting and restoring those ecosystems can thereby mitigate climate change and prevent its worst impacts (Poertner et al. 2021).

Nevertheless, nature-related risks are often more localized and multidimensional than climate-related risks, posing some challenges for policy design.[14] Yet, explicitly considering climate-nature interactions in policy designs provides opportunities to maximize co-benefits, while minimizing trade-offs and compounding risks for the economy and the financial sector (Poertner et al. 2021). Moreover, methodologies used for the assessment of climate-related risks may be tailored to assess nature-related risks as well, including scenario analysis and stress testing.

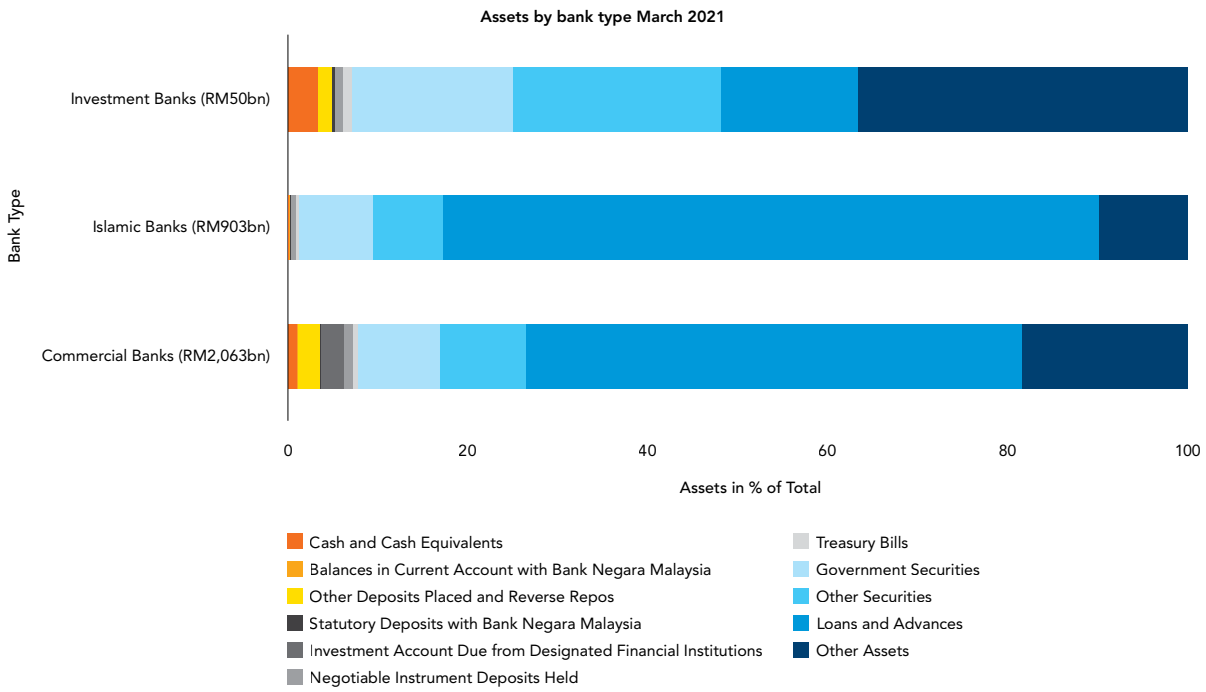
14 This multidimensionality, for instance, is one reason why there is no single high-level metric to assess the footprint of economic activity such as tons of CO_2 equivalent for nature, nor a global goal equivalent to keeping warming well below 2°C and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels (Power et al. 2022).

1.1 The Malaysian Banking Sector

Malaysia has a large, well-developed banking sector. Total assets[15] in March 2021 were RM 3,016 billion (USD 754 billion or about 224 percent of 2020 GDP) (Figure 6). Government securities (20 percent) and loans and advances (60 percent) make up the bulk of Malaysian banks' balance sheets, with differences across bank types. BNM is the principal regulator and supervisor of the Malaysian banking sector, which as the central bank for Malaysia, is mandated to promote monetary and financial stability conducive to the sustainable growth of the Malaysian economy.

The Malaysian banking sector has shown resilience through the COVID-19 crisis. Capital buffers were adequate with regulatory capital to risk-weighted assets at 18.2 percent as of September 2021. Reported non-performing loans to total gross loans ratio were 1.5 percent as of October 2021, one of the lowest compared to Association of Southeast Asian Nations (ASEAN) countries, although extended forbearance measures remained in effect for many individuals and firms. The systemwide liquidity coverage ratio was 153 percent as of October 2021, well above the Basel III regulatory minimum of 100 percent.[16] The contraction by 4.5 percent of the Malaysian economy in the third quarter of 2021 was a risk factor to financial stability. However, the Malaysian economy is expected to improve following the normalization of economic activities after the COVID-19 pandemic, which would relax pressures on financial markets.[17]

Figure 6: Overall assets per bank type

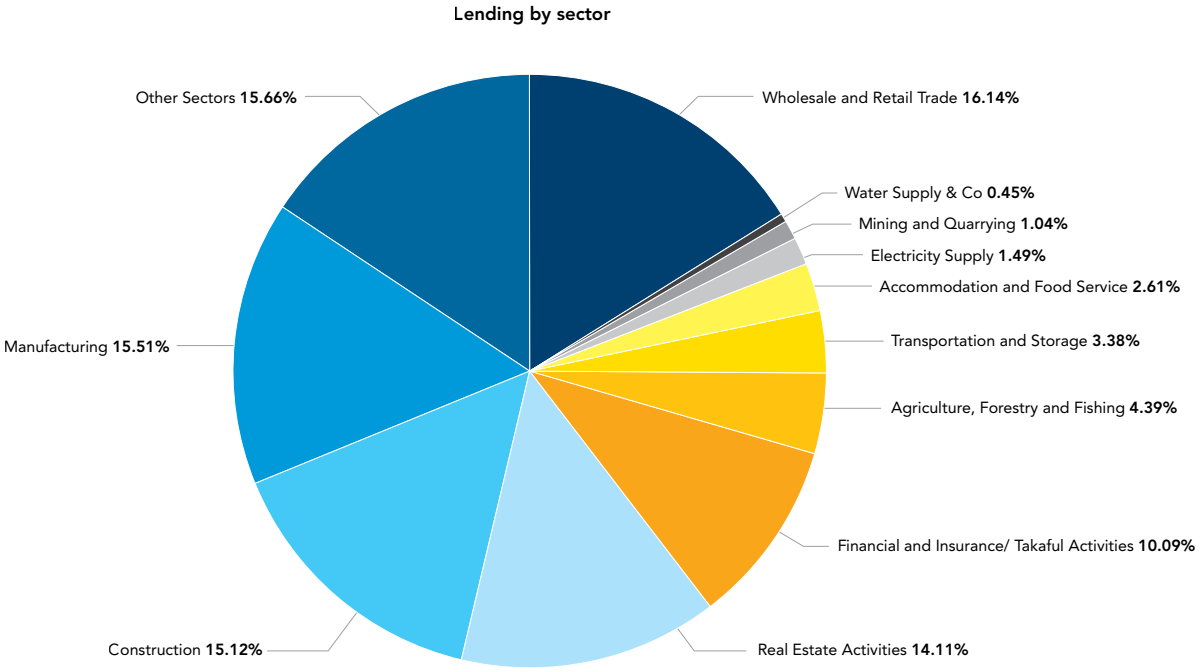


Source: Based on publicly available BNM data (BNM 2021)

15 This total includes all bank categories except for DFIs.
16 https://www.bnm.gov.my/-/monthly-highlights-and-statistics-in-november-2021)
17 https://www.bnm.gov.my/-/3q-gdp-2021

Finance provision to the real economy in Malaysia concentrates around loan financing, with a dominant role for the Malaysian banking sector. Seventy-four percent of outstanding net financing in December 2020 was provided by loans from banks and DFIs. Corporate bonds are a growing financing instrument, representing the remaining 26 percent of outstanding net financing. Nevertheless, the banking sector (and specifically loan financing) remains the dominant source of financing. For commercial lending, the wholesale and retail trade sector constitutes the largest share of Malaysian banks' commercial loans outstanding balance, at slightly more than 16 percent (Figure 6). Manufacturing is the second largest lending exposure (16 percent), followed by construction (15 percent), and real estate (14 percent). This reflects the high importance of manufacturing and construction sectors in the Malaysian economy. The agricultural sector (4 percent) and especially the mining sector (1 percent) constitute only a small share of Malaysian banks' commercial loans portfolio (Figure 7).[18] The following analysis considers Malaysian banks' commercial sector lending portfolio, which represents a significant share of Malaysian banks' lending.[19]

Figure 7: Overall commercial lending of Malaysian banks by sector, as of December 2020



Source: Based on unpublished BNM data

18 Comparing Malaysian banks' commercial sector lending with sectoral GDP data shows that capital intensive sectors such as construction have a higher lending share in banks' portfolios (15 percent) compared to their contribution to GDP (4 percent). Other sectors are relatively underrepresented, this may be because they have limited access to lending or are less capital intensive (e.g., agriculture has a lending share of 4 percent vs. a GDP share of 8 percent). Furthermore, some sectors might be dominated by large firms (e.g., oil and gas), which are capital intensive but acquire the bulk of their financing from capital markets. This has implications for the analysis as it only considers impacts and dependencies of sectors that have outstanding loans with the Malaysian banking sector.

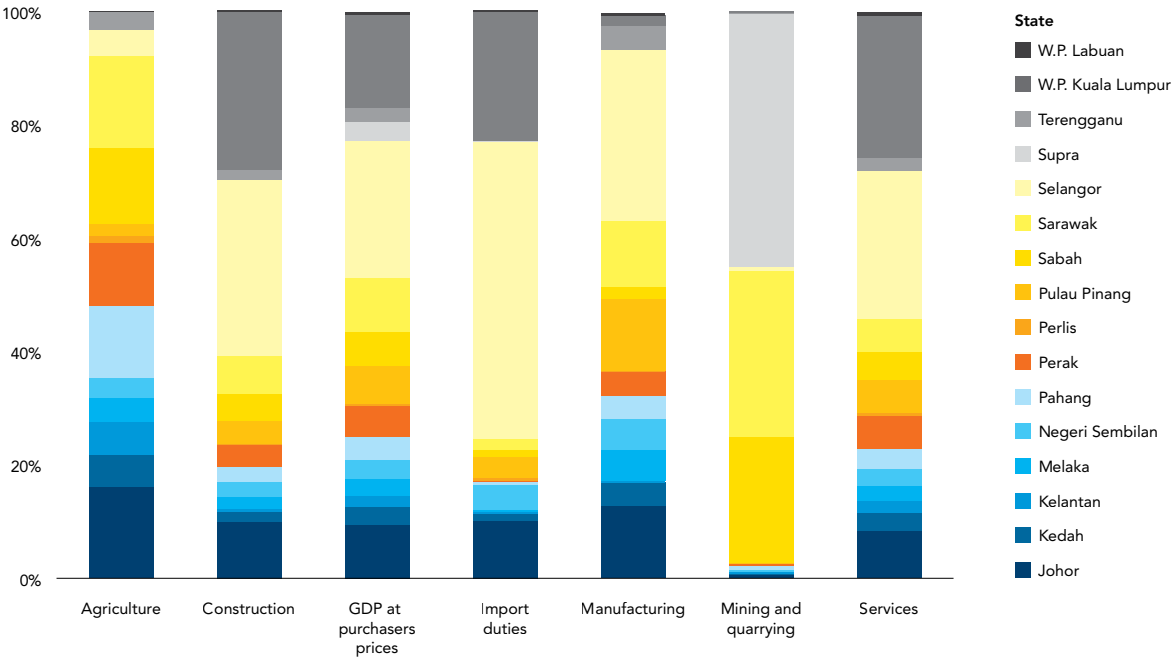
19 Household loans are the largest share of Malaysian banks' lending portfolio. 40 percent of commercial sectoral lending goes to corporates, micro, small, and medium enterprises and others.

Commercial lending by Malaysian banks is heterogeneously distributed among states (Figure 8), reflecting the population and economic centers of the country. Over 60 percent of commercial lending goes to Kuala Lumpur and Selangor, having a strong manufacturing, service, and real estate sector and contributing the largest share of Malaysian GDP (Figure 9). Johor with its strong oil palm sector (10 percent), Sarawak (6 percent), and Pulau Pinang (5 percent) also receive considerable lending shares. The other Malaysian states share the remaining 17 percent of banks' lending, with Perlis having the lowest share of only 0.1 percent of total lending.

Figure 8: Commercial lending by Malaysian banks by state, as of December 2020

Source: Based on unpublished BNM data

Figure 9: Projected GDP per sector by state level contribution (percent, 2019)



Source: Based on Department of statistics Malaysia (DOSM 2021) data[20]

20 'Supra' State covers production activities that are beyond the center of predominant economic interest for any state.

The sample of commercial loans outstanding by Malaysian banks represents 90 percent of the total commercial loan portfolio. The sample portfolio data, as of December 2020, totaled RM 733 billion (USD 183 billion). The largest bank type, with about 68 percent share of banking sector assets, are 26 commercial banks, which account for about 66 percent of the lending sample, followed by 16 Islamic banks.[21] Islamic banks cover about 30 percent of banking sector assets and about 31 percent of the lending sample. Investment banks are the third bank category, consisting of 10 domestically owned banks[22] that account for about 2 percent of total banking sector assets and 0.4 percent of the sample. Additionally, 9 DFIs[23] play a role in commercial lending in Malaysia, accounting for about 2 percent of the analyzed lending portfolio in this report.

1.2 **Malaysia, a Biodiversity Hotspot**

Malaysia's biological diversity is among the richest in the world. Spread across the three regions of Peninsular Malaysia, Sabah, and Sarawak, Malaysia's terrestrial, coastal, and marine habitats harbor a wide variety of floral and faunal communities. The country's forest cover extends to around 59 percent of the total land area (MyBIS 2015).[24] This includes extensive tropical peatlands, which cover more than 7 percent of Malaysia's total land area, and whose unique wet, acidic, and low-nutrient conditions harbor species of plants and animals not found in other tropical forests (MyBIS 2016). These peatlands also store more than 9 gigatons (Gt) of carbon (almost the size of annual global carbon emissions),[25] more than twice the 4 Gt carbon that is stored in the rest of Malaysia's forest vegetation (Page and Rieley 2018). Malaysia's vast shoreline has more than half a million hectares of mangroves, with five mangrove areas designated as Ramsar sites – an international network of wetlands recognized, among other things, for their importance to conservation of global biological diversity (Ramsar 2010). Together, these and other natural habitats nurture more than 15,000 species of vascular plants, 307 known species of mammals, 785 species of birds, 2,068 species of freshwater and marine animals, 150,000 species of invertebrates, and more than 612 species of hard corals in the country (MyBIS 2015). This rich variety of life has placed Malaysia, a country with only 0.2 percent of the world's land mass, as one of 17 megadiverse countries in the world.[26]

Malaysia's rich biodiversity, and the natural ecosystems it supports, sustain the country's economy. Natural resources such as oil, timber, and fish, and the provision of ecosystem services such as healthy soils, clean water, pollination, and a stable climate, strongly influence the productivity of various sectors of the economy. Many sectors rely directly on natural resources and ecosystem services for a range of factors within their production processes including inputs to production, inputs to research and development, business operations, and assimilation of waste in these sectors (WEF 2020).[27] A sector is highly reliant on an ecosystem service if any disruption in this service can prevent the production processes, and thus directly impact the financial viability of the businesses in these sectors (Box 1) (NCFA and UN-WCMC 2018).

21 https://www.bnm.gov.my/web/guest/islamic-banks: Eight commercial banks have domestic ownership while 18 banks have foreign ownership. Of the 16 Islamic banks, 11 are domestically owned and 5 are foreign owned.
22 https://www.bnm.gov.my/web/guest/investment-banks
23 6 DFIs regulated under the DFI Act and 3 DFIs not regulated under the DFI Act (https://www.bnm.gov.my/-/akta-institusi- kewangan-pembangunan-2002-act-618-)
24 https://data.worldbank.org/indicator/AG.LND.FRST.ZS?locations=MY
25 Note that global carbon dioxide emissions were 36.7 Gt in 2019 (Ritchie and Roser 2020), this corresponds to carbon emissions of 10 Gt in 2019.
26 https://www.biodiversitya-z.org/content/megadiverse-countries
27 Natural genetic diversity plays a particularly key role in pharmaceutical and biomedical research.

Sectors that are highly reliant on an ecosystem service include agriculture, fishing and forestry, construction, electricity, water utilities, and food, beverages, and tobacco sectors. Furthermore, there are other sectors which are moderately reliant on nature, meaning they have a limited dependency on ecosystem services within their direct operations. However, those sectors often rely on inputs from sectors with high direct nature dependencies and are thus indirectly dependent on its ecosystem services. This includes manufacturing, transport, chemicals and materials, aviation, travel and tourism, real estate, mining and metals, retail, consumer goods and lifestyle, oil and gas, and automotive sectors (WEF 2020). This supports the claim by the Dasgupta report (2021), that the entire economy is embedded in nature and as such reliant on a functioning biosphere.

Malaysia experienced strong economic growth in recent decades; yet this economic growth has come at the cost of a significant loss of biodiversity and natural capital in the country.[28] The country's high levels of economic growth in the last two decades have led to an exponential rise in demand for natural resources, which in turn has amplified key drivers of nature and biodiversity loss in Malaysia. These include habitat loss and fragmentation, pollution, unsustainable resource extraction and usage, and climate change.[29]

28 The recent Changing Wealth of Nations report by the WB (2021) shows that while human and produced capital in Malaysia have grown, natural capital has declined. Specifically, forests, mangroves, and fisheries-based wealth in Malaysia has declined, while protected areas', cropland, and pastureland wealth has increased.

29 See the Appendix Section A4 for a more detailed analysis on the current stage of drivers for nature and biodiversity loss in Malaysia as defined by the IPBES (2019).

BOX 1

Assessing materiality of an ecosystem service for a business

Materiality of potential dependencies

To assess the importance of the contribution an ecosystem service makes to a production process, and the materiality of the impact if this service is disrupted, two aspects can be considered:

1. **How significant is the loss of functionality in the production process if the ecosystem service is disrupted?**

   a. **Limited loss of functionality:** the production process can continue as is or with minor modifications.

   b. **Moderate loss of functionality:** the production process can continue only with important modifications (e.g., slower production or use of substitutes).

   c. **Severe loss of functionality:** Disruption in the service provision prevents the production process.

2. **How significant is the financial loss due to the loss of functionality in the production process?**

   a. **Limited financial loss:** Disruption to the production process doesn't materially affect the company's profits.

   b. **Moderate financial loss:** Disruption to the production process materially affects the company's profits.

   c. **Severe financial loss:** There is a reasonable possibility that disruption in the production process will affect the financial viability of the company.

The materiality assessment reflects both these considerations. A very high materiality rating means that the loss of functionality is severe and that the expected financial impact is severe as well.

Materiality of potential impacts on ecosystem services

To assess the importance of a potential impact of a production process on natural capital, the following three aspects were considered:

1. **How frequently might the impact occur?**

   - **High:** The impact and its resulting effects on natural capital are expected to occur continuously throughout the project life cycle.
   - **Medium:** The impact and its resulting effects on natural capital are expected to occur regularly throughout the project life cycle (i.e., from several times per year to several times per month).
   - **Low:** The impact and its resulting effects on natural capital are expected to occur only a small number of times in the project life cycle (e.g., only during construction/set-up).

2. **How quickly might the impact start to affect natural capital?**

   - **<1 year:** The impact and its resulting effects on natural capital will occur within one year of the start of the production process.
   - **1-3 years:** The impact and its resulting effects on natural capital will occur between one and three years after the start of the production process.
   - **>3 years:** The impact and its resulting effects on natural capital will occur more than three years after the start of the production process.

3. **How severe might the impact be?**

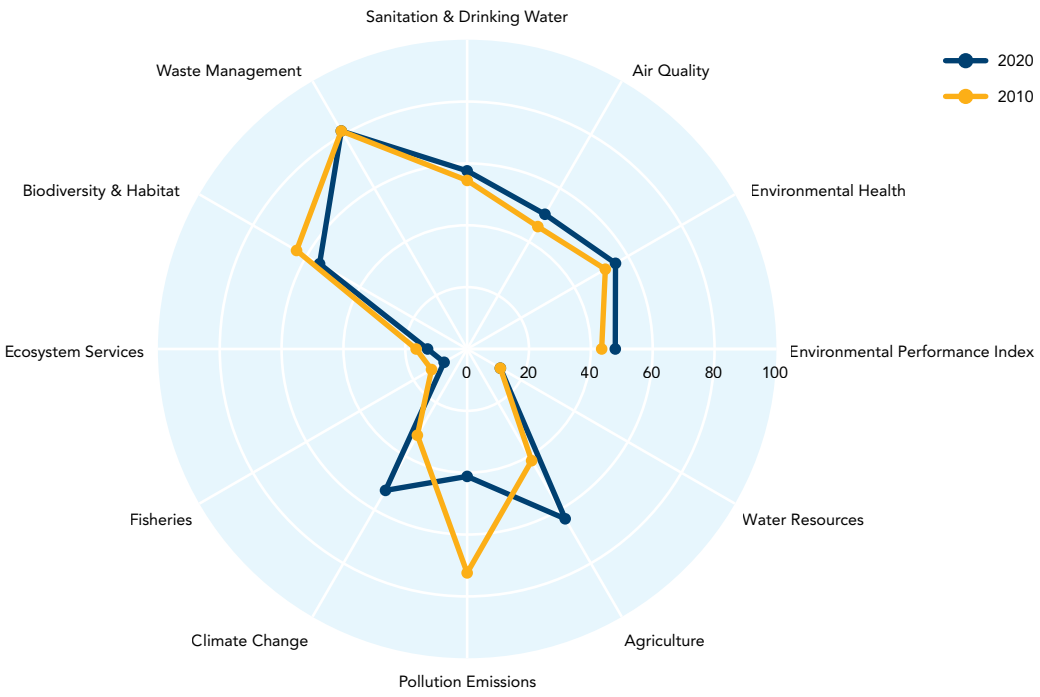
   - **High:** The impact and its resulting effects are expected to cause major, irreparable, and long-lasting damage to natural capital.
   - **Medium:** The impact and its resulting effects are expected to cause significant and lasting damage to natural capital.
   - **Low:** The impact and its resulting effects are expected to cause minor, reparable, and temporary damage to natural capital.

Source: Natural Capital Finance Alliance (2021)

Major environmental challenges exist with respect to deforestation, pollution, and water management. Figure 10 shows results from the Yale University Environmental Performance Index for Malaysia for the years 2010 (orange) and 2020 (blue).[30] Malaysian environmental performance showed improvements in areas like environmental health, air quality, agriculture, climate change, and sanitation and drinking water, though arguably starting from a low environmental performance base. In contrast, pollution emissions and, more notably, ecosystem services and biodiversity and habitat indicators show a deterioration over the past decade.

Those findings have also been confirmed in interviews with different stakeholders from academia, the government, and non-governmental organizations (NGOs).[31] Interview partners expressed concerns especially with respect to Malaysian forest management, water pollution, and species loss. Furthermore, governance related issues were frequently mentioned as a driver of nature and biodiversity loss. These issues stem mainly from the contention between the federal and state governments' jurisdiction over land and forest matters.[32]

Figure 10: Malaysian environmental performance across several indicators in 2010 and 2020

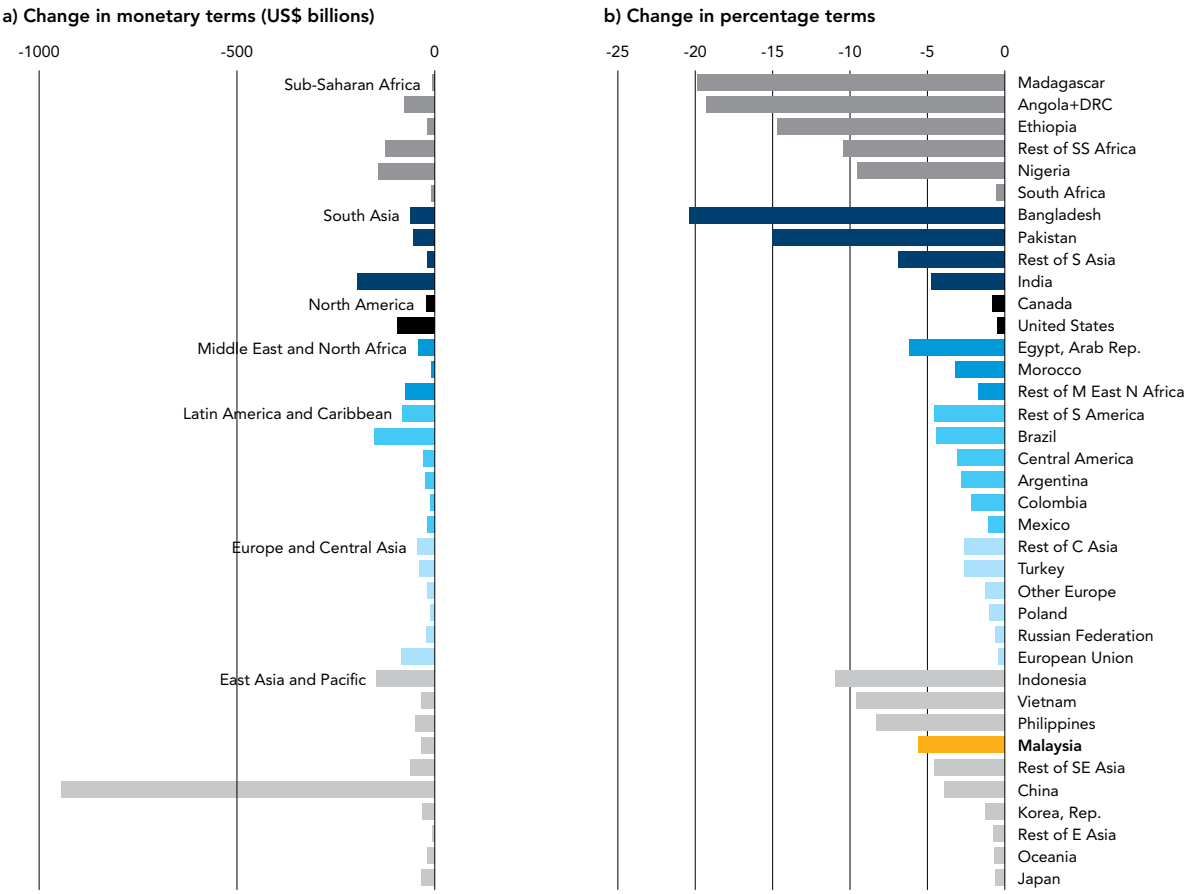


Sources: Based on the Yale Environmental Performance Index
Note: Scores are normalized to 100, with 100 being the target to reach.

30 Figure 3 compares environmental indicators between 2010 and 2020 that are scaled to 100. Hence, the graph also provides an indication of the current level of environmental quality in Malaysia, with 100 being perfectly healthy ecosystems.
31 Appendix Section A5 contains details on interview insights.
32 https://www.wwf.org.my/?18445/STATE-GOVERNMENT-HAS-JURISDICTION-OVER-FOREST-AND-LAND-MATTERS; https://www.malaysianbar.org.my/article/news/legal-and-general-news/legal-news/challenges-in-implementing-and-enforcing-environmental-protection-measures-in-malaysia-by-ainul-jaria-bt-maidin

Both nature preservation policies and nature loss can have impacts on the economy and hence can be sources of financial risks to Malaysian banks. A recent WB (Johnson et al. 2021) study analyzes the economic impacts from degrading ecosystem services. In an adverse scenario of partial ecosystem collapse, economic losses could mount up to 3.4 percent of GDP in East Asia and the Pacific region in 2030.[33,34] For Malaysia specifically, the effects of such a scenario are estimated to be higher than the region's average, projected at 6 percent of GDP loss by 2030 (Figure 11), driven by decline in export demand and adverse impacts of the collapse of forestry and fisheries ecosystem services.[35]

Figure 11: Change in 2030 real GDP under a partial ecosystem collapse scenario (compared with a no-tipping-point scenario)[36]



Source: Johnson et al. (2021)

33 Environmental degradation can push an ecosystem to a "tipping point" beyond which it will shift to a new state or collapse entirely. Such a collapse would lead to a large-scale, abrupt decline in ecosystem services.

34 See Johnson et al. (2021) "The Economic Case for Nature - A global Earth-economy model to assess development policy pathways". The model developed by the WB in collaboration with the University of Minnesota and Purdue University assesses a scenario of partial ecosystem service collapse—a 90 percent reduction in the flow of the following ecosystem services: wild pollination, marine fisheries, and provision of timber from native forests on real economic activity to 2030.

35 The CGE model utilized in the study accounts for a broad range of direct and indirect substitution effects. Under the tipping point scenario, global GDP declines relative to the business-as-usual (BAU) scenario. With less income in the rest of the world, demand for Malaysian exports declines and hence leading to a decline in domestic production in Malaysia relative to BAU. In addition, relative to East Asia and the Pacific, the adverse impacts of ecosystems collapse in Malaysia's forestry and fisheries are much larger, which would cause a larger decline in Malaysia's GDP relative to the rest of East Asia and the Pacific.

36 The model used in the analysis does not offer precise predictions about what the global economy or any given country's economy will look like in the future. Rather, the scenarios described in this report illustrate the direction and range of possible outcomes of select biophysical scenarios and policy responses. The estimations presented are conservative, due to the limited range of ecosystem services considered, as well as other limitations (for further details please see Johnson et al. 2021).

The Malaysian government has taken several policy actions on biodiversity, with additional initiatives by the private sector.

- Its National Policy on Biodiversity 2016-2025 serves as its guide for biodiversity management and complement to Malaysia's commitment to the United Nations Convention on Biological Diversity and the Sustainable Development Goals. The policy is part of Malaysia's agenda to promote sustainability and mentions that Malaysia is committed to conserve its biological diversity, promote its sustainable use, and ensure the fair and equitable sharing of benefits arising from the utilization of biological resources. A National Biological Diversity Roundtable group was created in 2019 to advise the minister on the direction and strategy of implementing the National Biodiversity Policy.

- Malaysia also signed the Glasgow Leaders' Declaration on Forests and Land Use at the 26th United Nations (UN) Climate Change Conference of the Parties, a commitment to halt and reverse forest loss and land degradation by 2030.[37]

Malaysia's financial regulators have demonstrated their leadership in driving the sustainability and climate change agenda in the financial sector by deploying several initiatives that aim to address climate related risks and sustainable finance practices.[38]

- In 2019, BNM and the Securities Commission of Malaysia formed the **JC3** to pursue collaborative actions for building climate resilience within the Malaysian financial sector. JC3 initiatives encompass aspects of risk management, governance and disclosure, product and innovation, capacity building and stakeholder engagement, and data.

- Since its formation, BNM has finalized the issuance of a principle-based taxonomy – Climate Change and Principle-based Taxonomy **(CCPT)**, that is intended to facilitate the financial institutions' categorization of economic activities against climate objectives and promote the transition to a low-carbon economy.

BNM has also collaborated with Islamic financial institutions under the Value-based Intermediation **(VBI)** Community of Practitioners to publish guidance documents on credit risk management practices to help financial institutions evaluate financing and investment activities against ESG criteria. The CCPT and VBI guidance documents refer to biodiversity risk as an element of managing environmental risks. In December 2021, BNM issued the Reference Guide on Climate Risk Management and Scenario Analysis for public consultation. The JC3 members also supported the proposal for financial institutions to make mandatory Task Force for Climate-related Financial Disclosure (TCFD)-aligned climate-related financial risk disclosures from 2024.

Private sector initiatives around biodiversity are also developing. In February 2020, an interim working group consisting of members from the private sector, academia, research institutes, and NGOs was formed with the mandate to establish the Malaysia Platform for Business and Biodiversity. This is envisioned as a platform for the private sector to discuss, share, and collaborate on issues related to biodiversity conservation and its mainstreaming, particularly to support the implementation of the National Policy on Biological Diversity.[39]

37 https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/
38 https://www.bnm.gov.my/climatechange
39 https://www.nst.com.my/opinion/letters/2021/10/738332/corporate-role-biodiversity-conservation

1.3 **Nature-Related Financial Risks**

Financial institutions' relationship with nature is twofold, often referred to as a "double materiality" (European Commission 2019, Oman and Svartzman 2021). On the one hand, the activities that are being financed can either contribute to or deteriorate the value of ecosystem services in Malaysia. On the other hand, ongoing biodiversity loss could have negative economic and financial implications for Malaysian firms and the financial sector (NGFS 2021, World Bank Group 2021b). Globally, nature-related risks are becoming increasingly likely, whereas precise timing and magnitude are difficult to predict (Kedward et. al. 2020). Malaysia could be particularly exposed to those risks, given its status as a megadiverse country and its high dependence of economic activity on ecosystem service provision (see section above for details). Better identification, assessment, and management of nature-related financial risks can help align capital allocation with sustainability goals.[40] Even though some nature-related risks may be gradual trends, these could turn into abrupt financial risks when financial sector participants reprice assets based on changed future expectations and better data.

The degradation of biodiversity and natural ecosystems could lead to physical and transition risks that could transmit through the economy. This could potentially pose a risk for the financial system (Figure 12), with reinforcing macroeconomic feedback effects (Dunz and Power 2021). *Physical risk* could emerge from the loss of ecosystem services that firms are depending on. Such dependencies could be direct (e.g., fisheries decline for the aquaculture sector) or indirect via supply chain impacts and relative price changes (e.g., higher food prices).[41] Physical risk could either be triggered through 'slow-onset' loss of ecosystem services (e.g., reduced agricultural yields) or 'sudden-onset' events like the triggering of an ecological regime shift (e.g., eutrophication of a lake).

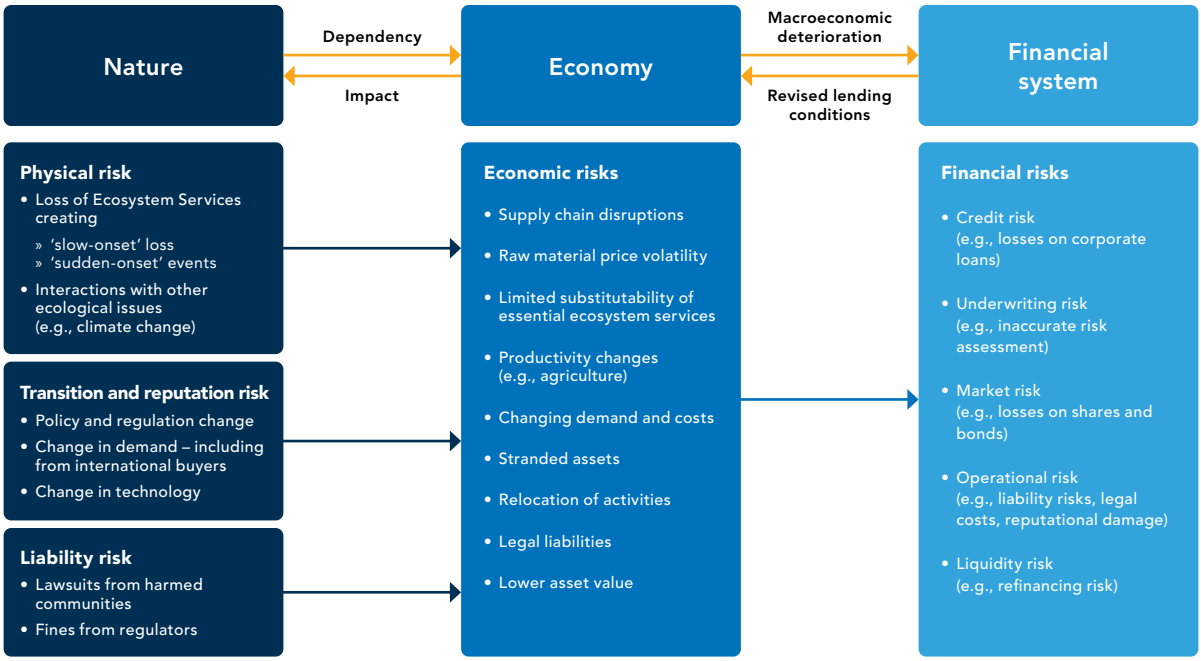
40 One of the main roles of the financial system is to allocate capital (both equity and debt) to productive activities. When risks are not adequately understood and priced in, this could lead to an overallocation of capital to sectors that is not in line with sustainability objectives. Further, it hinders adequate mitigation actions to prevent or limit financial impacts of such risks.

41 Subsequent exposure analysis of this report focuses on direct dependencies only.

Sudden changes in policy, technology, and consumer preferences in response to nature loss can have a substantial impact on the economic, financial, and reputational[42] position of firms and their financing banks with large impacts on biodiversity and ecosystems. Business operations may have an impact on biodiversity and ecosystem services via *excessive* natural resources extraction, disposal of waste, or land-use change. If firms do not adapt timely and banks do not adjust their lending portfolio, nature-related financial *transition risk* could materialize following sudden changes in policy, technology, and consumer preferences. Those pressures on companies could stem from domestic changes as well as changes in important export markets for Malaysia such as the European Union (EU).

Physical and transition risks can directly disrupt production processes or indirectly materialize across value chains of businesses (second- and third-order effects), thus impacting their ability to generate profits and repay debts. The degree of nature-related risk emergence, however, depends on the availability of substitutes for those depleted ecosystem services as well as the ability of firms and banks to adapt timely. If not anticipated and no action is taken, the sectors with high negative impacts on biodiversity may see abrupt write-downs in their asset valuations (stranded assets) as the economies transition to more sustainable pathways and higher liability claims (*liability risk*)[43] arising from impacts and dependencies on biodiversity. For financial institutions, this adverse impact on the profitability of businesses they lend to may translate into market, credit, liquidity, and operational risks (Figure 12).

Figure 12: From nature-related risks to financial risks



Source: WB based on van Toor et al. 2020 and Svartzman et al. 2021

42 See Appendix Section A3 for details on reputational risk.

43 The impacts of Malaysian companies on biodiversity and nature may also expose them to liability risk. Such risks may materialize for companies through litigation or other legal avenues outside courtrooms such as regulatory fines and enforcement. Physical risk could pose liability risk to companies as they might be deemed responsible for a loss or injury associated with nature loss and may be required to pay compensation to the affected parties. Nature-related transition risk could pose liability risk as firms continuously contributing to nature loss could be sued. Liability risk can materialize for banks through various avenues – direct impacts as defendants in litigation, and indirect second order impacts through credit, investment, and underwriting risk stemming from their exposure to the affected companies, as well as third order indirect impacts through systemic risks if nature-related liability risk is of a sufficient magnitude across sectors or geographies (Barker et al. 2020).

CHAPTER 2

Exposure Assessment

This report investigates the exposure in the commercial loan book of Malaysian banks using a combination of sectoral and spatial analyses.[44]

1. First, it investigates banking sector exposures to economic sectors by using the ENCORE biodiversity tool. Following the work of other central banks, the analysis is focused on relationships between economic sectors and ecosystem services with high or very high dependencies, as the degradation of those ecosystem services is likely to have a strong detrimental impact on firms' business processes (physical risk).

2. Second, exposures of banks to sectors that have a negative impact on ecosystem services and that could hence be subject to transition risk in case of unanticipated policy introduction and consumer preference change are mapped.

3. Third, spatial exposure of banks' commercial property purchase lending to areas that may become protected in the future are analyzed.

4. Fourth, a first non-exhaustive set of nature-related risk scenarios for Malaysia (see Figure 26) are explored. These are based on interviews (the conclusions of which are summarized in Appendix Section A5), datasets such as ENCORE and the WB Terrestrial Biodiversity Indicators, and reports from Malaysian stakeholders which are summarized in Appendix Section A4. For most analyses results are obtained for individual banks, however outcomes are reported at the bank segment level to ensure confidentiality of respective bank's exposures.

The analysis on ecosystem dependency and impact is conducted by using ENCORE (Natural Capital Finance Alliance 2021).[45] ENCORE is a database that maps sector-based impacts and dependencies on ecosystem services for sectors of the economy.[46] This allows a detailed assessment of the interactions of the economy with the natural environment and thus an exposure analysis of Malaysian banking sectors' lending portfolio to potential nature-related physical and transition risks. The overall commercial loans outstanding in the sample stood at RM 733 billion (USD 183 billion) as of December 2020. The analysis follows closely the approach proposed by the Dutch Central Bank (DNB) (van Toor et al. 2020), consisting of several steps of data reclassification and remapping. Reclassification and remapping are needed to align sector classification of the lending data with sector classification used in ENCORE. Following the DNB approach, the focus of the analysis is on relationships between economic sectors and ecosystem services with high or very high dependencies only, as the degradation of those ecosystem services is likely to have a strong detrimental impact on firms' business processes. Likewise, only linkages of economic sectors and drivers of environmental change with a high or very high impact to assess transition risk exposure are considered. The reclassification allows assessment of the nature-related physical and transition risk exposure of the Malaysian banks' commercial lending portfolio.

ENCORE is a global tool and thereby subject to some caveats. Ecosystem service dependencies and the state of natural assets differ by country and require a geographical context to refine the assessment provided by ENCORE. ENCORE focuses on direct nature-related impacts and dependencies for the various sectors of the economy. Thus, ENCORE can only give a comprehensive view on the key first-order nature-related impacts and dependencies at the level of sectors of the economy. Furthermore, the currently applied equal weighting approach in the case of multiple sector or ecosystem service linkages influences the exposure results.[47]

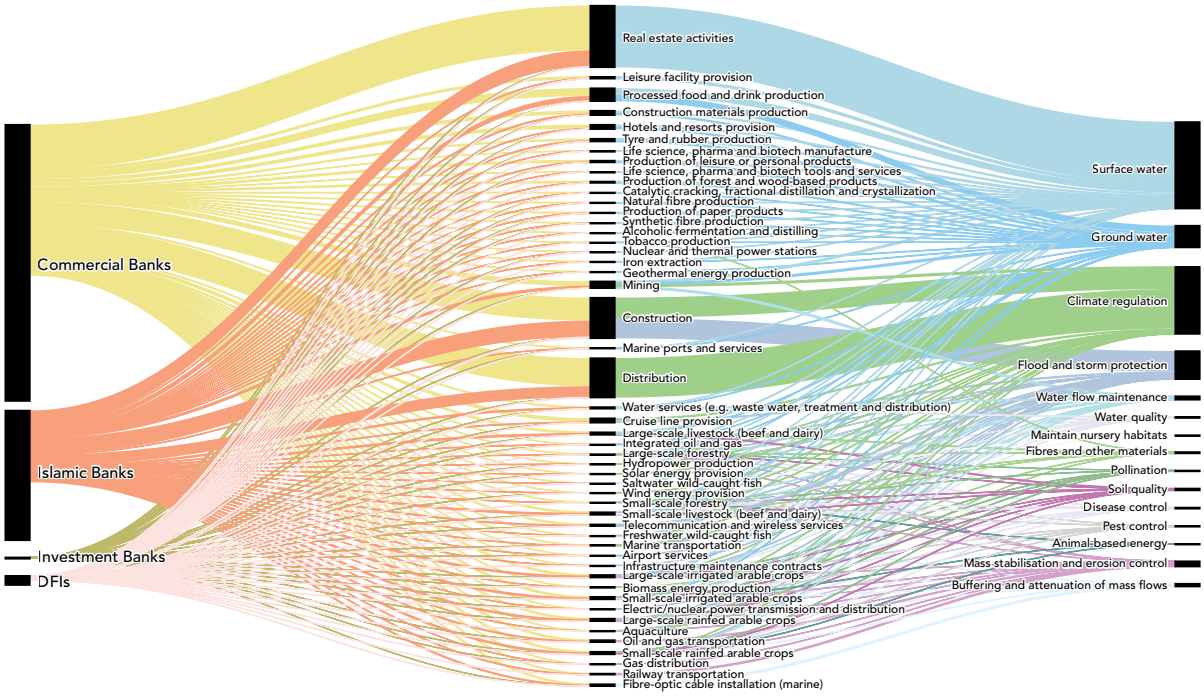
44 A detailed description of the underlying methodology in this report can be found in Appendix Section A1.
45 https://encore.naturalcapital.finance/en/explore
46 Box 1 provides an overview of the core assumptions of ENCORE with respect to materiality of ecosystem services for businesses.
47 One could argue, however, that absent more detailed information on the production process of Malaysian firms, this approach is conservative as it caps the exposure towards one ecosystem service to its relative share of the entire lending portfolio.

2.1 Dependency on Ecosystem Services

This section estimates the risks that Malaysian banks may be exposed to from the loss in ecosystem services (physical risk). Multiple sectors of the economy depend directly or indirectly on ecosystem services. The resilience of these ecosystem services, in turn, is contingent upon a thriving biodiversity. Biodiversity loss, driven by unsustainable business processes, could thus lead to a degradation of the ecosystem services it sustains. In turn, negative impacts on the financial position of companies that depend on these ecosystem services could emerge, with negative financial implications for banks financing them.

Fifty-four percent of the commercial lending portfolio of Malaysian banks is to sectors which are highly or very highly dependent on one or several ecosystem services (Figure 13). This amounted to RM 398 billion (USD 94 billion) lent to these sectors as of December 2020.[48] Most of these ecosystem service dependencies concentrate around a few economic sectors, with real estate and construction activities constituting about 42 percent of all sectors' dependencies (Figure 14).[49] Real estate activities strongly depend on surface water provision. Construction activities are especially vulnerable to climate physical risk, thus depending on climate regulation (chronic temperature increase) and flood and storm protection (acute climate physical risk). Wholesale trade is also strongly dependent on ecosystem services due to its reliance on climate regulation provision. Agricultural activities make up about 8 percent of sectors' dependencies on ecosystem services, whereas they depend on a multitude of different ecosystem services such as disease control and maintenance of nursery habitats. This makes agriculture especially vulnerable to a multitude of ecosystem service deteriorations.

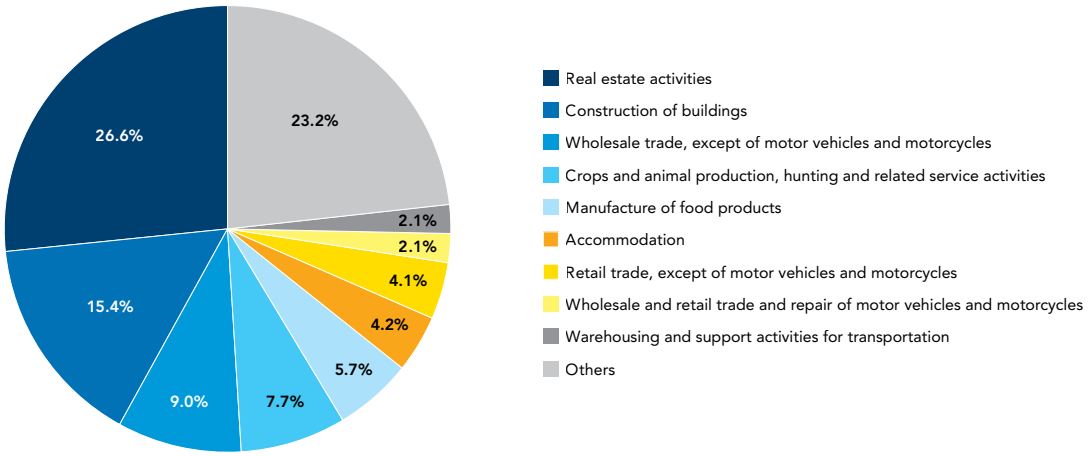
Figure 13: The financial sector and ecosystem services dependencies per Malaysian ringgit invested (in million RM)



Source: BNM (unpublished data), ENCORE, WB calculations

48 This sectoral analysis covers approximately 90 percent of the total corporate loan portfolio of Malaysian banks.
49 The oil and gas sector that is relatively important for the Malaysian economy does not show up prominently in this analysis as oil and gas companies receive large shares of their financing from capital markets.

Figure 14: Relative commercial lending exposure to sectors with high or very high dependencies (physical risk)



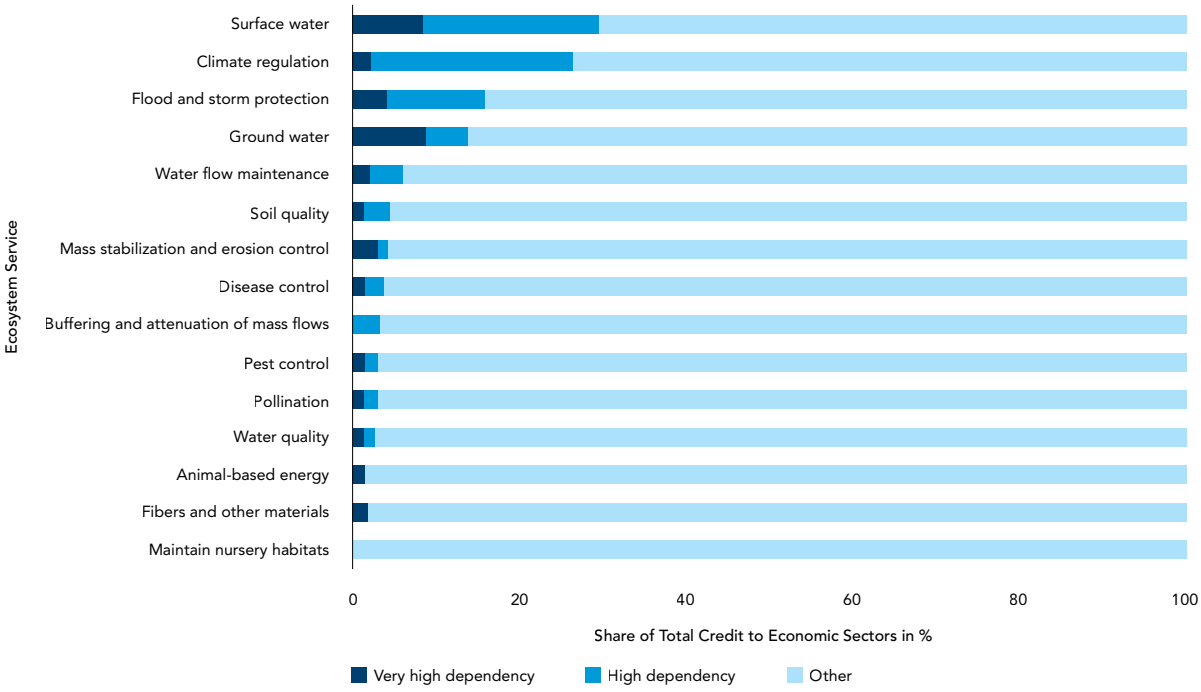
Source: BNM (unpublished data), ENCORE, WB calculations
Note: Sectors according to the Statistical Classification of Activities in the European Community (NACE)

Among all ecosystem services, Malaysian banks depend most strongly on individual ecosystems which provide surface water (30 percent), ground water (14 percent), flood and storm protection (16 percent), and climate regulation (26 percent) (Figure 15). Of every RM per loan, almost half depends highly or very highly on these four ecosystem services. For instance, Ulu Muda forest complex, covering 7 forest reserves, is an important water catchment forest not only for Kedah (96 percent of its water supply), but also the neighboring states of Penang and Perlis (80 percent and 50 percent of water supply respectively) (Sharma 2016, Ramasamy 2017). Flood and storm protection is becoming increasingly important as climate change grows. For example, floods have already had a substantial impact in Malaysia, with the recent Klang Valley and East Coast floods. The high dependence on climate regulation – long-term carbon storage in natural assets such as soils, vegetable biomass, and the oceans, as well as the role of vegetation to modify temperatures, humidity, and wind speeds at local levels – indicates the strong relevance of natural asset intactness moderating climate change impacts. This shows how climate- and nature-related risks are interacting, with large potential for co-benefits from policy, regulation, and investment.

These dependencies of Malaysian banks on ecosystem services vary widely across the types of banks and across individual banks within the same category.[50] Ecosystem service dependency varies across bank types, with commercial banks (54 percent) and Islamic banks (55 percent) showing the highest dependency. Both bank types are specifically dependent on climate regulation and surface water, indicating their large exposure towards real estate activities and wholesale sectors. DFIs (46 percent) show a relatively strong dependency on flood and storm protection, indicating the importance of infrastructure and agricultural sectors in their loan portfolio. Dependencies on ecosystem services vary across individual banks, even within the same bank type (Figure 16). Investment banks have the lowest exposure to ecosystem service dependent sectors on average (40 percent), with a high variability across peers. While the overall categories of commercial banks and Islamic banks have the highest dependency on ecosystem services in their loan portfolios, for individual banks dependency can be as low as 10 percent. Those dependencies are often driven by a specific lending focus in banks' portfolios, with agriculture, real estate, and construction lending showing high dependencies.

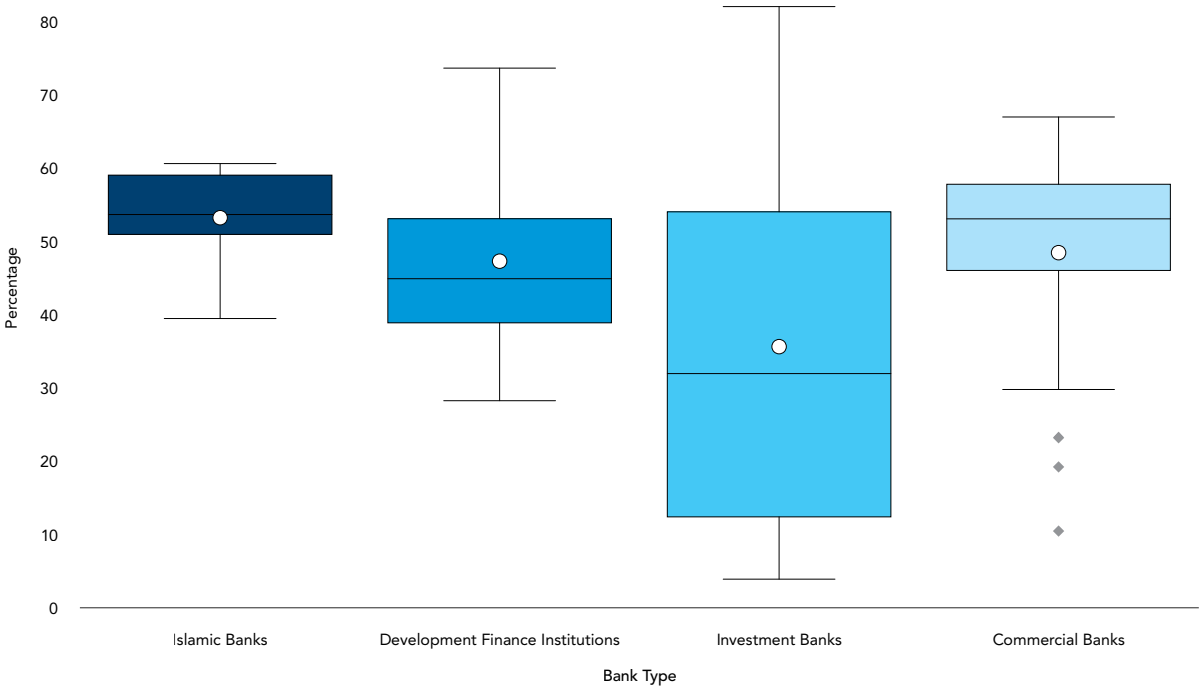
50 It should be noted that the indicated dependencies per bank level rely on sectoral global averages from the ENCORE database. Ecosystem service dependency might differ depending on project design and should ultimately be assessed on a project level. For instance, a real estate investment that incorporates a passive house standard (i.e. a green building standard) might be far less dependent on ecosystem services such as water compared to conventional real estate projects.

Figure 15: Dependency of the commercial lending portfolio to individual ecosystem services (percentage)



Source: BNM (unpublished data), ENCORE, WB calculations

Figure 16: Unweighted share of commercial lending portfolio with high or very high dependencies on ecosystem services by type of bank



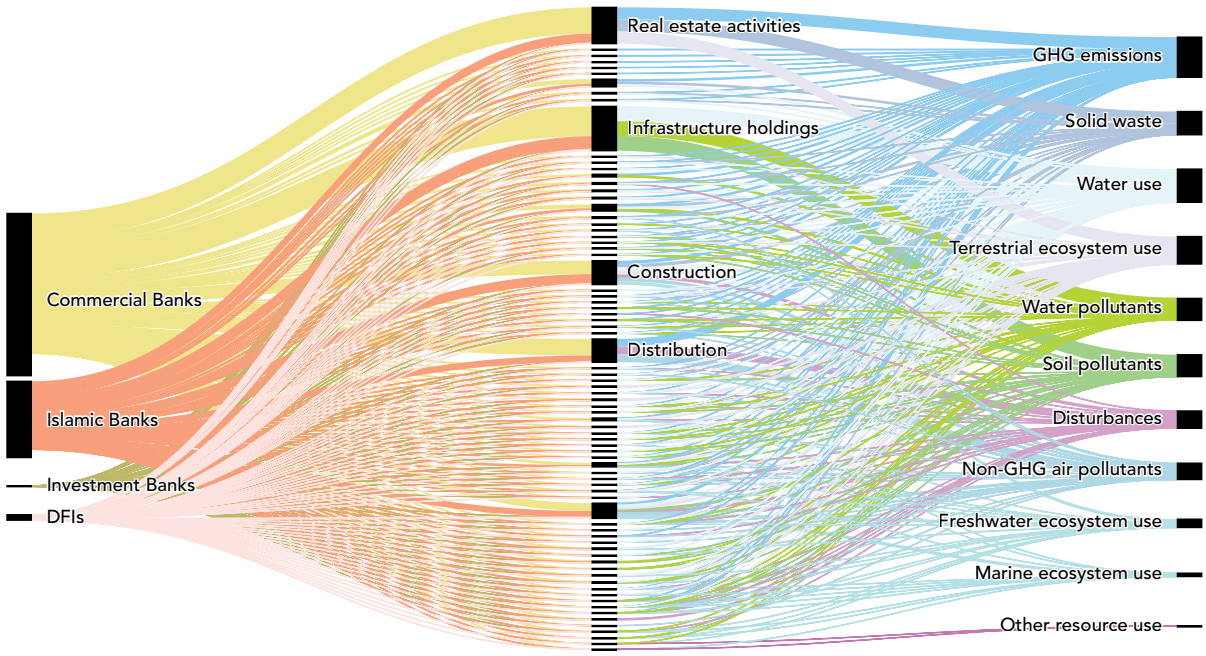
Source: BNM (unpublished data), ENCORE, WB calculations

2.2 Impacts on Ecosystem Services

Nature-related financial transition risk could emerge for Malaysian banks through the financing of companies that have negative impacts on biodiversity and ecosystem services, as these companies could face regulatory or reputational implications. A transition to conserve and restore biodiversity may expose companies, and the banks financing them, to potential disruptions and shocks (see Section 1.3 for details). Regulatory and reputational issues could emerge for entire sectors, posing sectoral transition risk. For example, in 2019, Norway's USD 1 trillion Government Pension Fund Global, revealed that since 2012, the Fund had divested from 33 palm oil companies over deforestation risks.[51,52] This included Malaysia's Sime Darby Plantation, the world's largest oil palm planter by land size. The Fund also announced that it was asking banks in Indonesia, Malaysia, and Brazil to adopt No Deforestation criteria for their loans to the agricultural sector (Norges Bank 2019). The analysis of impacts on ecosystem services follows the same methodology as for the dependency of ecosystem service assessment.

Eighty-seven percent of the commercial loan portfolio analyzed are channeled to sectors which highly or very highly impact various natural assets and ecosystem services (Figure 17). This represented RM 639 billion (USD 151 billion) of commercial loans outstanding to these sectors as of December 2020. Malaysian banks could face high risk to changes in regulations, technologies, and consumer preferences driven by concern over these environmental impacts. This further emphasizes the importance for the financial sector to start taking actions to mitigate such transition risk.

Figure 17: The environmental impact of financial sector lending per Malaysian ringgit invested (in million RM)

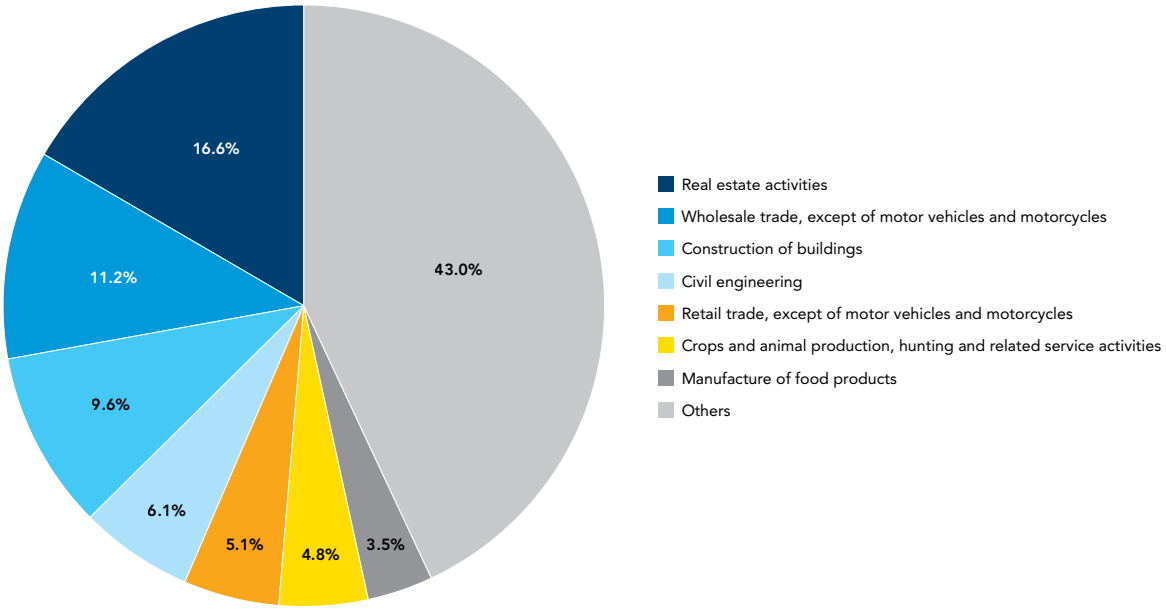


Source: BNM (unpublished data), ENCORE, WB calculations

51 https://www.nbim.no/en/the-fund/investments/holdings-as-at-31.12.2018/
52 https://www.regnskog.no/en/news/norways-government-pension-fund-acts-against-deforestation-divests-major-agricultural-companies

Yet, the commercial lending portfolio of Malaysian banks that highly or very highly drive impacts, are mainly accounted by six sectors which are responsible for over half of those impacts. This is both due to the size of lending exposure and the sectoral characteristics. Those sectors include real estate activities (17 percent), wholesale trade (11 percent), construction of buildings (10 percent), civil engineering (6 percent), retail trade (5 percent), and crops and animal production (5 percent) (Figure 18). Drivers of environmental impact, such as excessive water use, in turn affect the underlying natural assets, such as species, water, and habitat.

Figure 18: Relative commercial lending exposure to NACE sectors with high or very high impacts



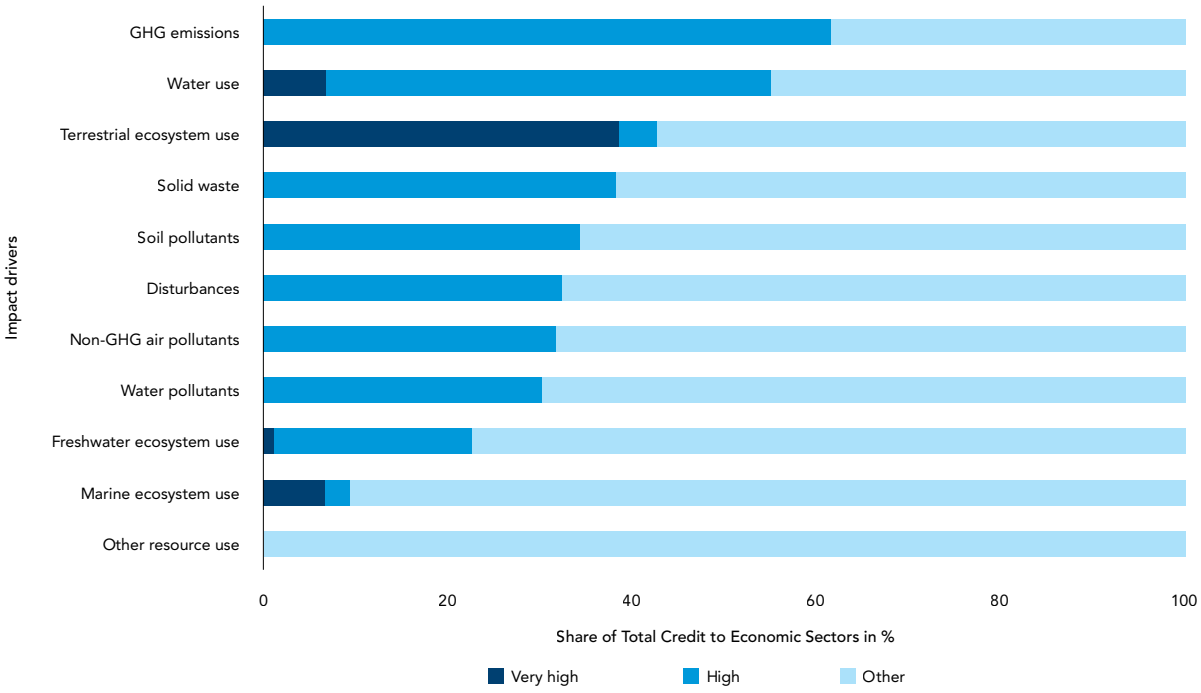
Source: Based on unpublished BNM data and ENCORE data

The banking sector could be particularly exposed to these drivers of environmental impacts given that Malaysia is a megadiverse country and the structure of its economy largely comprises production activities that are closely tied to natural assets and ecosystems. However, as becomes evident, the sectoral impacts on natural assets and ecosystem services are less concentrated than sectoral dependencies on ecosystem service provision. This indicates the wide range of economic activities that have a negative impact on nature and the scope of the challenge to reduce those impacts.

Among all impact drivers, the ones individually impacted the most[53] through commercial lending by Malaysian banks are GHG emissions (61 percent), water use (56 percent), and terrestrial ecosystem use (43 percent) (Figure 19). Of every RM of lending by the banks, about 40 cents are in sectors that highly or very highly impact these three impact drivers. This indicates the strong exposure of the natural assets that are most severely impacted by those impact drivers. GHG emissions are a main driver of impact on ecosystem services by contributing to climate change, which highlights the interlinkage between climate-related and nature-related risks. It further highlights the relevance of marine and terrestrial protected areas to lower impacts, and helps to maintain key ecosystem service provision in Malaysia. Enforcement of existing protected areas and the creation of new areas could pose significant nature transition risk to the Malaysian banking sector.

53 The impacts considered here are classified as high or very high impacts.

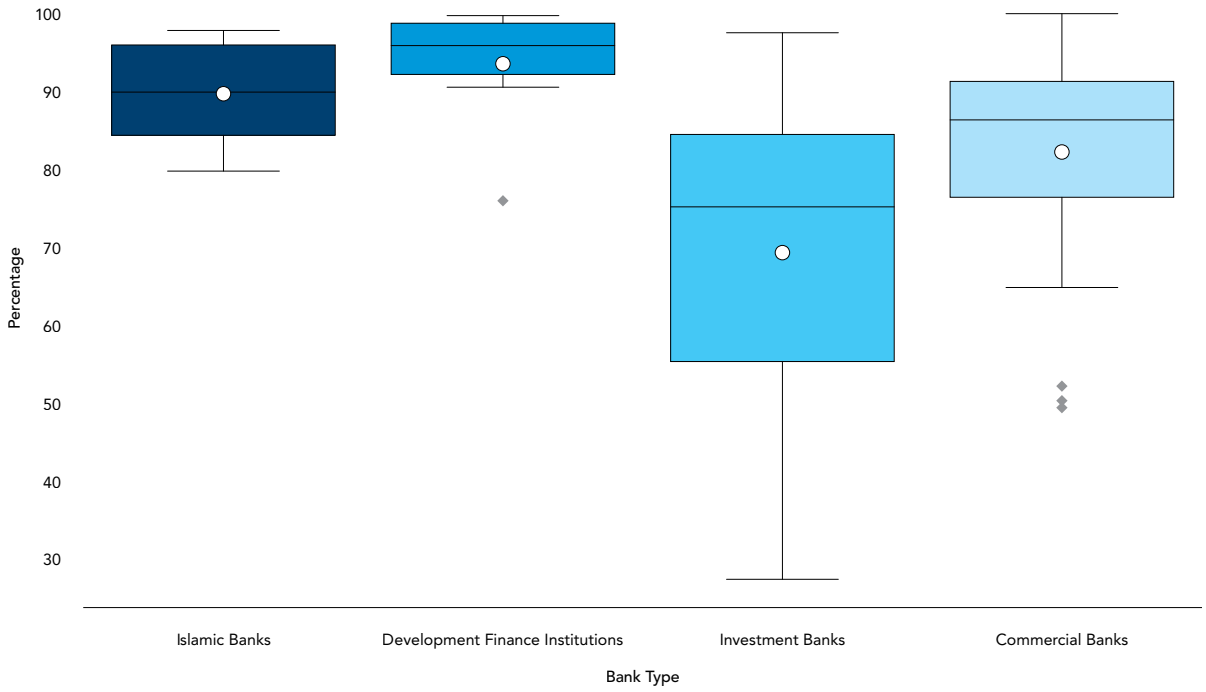
Figure 19: Impact of the commercial lending portfolio on impact drivers from firms' business activities (in percentage)



Source: BNM (unpublished data), ENCORE, WB calculations

The impacts of Malaysian banks on natural assets and ecosystem services are generally high but vary across types of banks and individual banks.[54] Impact drivers vary strongly across individual banks (Figure 20), depending on their lending focus. Banks that have a large exposure towards real estate activities and infrastructure projects, for instance, contribute to the deterioration of natural assets and ecosystem services via GHG emissions, terrestrial ecosystem use, and water-related impacts (i.e., water use and water pollutants). This partially explains why DFIs have a relatively high impact on natural assets and ecosystem services in their loan portfolio (95 percent), followed by Islamic banks (89 percent). There is a relatively low variability in impact among DFIs and Islamic banks, indicating a homogenous impact in their lending activities amongst peers (e.g., DFIs usually lend to sectors with high impacts on nature such as infrastructure and agriculture[55]). Investment banks show the lowest impact on average; but it is still 70 percent. Additionally, there is high variability across the group.

Figure 20: Unweighted share of commercial lending portfolio with high or very high impact drivers from firms' activities on natural assets and ecosystem services by type of bank



Source: BNM (unpublished data), ENCORE, WB calculations

54 It should be noted, however, that the indicated impacts per bank level rely on sectoral global averages from the ENCORE database. Ecosystem service impacts might differ depending on project design and should ultimately be assessed on a project level. For instance, a civil engineering project that includes a comprehensive environmental impact assessment in the planning phase might be far less impacting on ecosystem services compared to conventional real estate projects.

55 Note that impact might vary with projects and only global averages are considered here. For example, a sustainable agriculture project with no fertilizer and pesticide use and space for species that is financed by a DFI might actually create a nature-positive impact.

BOX 2

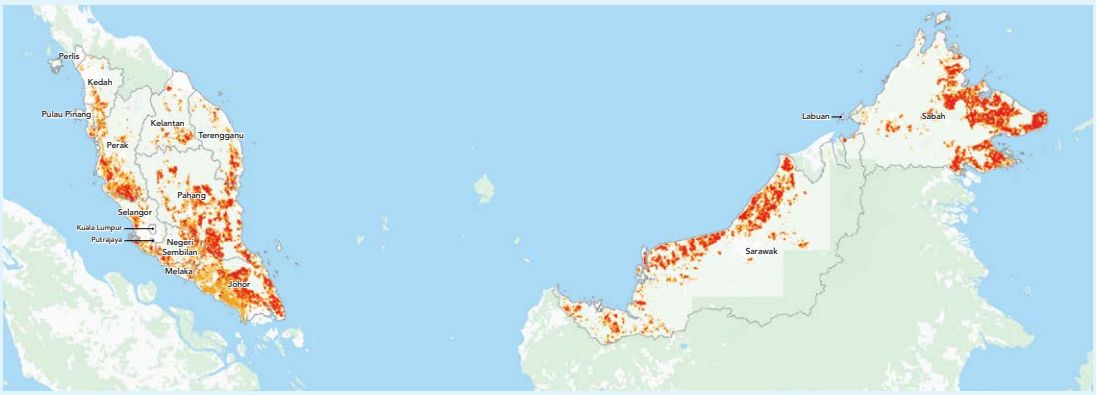
Case Study – Transition risk for Malaysia's palm oil sector

The upstream palm oil sector is often linked with deforestation, making it particularly susceptible to transition risk. The sector is particularly relevant for Malaysia as it contributed to 2.7 percent of the country's GDP in 2019 and is its biggest agricultural export (DOSM 2021). However, shifts in public perception and increased investor pressure have led to an increased focus on reducing the use of commodities with negative environmental impact within the supply chains and production processes of companies. The environmental concerns linked to palm oil have triggered major regulatory and market movements, such as the EU's 2019 Renewable Energy Directive, which requires that by 2030, no crop sourced from recently deforested areas or peatlands can be used to produce biofuels.[56]

These considerations linked to negative environmental impacts of the palm oil sector in Malaysia can be a source of transition risk to companies and the financial institutions linked to them. Already, there have been tentative signs of transition risk impacting companies' stock price performance. While crude palm oil prices rose 42 percent year to year in November 2021, the FBM KLCI Plantation Index slipped 3.8 percent during the corresponding period. This was partly attributed to the "steep ESG discount attached to plantation stock valuations" amid "deforestation, fire and haze, and labor concerns".[57]

The Malaysian government has enacted policy measures to boost the share of sustainability certified palm oil[58], aiming to mitigate such transition risk. It has enforced mandatory sustainability standards under the Malaysia Sustainable Palm Oil (MSPO) scheme, which mandate all oil palm plantations to be certified for sustainability (Malaysia Palm Oil Board, Government of Malaysia). As of end-2020, 88 percent of the total oil palm planted area in Malaysia, equivalent to 5.2 million hectares, has been MSPO certified.[59] Meanwhile, 21 percent of the planted area has also been certified under the internationally recognized Roundtable on Sustainable Palm Oil.[60] There is also a proposal to cap the area of oil palm plantations to 6.5 million hectares by 2023, whereas the area recorded in 2018 was 5.8 million hectares.[61]

Figure 21: High resolution Malaysia industrial and smallholder oil palm map for 2019



Industrial oil palm plantations Smallholder oil palm plantations Other land cover

Source: Adrià et al. 2021, WB calculations

56 https://ec.europa.eu/commission/presscorner/detail/en/MEMO_19_1656
57 *CPO Price Rally Marred by ESG Concerns*, Public Invest Research Sector Update November 8, 2011
58 https://www.eco-business.com/news/what-is-sustainable-palm-oil/
59 https://mspotrace.org.my/Home
60 https://rspo.org/news-and-events/news/press-release-positive-growth-for-sustainable-palm-oil
61 https://www.thestar.com.my/business/business-news/2021/01/05/malaysia-committed-to-cap-total-oil-palm-planted-area-at-65m-hectares

2.3 Activities in Key Biodiversity Areas

Malaysian banks could also be exposed to spatial biodiversity transition risk by financing companies that operate in nature and biodiversity-relevant areas. To protect those sites, the government could introduce new protective policy measures that would restrict or even impede business operations in those locations. Companies could face relocation costs or a need to adjust business models, potentially weakening their financial position. Consequently, transition risk for the Malaysian banking sector could emerge.

Ambitious global nature conservation targets would require Malaysia to significantly increase its protected area scope (currently at about 13 percent of its land area [UNEP-WCMC 2021]), posing a potential risk for firms that currently operate in to-be protected areas. Recent research shows that more ambitious and urgent steps are needed to stop the rapid decline in biodiversity (IPBES 2019). Thus, a target of 30 percent protection of the Earth's land and sea area by 2030 ("30x30" goal) is currently being discussed[62] and was officially put forward at the UN Convention on Biological Diversity in October 2021 in Kunming, as part of the 'Kunming Declaration' (2021).[63] This would mean a significant step-up compared to the 2010 declared Aichi Biodiversity Targets, which aim for 17 percent of terrestrial and 10 percent of maritime area protection across the globe (currently at 15 percent globally [Lewis et al. 2019]).

Current non-protected KBA could serve as a proxy for areas that could become protected if Malaysia follows the targets of the 'Kunming Declaration'. Protecting currently non-protected KBA would increase the share of terrestrial protected areas (Figure 22, panel a and b) of total land area from 13 percent (UNEP-WCMC 2021)[64] to about 24 percent. However, KBA relevance is not equally distributed across Malaysian states (Figure 23). States such as Perak, Pahang, Kedah, and Selangor are biodiversity hotspots, with KBA making up almost 50 percent of Perak's land area. While Malaysia has seen ambitious efforts in stepping-up protected areas since the 2000s (UNEP-WCMC 2021), a large share of KBA in Malaysian states is currently non-protected (see light blue bars in Figure 23 as a share of dark blue bars). As such, firms currently operating in those regions could be restricted, with implications for their financing banks.

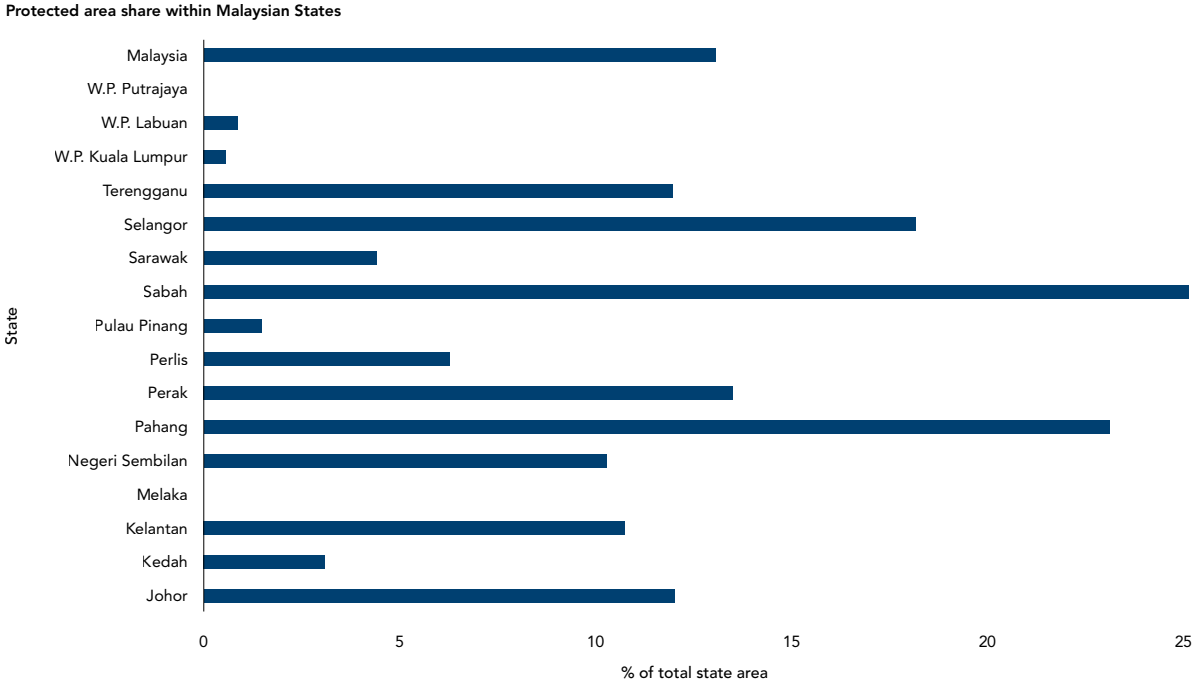
For the spatial transition risk analysis, postal code-based lending data[65] for commercial non-residential and residential property purchases (excluding household loans) are mapped to KBA. KBA could potentially be designated as protected in the future and it is thus relevant to see banks' financial exposure to those areas. This report refers to the gap between the protected areas and KBA as "currently non-protected KBA" and is intended to provide a proxy for areas that could become protected in the future. The sample has loans outstanding and the location of loan utilization as of December 2020 and covers about 5 percent of the overall commercial lending data sample.

The Malaysian banking sector has RM 329 million (USD 78 million) in lending exposure to firms that are active in currently non-protected KBA, although limitations in the analysis, such as data restrictions, suggest this could be a conservative estimate. Figure 24 shows the geographical distribution of Malaysian banks' commercial residential and non-residential property lending that occurs in currently non-protected KBA.

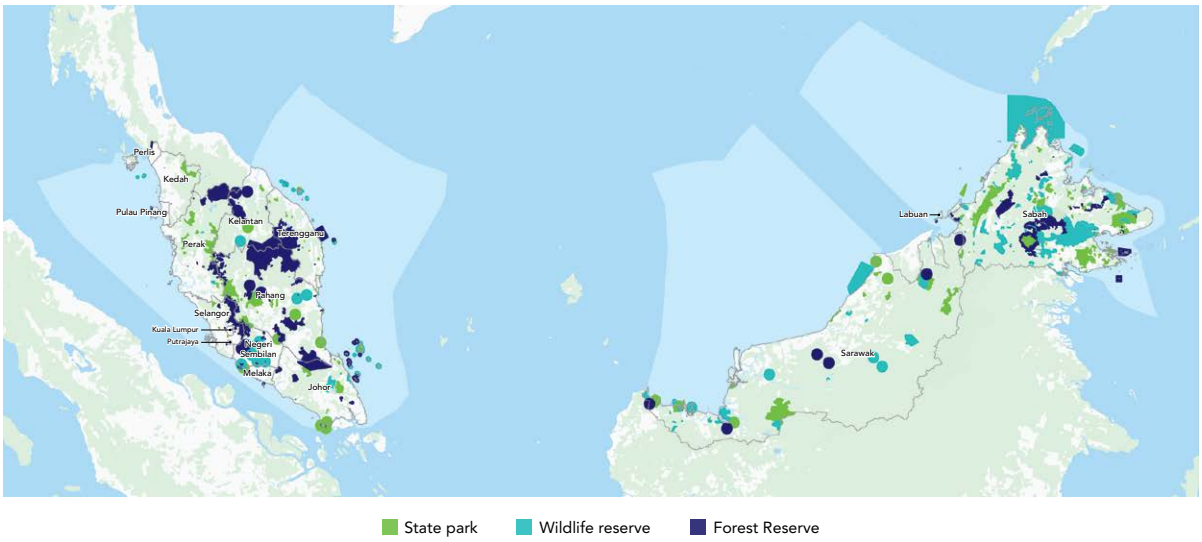
62 Malaysia is also currently considering protecting at least 30% of terrestrial areas and inland waters and 15% of coastal and marine areas through an effectively managed and ecologically representative system of protected areas and other effective area-based conservation measures by 2030.
63 Due to COVID-19, the final negotiations on the Kunming Declaration will not take place until May 2022.
64 Terrestrial protected areas are as of 2016, marine protected areas as of 2022.
65 Data correspond to the location of loan utilization i.e., where the economic activity is undertaken.

Figure 22: Protected areas in Malaysia

a) Protected terrestrial area share of total state area as of 2016, by state in Malaysia (percent)

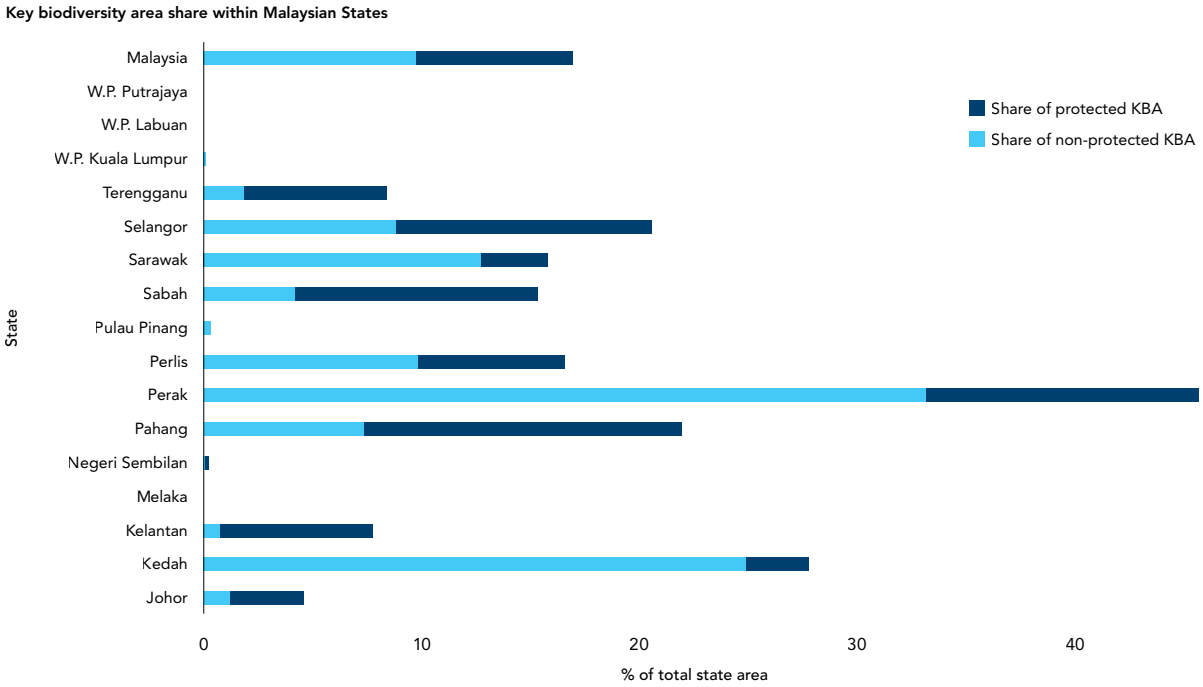


b) Protected area (state parks, wildlife reserves, forest reserves) in Malaysia (terrestrial and marine)



Source: UNEP-WCMC 2021, WB calculations

Figure 23: Protected and non-protected KBA as a share of Malaysian States area (percent of total state area)



Source: Statistical Office Malaysia, IBAT (BirdLife International Partnership, Alliance for Zero Extinction), WB calculations

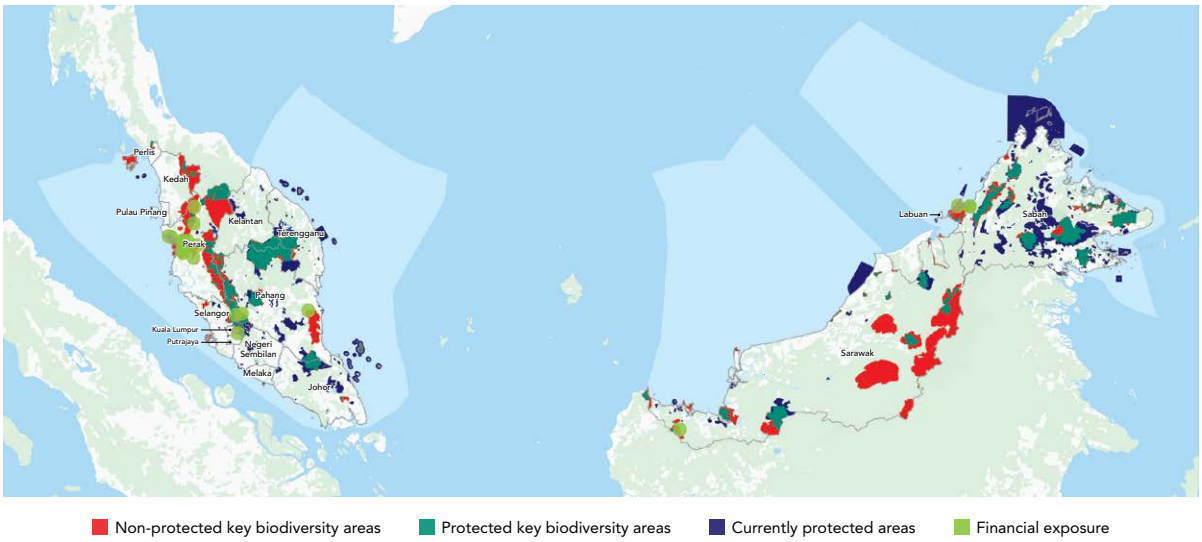
The share of commercial lending to non-protected KBA of overall commercial lending is relatively small, which could be explained by three reasons. First, the geospatial resolution of available financial data only covers residential and non-residential property lending, constituting only a share of 5 percent of overall commercial lending in our sample. Further, the matching process would benefit from geospatial files that could provide the full extent of postal code level territories. Second, sectors that are most likely to be active in those areas include agriculture and mining, only constituting about 5 percent of overall commercial lending of Malaysian banks (Figure 7). Third, the states with the highest shares of non-protected KBA such as Perak, Kedah, and Sarawak only make up about 3 percent, 2 percent, and 6 percent respectively of state-level lending by Malaysian banks (Figure 8), whereas the bulk of the lending of over 60 percent goes to just two states that have limited KBA in their state area (Kuala Lumpur) or no lending that would occur in KBA (Selangor).

KBA are in areas that are relatively untouched by economic activity as strong economic activity in those areas would have deteriorated biodiversity and as such impacted their status as KBA. This could point to the fact that first-order spatial transition risk might not be as problematic for the Malaysian banking sector but instead second-order dependencies for firms that depend on the primary inputs from agriculture and mining, such as manufacturing and construction firms, could be indirectly impacted by spatial transition risk.[66] Figure 25 supports this claim as the net balance of potential provision of ecosystem services and use of ecosystem services for each district in Malaysia differ strongly across the country. The coastal urban areas of

66 An analysis of upstream and downstream input dependence for selected countries has been conducted by Cahen-Fourot et al. (2020) and Cahen-Fourot et al. (2021)

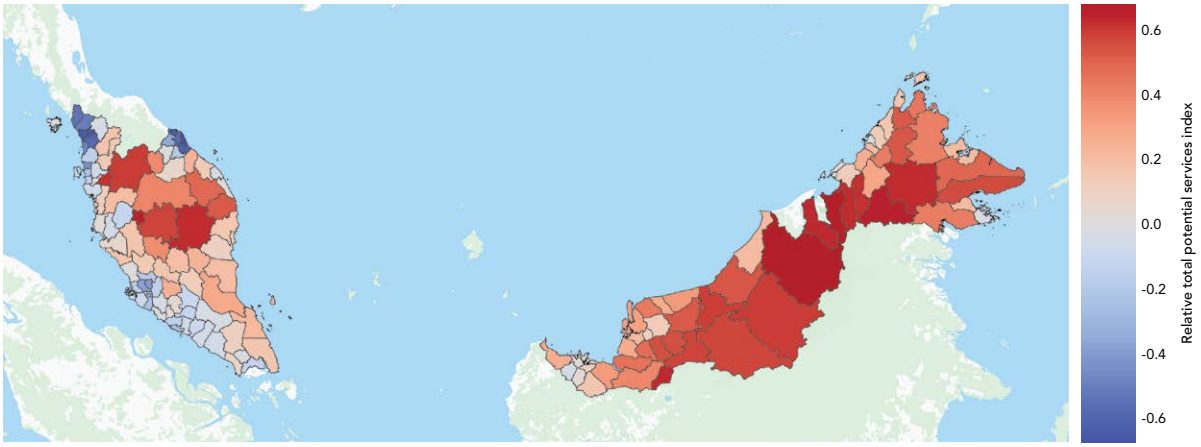
Peninsular Malaysia's west coast with its strong manufacturing, services, and construction sectors (Figure 9) are net consumers of ecosystem services. The protected areas in Perak, Pahang, Sarawak, and Sabah, in contrast, are net providers of ecosystem services.

Figure 24: Commercial residential and non-residential purchase lending exposure by Postal Code area of Malaysian banks to non-protected KBA



Source: Statistical Office Malaysia, IBAT, BirdLife International Partnership, Alliance for Zero Extinction, BNM (unpublished data), Humanitarian Data Exchange 2021,[67] WB calculations

Figure 25: Net ecosystem service use (potential vs. realized services index) per district in Malaysia. Model results from the Co$tingNature version 3 policy support system



Source: Mulligan, M. (2021), Humanitarian Data Exchange 2021, WB calculations

67 https://data.humdata.org/

2.4 **Physical and Transition Risk Scenarios**

To assess nature-related financial risks for prudential purposes, there is a need to go beyond exposure analysis and identify those risk scenarios that can materially affect banks' balance sheets. The scenarios should provide a coherent narrative for adverse events that produce severe economic and financial damage while at the same describing a set of plausible futures. In practice, macroprudential authorities and micro prudential supervisors often work with scenarios that have yearly probabilities of occurring between 1 in 10 to 1 in 1,000 years, to reflect that distributions of event occurrences might shift with growing climate change or nature-related risks.

In contrast to climate-related scenarios, however, nature-related risks are less well understood and to a higher degree multidimensional.[68] For example, ENCORE identifies 21 different ecosystem services and 27 different drivers of environmental change. This poses challenges for the development of nature-related financial risk scenarios and more research is needed on this matter.

A preliminary set of scenarios were developed for this report based on ENCORE, stakeholder interviews, and an explorative analysis of drivers of nature-related financial risk scenarios in Malaysia.[69] The scenarios capture current banking sector exposure in case of adverse events, such as floods or storms, far-reaching ecosystem service deterioration, or sudden policy changes, that could affect a combination of different ecosystem services and thus a multitude of economic sectors. The analysis above considered Malaysian banking sector exposure to nature risks in sectors and individual or entire ecosystem services. The scenarios for this section are not projections of business-as-usual, but rather state the current financial exposure if identified ecosystem services defaulted.

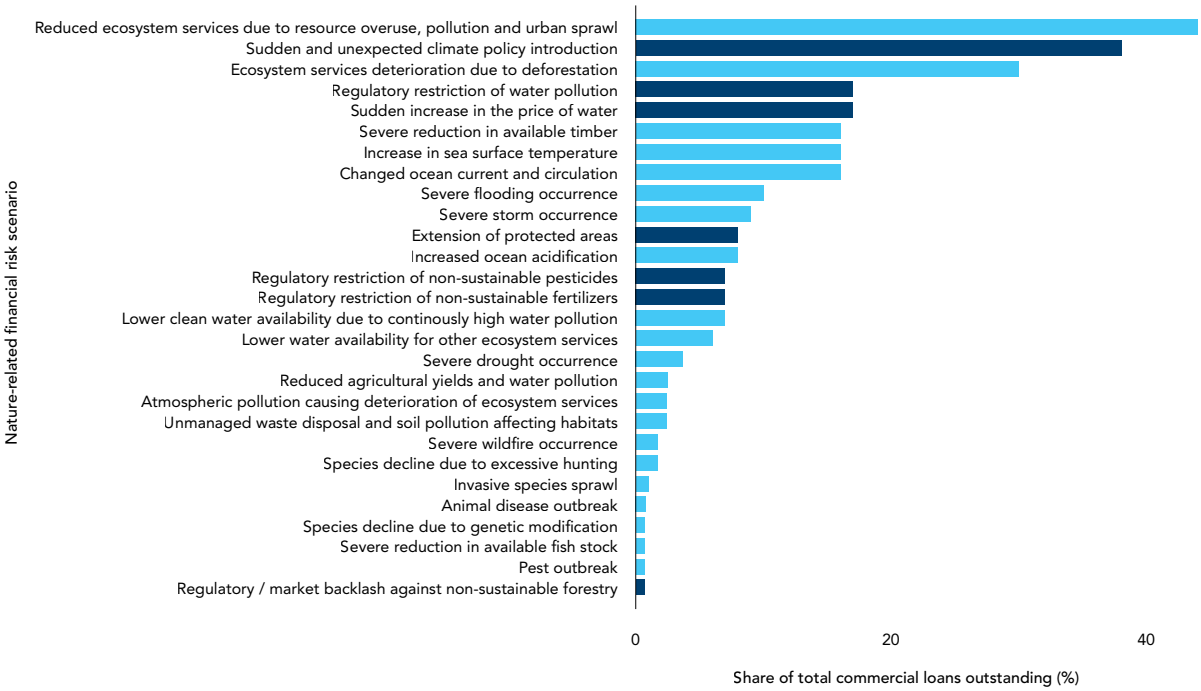
The identification of 21 physical and 7 transition risk scenarios shows the range of the banking sector's commercial loans portfolio exposure. Exposure ranges from 44 percent (reduced ecosystem services due to continued high resource use, pollution, and urban sprawl) to 0.5 percent (species decline due to excessive hunting) (Figure 26). Scenarios with the highest banking sector exposure are those that would affect a wide range of sectors, such as a general deterioration of ecosystem services for example due to high resource use, pollution, and urban sprawl (44 percent) or high rates of deforestation (30 percent). Exposure was also high regarding scenarios that could affect firms' costs and business models in multiple sectors, for example sudden and unexpected climate policy introduction (38 percent), regulatory restriction of water pollution (17 percent), and sudden increase in the price of water (removal of subsidies / market dynamics) (17 percent). Some physical risk scenarios were only expected to directly affect a few sectors with banking sector exposure. These included reduced agricultural yields and water pollution due to intense agri- and aquaculture (2.5 percent), animal disease outbreak (0.8 percent), and severe reduction in available fish stock (0.7 percent).

Sectors that are exposed in almost every physical and transition risk scenario are the agricultural, forestry, and fishing sectors as they have a high and direct dependence on multiple ecosystem services. Further, the electricity sector would be affected in multiple scenarios as it is highly dependent on regulating ecosystem services such as flood and storm protection and climate regulation. Drivers that could lead to the most severe scenarios in terms of Malaysian banking sector loan exposure are land- and sea use change,

68 Nature-related risks are often interconnected (e.g., soil erosion, groundwater depletion, biodiversity loss), caused by multiple anthropogenic drivers (e.g., intensive agriculture, deforestation, pollution), while acting on multiple scales (from local ecosystems to planetary processes), while interacting with climate change (Kedward et al. 2020).

69 See Appendix Section A4 and A5 for details. Appendix Section A4 provides a high-level analysis of the five core drivers of biodiversity and nature loss, land- and sea-use change, extensive natural resource use and exploitation, climate change, pollution, and invasive species spread (IBPES 2019), as well as governance and policy uncertainty related issues in the context of Malaysia. Appendix Section A5 describes core findings of the interviews in detail.

Figure 26: Identified nature-related financial risk scenarios by banking sector exposure



Source: ENCORE, BNM, interviews, WB calculations.
Note: Dark blue scenarios are nature-related financial transition risk scenarios, light blue scenarios are nature-related financial physical risk scenarios. Exposure amounts are based on the share of corporate loans to economic sectors that could be directly affected in the scenario under consideration.

natural resource use and exploitation, and climate change. Further, governance is an important scenario driver, especially with respect to transition risk.

Within the environmental risk dimension of the ESG framework on sustainability, nature-related risks complement and partly overlap with those risks associated with climate change. For example, this study found that two important nature-related risk factors to which Malaysian banks have exposure are: (1) imposition of more stringent climate policies and (2) efforts to preserve nature's function as a store of CO2. However, there are highly relevant risk factors not directly related to climate change – including extensive water use, land use, and pollution other than GHGs.

This report restricts itself to a 'possibility range' of nature-related risk scenarios. The reported scenarios are not projections of a business-as-usual scenario. They constitute a range of possible nature-risk scenarios for Malaysia. The materialization and degree of risk depends on vulnerability, likelihood of occurrence, and indirect impacts, which require further research. In general, the likelihood and financial consequences of specific nature-related risk scenarios are challenging to determine given the complexity, non-linearity, and endogeneity of causal relationships (Svartzman et al. 2021; NGFS 2021; Kedward et al. 2020). Likelihood of occurrence would depend on the current conditions of scenario relevant aspects such as natural assets or policy regulation as well as an uncertainty range, considering nature and policy related factors as well as shared socioeconomic pathways.[70] There exists a wide range of models that could assess impacts of scenarios of drivers of biodiversity and ecosystem service-related issues (Kim et al. 2018; Lade et al. 2021; Schaphoff et al. 2018) but important knowledge gaps specifically with respect to economic and financial impacts remain (IPBES 2016). Studies on nature-related risks from diverse countries can help fill these gaps (See Box 3).

70 See O'Neill et al. (2014) for discussion of shared socioeconomic pathways and their use.

BOX 3

Context for nature-related risks to the financial sector: Findings from the Netherlands, France, and Brazil

Central banks around the world are increasingly beginning to investigate biodiversity and other nature-related impacts and dependencies of financial systems. Initial studies by central banks including the Netherlands (van Toor et al. 2020), France (Svartzman et al. 2021), and Brazil (Calice et al. 2021) were recently published. In each country, the studies indicate material exposures to risks resulting from biodiversity loss.

Results from these countries are not necessarily directly comparable to those of Malaysia but are described here as additional context. This is due to differences in: 1) economic structures, 2) level of biodiversity (Brazil is classified as megadiverse like Malaysia but France and the Netherlands are not), 3) study scope and methodologies applied (only Malaysia looks at transition risk from ENCORE drivers of environmental impacts), and 4) scope of data used for the analysis (each study relied on the ENCORE database for data on ecosystem services, but in the Netherlands this covered not only banks' corporate loan portfolio, as in Malaysia, but also other parts of the financial system).

- **The Netherlands:** Van Toor et al. (2020) find that financial institutions have material exposures to risks resulting from biodiversity loss and that the sector finances companies that have an impact on biodiversity. Dutch financial institutions have provided EUR 510 billion in finance (36 percent of the portfolio of investments by Dutch financial institutions) to companies that are highly or very highly dependent on one or more ecosystem services. Financial institutions also have exposure of EUR 28 billion to companies operating in areas that are protected or that might come under protection and EUR 96 billion of investments in, or loans to, companies involved in environmental controversies with negative consequences for ecosystem services or biodiversity.
- **France:** Svartzman et al. (2021) also find substantial exposures to biodiversity risks in its estimates of dependencies and impacts of the French financial system on biodiversity. 42 percent of the value of securities held by French financial institutions comes from issuers that are highly or very highly dependent on one or more ecosystem services. The accumulated terrestrial biodiversity footprint of these securities is comparable to the loss of at least 130,000 km^2 of "pristine" nature, which corresponds to the complete artificialization of 24 percent of the area of metropolitan France.
- **Brazil:** Results in Calice et al. (2021) also suggest that exposures to biodiversity loss and related economic costs are material. 46 percent of Brazilian banks' non-financial corporate loan portfolio is concentrated in sectors highly or very highly dependent on one or more ecosystem service. Output losses associated with the collapse in ecosystem services could translate into a cumulative long-term increase in corporate non-performing loans of 9 percentage points. 15 percent of Brazilian banks' corporate loan portfolio is to firms potentially operating in protected areas, which could increase to 25 percent should conservation gaps close, and 38 percent should all priority areas become protected. Finally, 7 percent of corporate loans are to firms with recorded environmental controversies.

CHAPTER 3

Potential Actions to Address Nature-Related Financial Risks

Based on the initial assessment on nature-related financial risks to the financial sector in Malaysia and the exposures identified, further steps could be considered by financial sector regulators and supervisors in Malaysia in tandem with its ongoing climate change initiatives to effectively manage nature-related financial risks. Although the discussion on nature-related financial risks is still at a nascent stage compared to climate-related financial risks, BNM, as part of its mandate to promote monetary and financial stability conducive to the sustainable growth of the Malaysian economy, could take a proactive approach to gradually build its internal regulatory and supervisory capacity in identifying, assessing, monitoring, and managing nature-related financial risks.

Efforts to address nature-related financial risks could follow a similar roadmap as used to address climate-related financial risks, where BNM has adopted a phased strategy. Initial efforts could focus first on increasing awareness of nature-related financial risks and capacity building. Later efforts could enhance existing regulatory and supervisory measures, in line with the evolving global regulatory and supervisory good practices, to which BNM could also help contribute knowledge development and regulatory discourse on nature-related financial risks in the region and globally – as part of bodies such as the NGFS.

Four domains where actions could be undertaken are: (1) Raising awareness, stakeholder engagement, and policy discourse on understanding nature-related financial risks, (2) Enhancing capacity building of relevant stakeholders, (3) Strengthening macroeconomic surveillance capacity and risk identification, and (4) Developing regulatory and supervisory requirements, described in further detail below.[71] Actions are categorized according to intensity of effort, recognizing that resources are scarce in any central bank and trade-offs will need to be made in allocating resources to nature-related risks, particularly relevant during this COVID-19 period.

While this report focuses on actions that are largely in the domain or sphere of influence of BNM as a central bank, it recognizes that national governments bear primary responsibility and have broader tools to address biodiversity loss and climate change in an integrated manner. Additional actions could be considered by other Malaysian authorities as the country moves towards a net-zero economy. For instance, the Ministry of Environment and Water could better coordinate alignment between upcoming climate policies, such as the Long-term Low Emissions Development Strategy, with the action plans and targets of the National Policy on Biological Diversity. Delineating nature-positive low carbon pathways would be an important step to avoid potentially negative trade-offs from climate mitigation strategies that could have detrimental impacts on biodiversity and ecosystem health (e.g., poorly designed low-carbon infrastructure or energy projects). Such broader efforts to promote integrated approaches to nature-related risks would lend greater impetus and impact to financial sector actions.

1. Raising awareness, stakeholder engagement, and policy discourse on understanding nature-related financial risks:

- **Socialize key themes from this report with key stakeholders:** As part of the broader discourse in Malaysia on nature and biodiversity, and in parallel with other efforts to support climate action, BNM could socialize findings of this report with government agency stakeholders such as the Ministry of Environment and Water and the Ministry of Energy and Natural Resources. BNM could also encourage engagement of state-level agencies and the broader community of non-government and financial sector professionals, including its supervised financial institutions.

71 See also the recent World Bank report (2021c) for more universal recommendations on nature-related actions.

- **Contribute to knowledge programs that raise awareness of nature-related financial risks:** BNM could share its understanding of nature-related financial risks within knowledge programs on climate change and other relevant themes as part of its efforts to address emerging risks.

- **Advocate and work closely with the government to ensure nature-related financial risks are considered in relevant policies and investment decisions.** Complementary actions could include encouraging the public and private sector to consider the value and price of ecosystem services and relevant policies in investment decisions. Natural capital accounting (as, for instance, proposed by the UN System of Environmental Economic Accounting)[72] provides a more comprehensive stocktake of a country's natural wealth (WB 2021a). It can support government, regulators, and private sector participants to better manage natural assets and inform investment and development decisions for conservation, restoration, and sustainable use of nature.

- **Encourage and support the government towards developing a cohesive national strategy to address nature-related risks along with climate change:** Plans to address nature-related financial risks for the wider financial sector should be designed to leverage synergies with ongoing efforts for climate change. Coordinated efforts would support timely and smooth implementation and support effective prioritization amidst multiple competing priorities. It would also avoid unintended consequences such as detracting efforts from ongoing climate change implementation.

2. Enhancing capacity building of relevant stakeholders:

- **Expand capacity building and stakeholder engagement with key working groups for the financial sector:** Existing capacity building and stakeholder engagement programs under the JC3 could be leveraged and expanded to include increased awareness of nature-related risks with other stakeholders.

- **Collaborate with key knowledge partners to build understanding and tools for nature-related financial risks.** Further collaboration with conservation organizations, ecologists, and interdisciplinary academic researchers can help to strengthen understanding and tools for assessing nature-related risks.

- **Support development of incentives and instruments to mobilize private finance for the protection and management of biodiversity and ecosystem services.** A key challenge is to attract private finance for the conservation of nature, particularly when financial returns to investment are low. Along with other stakeholders, BNM could support the development of short-term financial incentives for companies to implement their sustainability strategies or to drive nature-smart investments[73] and disseminate relevant information on borrowers, incentives, and instruments for greater mobilization of private finance for protection and management of biodiversity and ecosystem services (see Box 4).

- **Provide financial sector perspectives to government to expand existing government grants/funds related to climate change to encompass goals relevant to protection of biodiversity and ecosystem services:** Over time, BNM and other stakeholders could advocate expanding existing funds for mitigating the impacts of climate change to encompass goals that reduce nature-related risks. In addition, DFIs have

72 https://seea.un.org/
73 A range of instruments to encourage private finance, including the sustainability linked loan tying interest rates to a company's reduction of biodiversity impact and associated risk and incentives to bridge the gap between public and private financing, are discussed in the World Bank report, Mobilizing Private Finance for Nature (2020).

a mandate to support national development objectives and may show substantial exposure to nature-related financial risks. Given their proximity to government and status as regulated entities, their funding could also be leveraged to mobilize private capital towards green finance and provide a demonstration effect of how sustainable finance could be mainstreamed within their own operations.

BOX 4

Mobilizing private finance for nature

One of the key issues hampering protection of nature in Malaysia has been the lack of funds available for habitat and species conservation activities. State governors are often landowners of key areas but have traditionally been reliant on revenues from natural resource extraction practices such as timber harvesting, mining, and agricultural development that can be detrimental to ecosystems.

Governments and regulators can help harness the power of the financial sector to mobilize private finance at a scale to protect nature. The 2021 WB Report on Mobilizing Private Finance for Nature highlighted a set of ideas including: (1) environmental fiscal reforms: using reforms as part of COVID-19 crisis recovery plans, reforming agricultural subsidies and land ownership with detrimental impacts, (2) national data provision: supporting the integration of nature-related criteria in financial decisions by adopting national capital accounting practices and providing relevant data as a public good, (3) establishing a task force for nature-related financial disclosure (TNFD) (discussed in Box 5) to provide a framework for reporting and risk assessment, (4) identifying companies with the greatest negative impact on nature, and v) providing catalytic capital from multilateral development banks and government to funds and other financial instruments to finance nature.

Financial incentives can help drive the transition to a nature-smart economy. For example, in 2019, Bunge, one of the world's largest agricultural producers, took out its first sustainability-linked loan. The interest rate was tied to the company reducing its biodiversity impact and associated risks, namely increasing traceability for its main agricultural commodities, and adopting sustainable practices across its wider soybean and palm oil supply chain. These instruments have the potential to help drive the transition to a nature-smart economy by offering short-term financial incentives for companies to implement their sustainability strategies.

Enabling financial infrastructure can also help green finance. In 2020, the Central Bank of Brazil launched the sustainability pillar of its strategic plan which included the creation of a Sustainable Rural Credit Bureau. This will be associated with the rural credit information system and contain information on farmers' sustainable practices as part of efforts to mitigate social, environmental, and climate risks in the financial system. Rural credit beneficiaries can make information registered in the new system (replacing its existing rural credit and agricultural operations system) available to any interested party. Several of the 270 data fields collect and verify information on the environmental and sustainability practices of each operation. A set of parameters associated with the sustainability of rural projects will be prepared, which will allow agricultural policy makers to assess the possibility of granting additional incentives to the financing of these projects (Banco Central Do Brasil 2021).

3. Strengthening macroeconomic surveillance capacity and risk identification

- **Improve understanding of interacting factors between climate and nature-related financial risks:** In the near-term, BNM could consider further developing its understanding of relevant scenarios, transmission channels, and modelling methodologies, while continuing to monitor exposures to nature-related risks periodically. This work could be informed by the developing global discourse on nature-related financial risks, and could also influence it, given Malaysia's relatively unique status as a megadiverse country with high dependence on its ecosystem services.

- **Incorporate a basic concept of nature-related financial risks in existing plans for a surveillance framework on climate risks:** This element could be incorporated where both risks have strong synergies, such as deforestation and disaster resilience, without requiring an additional surveillance framework related to nature-related risks.

- **Improve data collection relevant to managing nature-related financial risks:** Stronger collaboration and coordination amongst interdisciplinary stakeholders such as ministries, regulators, the private sector, and academics and experts from economic and natural sciences disciplines can help to fill gaps in data needed to manage both climate and nature-related risks and support sharing of proprietary data, particularly at local levels. Specifically, this could focus on building capacity to provide data on economic impacts under different nature-related physical and transition risk scenarios (parallel to similar efforts on climate-related risks). This could help identify the risks and opportunities that are most relevant for Malaysia and complement the global data obtained from ENCORE. Government authorities could also establish centralized environmental databases (e.g., forest cover and protected area maps, emissions data, water stress maps, etc.) that are accessible and frequently updated as a public good to support wider monitoring efforts. This process could also leverage ongoing work by the JC3 subcommittee on data needs, which has undertaken a stakeholder consultation process to identify and prioritize the collection of climate data for uses such as exposure quantification, investment and lending decisions, and macroeconomic and financial stability modeling. Indicators on biodiversity are among the data that could be considered for prioritized collection. Building these data over time, not only for the banking sector, but also for non-bank financial institutions exposed to nature-related risks (e.g., insurance/takaful) could provide a clearer picture of nature-related risks in the financial system.

- **Consider nature-related financial risks as part of high-level reference scenarios for Malaysia:** In the medium to long term, Malaysia could develop stress testing for nature-related scenarios alongside those being developed to examine climate-related risks.

- **Consider supervisory deep dives at select banks that are deemed at higher risk:** These supervisory efforts could look at banks whose data indicates a greater level of risk, for example those who are financing activities in (future) protected areas.

4. Enhancing regulatory and supervisory guidance related to nature-related financial risks

- **Enhance existing guidance in relevant taxonomies and frameworks to include findings on nature-related financial risks:** BNM could expand guidance for biodiversity or nature-related aspects in its CCPT (BNM 2021) and Value-based Intermediation and Impact Assessment Framework (VBIAF) (BNM 2019) to include more prominent considerations of nature-related financial risks. The CCPT adopts the principle of 'do no significant harm to the environment', which means that an economic activity must protect healthy ecosystems and biodiversity in order to satisfy the principle's assessment criteria. Similarly, the ASEAN Taxonomy for Sustainable Finance has also recognized the protection of healthy ecosystems and biodiversity as a key environmental objective in its consultative draft. Guidance could be expanded, for example by incorporating the concepts of drivers of environmental impacts and dependencies on ecosystem services in the assessment process.

- **Signal expectations for supervised financial institutions to understand the most relevant nature-related financial risks faced by their institution:** Based on the findings of this study, BNM could facilitate further analysis and deep dives on potential risk exposures that stand out or indicate baseline practices that could be adopted by financial institutions to identify high exposures to nature-related financial risks.

- **Enhance climate-related regulatory guidance on risk management and voluntary disclosures with specific aspects of nature-related financial risks:** BNM could also consider efforts to enhance regulatory guidance on climate-related disclosures with voluntary disclosure guidance on nature-related financial risks, such as those being piloted by the TNFD (described in Box 5).

- **Communicate regulatory and supervisory expectations on managing nature-related financial risk along with climate change risks for supervised institutions:** In the longer term, as diagnostics mature and international guidance develops, regulatory and supervisory expectations and requirements could be formulated in line with evolving good practices. For institutions that have high exposures to vulnerable sectors or regions, BNM could communicate additional expectations and include consideration of nature-related financial risks as part of the supervisory process.

- **Develop a monitoring system for new credit to be compliant with climate and nature-related regulations:** Such a system could include mechanisms for checking whether business activities will take place in (future) protected areas. As described in Box 4, Brazil is developing a Sustainable Rural Credit Bureau which will be associated with the rural credit information system and contain information on farmers' sustainable practices as part of efforts to mitigate social, environmental, and climate risks in the financial system.

BOX 5

Nature-related disclosure developments

Following the global push for companies to disclose their climate-related risks and opportunities, momentum has recently been building behind the nature-related disclosure agenda. The TCFD four pillars framework has become the most used framework globally for corporations and other organizations disclosure on climate criteria. A TNFD was formally launched in June 2021 with the mandate to build a similar framework for nature. The mission of the TNFD is, "to develop and deliver a risk management and disclosure framework for organizations to report and act on evolving nature-related risks, which aims to support a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes."

The TNFD has committed to working closely together with standard setting and disclosure mechanism bodies to promote global consistency for nature-related reporting, building upon the structure and foundation of the TCFD. The TNFD aspires to ensure the two frameworks will be comprehensive in their coverage of climate and nature-related financial risks, and complementary in their usability and adoption by market participants. The G7 Finance Ministers and G20 Sustainable Finance Roadmap have endorsed the TNFD, and the governments of Switzerland, the United Kingdom (UK), France, the Netherlands, and Australia are its funding partners.

The TNFD will go through five phases of work from 2021 to 2023: Build, Test, Consult, Disseminate, and Uptake. According to its website, "The TNFD will not create a new disclosure standard, but rather establish and promote the adoption of an integrated risk management and disclosure framework that aggregates the best tools and materials." The TNFD is taking an open innovation approach similar to the iterative innovation models used in the technology sector. The TNFD aims to share the initial high-level architecture of the framework shortly, to enable early pilot testing and consultation, and then evolve and develop the framework further with feedback from the market and relevant experts, given the complexity and urgency of the task of tackling nature-related risks. A beta version of the framework will be released in March 2022.

The most explicit biodiversity disclosure requirements to date have been imposed by France. Article 173-VI of France's Energy Transition and Green Growth Law, which went into effect in January 2016, requires investors to disclose how they factor ESG criteria and carbon-related aspects into their investment policies. The French Parliament amended Article 173 to require the disclosure of biodiversity impacts starting in 2021 (Ernst and Young 2017). This prompted French investors to start to develop better data on nature-related impacts and dependencies (Mirova 2020). Other European governments are following suit, including the UK, which pledged in its Green Finance Strategy (2019), to "work with international partners to catalyze market-led action on enhancing nature-related financial disclosures" (Her Majesty's Treasury UK Government 2019). The DNB's June 2020 report on risks to the financial sector from biodiversity loss calls for the development of a biodiversity risk disclosure framework (van Toor et al. 2020). The EU Taxonomy of Sustainable Activities also creates pressure for disclosure. Conservation and restoration of biodiversity and ecosystems is one of the categories of the taxonomy. Additionally, all investments under the taxonomy are required to 'do no harm' under its six categories of environmental objectives (European Commission 2020).

Source: Prepared by World Bank and TNFD secretariat staff

CHAPTER 4

Conclusions

4.1 Key Findings

This report provides a first assessment of nature-related financial risks for the Malaysian banking sector, examining their lending exposure to businesses which depend on and impact nature and its ecosystem services. Nature-related financial risks for Malaysian banks are examined using a conventional risk management approach which focuses on risk identification, risk assessment, and risk mitigation with a focus on exposures to sectors at risk. Better understanding of nature-related risks is key to align capital allocation, including loan origination, with Malaysian and global sustainability goals. Better understanding of nature-related financial risks is also important for prudential supervision, to identify any emerging risks on the books of banks and other financial institutions.

Nature-related risks in Malaysia center around the deterioration of natural assets and ecosystems tied to water use, climate regulation, GHG emissions, and deforestation, which could have implications for the Malaysian banking sector.

- About 54 percent of Malaysian banks' commercial lending portfolio could currently be exposed to physical risk, being highly or very highly dependent on well-functioning ecosystem services. Dependency on surface water (29 percent), climate regulation (26 percent), and flood and storm protection (16 percent) stand out specifically. At the same time, current banks' lending portfolio allocation is also exposed to significant transition risk, if the government introduced unexpected nature-related policies or if consumer preferences were to change (both domestically and abroad).

- About 87 percent of Malaysian banks' commercial lending portfolio could currently be exposed to sectors that strongly impact ecosystem services, thus facing a higher level of transition risk. The strongest impact drivers in this analysis were GHG emissions (61 percent of total lending portfolio), water use (55 percent), and terrestrial ecosystem use (43 percent).

Findings suggest substantial differences between individual banks in their exposure to sectors that depend highly on ecosystem services and that highly impact natural assets and ecosystem services. Those differences can be explained by different target sectors of lending which individual banks lend to; construction lending, for instance, is strongly dependent on surface water, climate regulation and flood and storm protection, and generally has strong environmental impacts via terrestrial ecosystem use, freshwater use, and GHG emissions. For ecosystem services, exposures to one or more highly or very highly dependent sectors range between 5 and 83 percent of the total commercial loan portfolio for individual banks. For environmental change, exposures to highly or very highly contributing sectors range between 28 and 100 percent. This indicates a necessity for more in-depth analysis of individual banks' portfolio composition and assessment of respective implications for financial stability.

Transition risk exposure from lending in potentially to-be-protected areas seems currently limited to less than 1 percent of outstanding loans in our sample, although limitations in the analysis, such as data restrictions, suggest this could be a conservative estimate. The analysis shows that most Malaysian bank loans are in areas that are already well developed. Less than one percent of Malaysian banks' commercial lending portfolio (RM 329 million, USD 78 million) is estimated to go to firms in currently non-protected KBA. However, due to data limitations, this may be a somewhat conservative estimate and exposures may be higher. There may also be an important role for more indirect exposures through supply chain linkages among firms in and outside protected areas. Also, it could be important to monitor new loan origination practices towards both currently protected areas and areas that may become protected in the future.

This report develops a first set of twenty-one nature-related physical and seven transition risk scenarios, using ENCORE and stakeholder interviews, that show potentially high but heterogenous banking sector exposure. This serves as a 'possibility range' of potential nature-related risk scenarios and related banking sector exposure, given data and knowledge gaps in assessing likelihood and financial consequences. Scenarios with the highest banking sector exposure are those that would affect a wide range of sectors such as a general deterioration of ecosystem services:

- Reduced ecosystem services due to continued high resource use, pollution, and urban sprawl: 44 percent of Malaysian banking sector's commercial lending portfolio
- Ecosystem service deterioration due to continued high rates of deforestation: 30 percent
- Policies that could affect firms' costs and business models in multiple sectors (sudden and unexpected climate policy introduction): 38 percent.

The agricultural, forestry, and fishing sectors are exposed to almost every physical and transition risk scenario as they have a high and direct dependence on multiple ecosystem services. Some physical risk scenarios are expected to directly affect only a few sectors, which constrain banking sector exposure.[74]

This analysis indicates that the financial sector has an indirect, yet important, two-way relationship with nature. Recent research by the WB shows that significant benefits could emerge from aligning policy responses to the nature and biodiversity crisis, including economic stimulus as well as climate change mitigation and adaptation (Johnson et al. 2021). Banks' lending behavior is an important determinant of the effectiveness of policies and of the degree to which nature-related risks could emerge. Their financing impacts the drivers of environmental change while being dependent on nature and its ecosystem services, constituting a *double materiality* (European Commission 2019, Oman and Svartzman 2021).

Thus, banks' lending behavior has an impact on their financial physical, transition, and liability risk exposures. By aligning their lending exposure to sectors and activities that benefit nature or do no harm, banks could in turn lower their risk exposure. In some cases, this could even increase economic and financial returns. For example, a WB study (2017) indicates that reducing overfishing and overcapacity by 40 percent, could result in more fish eventually being caught, allowing the recovery of more than USD 80 billion in "sunken billions" (loss of potential economic rents in global fisheries) while rebuilding the global fish stock.

4.2 Potential Actions to Address Challenges of Nature-Related Financial Risks

The findings of this report could inform and facilitate further policy discussions to better understand the impacts of nature-related financial risks on the financial sector and economy. BNM, as financial regulator, could act as a central coordinator for a financial sector action plan, working closely with multiple stakeholders and in line with the government's national biodiversity strategy. Further actions related to nature-related financial risks could be developed that are cohesive and integrated within its existing climate change strategy. These would consider: (1) national policy discussion and direction on nature-related risks, (2) further

74 Those scenarios include amongst others "Reduced agricultural yields and water pollution due to intense agri- and aquaculture" (2.5 percent), "Animal disease outbreak" (0.8 percent), and "Severe reduction in available fish stock (0.7 percent).

development of nature-related financial risk methodologies and analyses, (3) progress of ongoing climate change initiatives and determined linkages with nature-related financial risks, and (4) evolving practices and standards from the global financial regulatory and supervisory community.

Key areas for actions to manage nature-related financial risks include, (1) raising awareness and policy discourse, (2) enhancing capacity building of relevant stakeholders, (3) enhancing macroeconomic surveillance capacity and risk identification, and (4) developing regulatory and supervisory requirements. Section 3 and Figure 4 in this report depict recommended actions that could be considered by BNM (and relevant stakeholders such as ministries with responsibility for environmental issues, state-level agencies, and financial institutions) in more detail. Recommended actions differ by the level of policy intervention intensity, recognizing the need for prioritization in this challenging pandemic period.

4.3 **Areas for Future Exploration**

The exposure analysis conducted in this report is a step towards a fully-fledged nature stress-test. However, addressing certain limitations and knowledge gaps would require further research across multiple stakeholders from natural science, finance, the economy, and society. The analysis in this report can provide initial insights and a general understanding of potential risks that might become more likely in the future and that supervisors should consider within their financial stability mandate. More research is necessary to further refine exposure estimates from the ENCORE tool. A better understanding is needed of economic and financial vulnerabilities, scenario analysis needs to be refined, and methodologies are required to account for the economic and societal relevance of sectors beyond GDP and the share of financial exposure.

While it is understood that some activities negatively affect nature and its ecosystem services (Oliver et al. 2015, Folke et al. 2016), it is unclear when and how this could result in severe economic and financial losses.[75] Like in a Jenga game, where it is the players' goal to remove a block from a tower in each round without making the tower fall, the ongoing pressure on nature reduces its resilience, threatening collapse. Cascading and feedback effects from interactions between different ecosystems could thereby amplify human impacts (Lade et al. 2020). Sudden shocks to ecosystem services could lead to strong economic and financial risks. They could also result in high-risk materialization, especially if economic vulnerability is high, if substitutes for economic production are expensive or non-existent, and damage to nature is irreversible.

Beyond direct impacts, such as for the agricultural sector, indirect impacts could emerge via supply chains that could result in even larger economic and financial risks for the economy. Information is needed on the potential economic and societal relevance of certain sectors beyond their GDP share or direct financial sector exposure. Agriculture for instance constitutes a relatively small share of GDP and even smaller share of Malaysian banks' lending; yet strongly reduced agricultural yields could have severe social implications on food security, and food imports might not be able to compensate for the decline. Social implications like this could emerge from the collapse of ecosystem services and could become a critical risk to the macroeconomy.

The reported scenarios should be considered as a range of possible nature-related financial risk scenarios for Malaysia, whereas the materialization and degree of risk depends on vulnerability, likelihood of occurrence, and indirect impacts. The scenarios are not projections of a business-as-usual

75 At the local level understanding is more advanced.

scenario, but rather state the current financial exposure if the affected ecosystem services of this range of identified scenarios defaulted. Indeed, the likelihood and financial consequences of specific nature-related risk scenarios are challenging to determine given the complexity, non-linearity, and endogeneity of causal relationships (Svartzman et al. 2021; NGFS 2021; Kedward et al. 2020). Yet, an analysis of the main drivers of nature-related risks, such as land- and sea use change, nature use and exploitation, climate change, pollution, invasive species, governance, and policy uncertainty, indicates potential sources for nature-related financial risk scenarios.

Several areas merit further analysis to support the identification and assessment of nature-related financial risks. Global nature and biodiversity work programs are progressing but started later than similar work on climate-related financial risks, and are both broader in scope and more complex in their causal relationships.[76] Information is lacking on the likelihood and severity of adverse scenarios related to biodiversity loss as well as their economic and financial impact. The analysis in this report could also be complemented by the development of a comprehensive set of scenarios to be used in assessing nature-related financial risks and a better understanding of how scenarios lead to adverse economic and financial outcomes (e.g., transmission channels). Additionally, the development of models to understand the quantitative impact of scenarios and transmission channels on financial institutions, including banks and non-bank financial institutions, would enhance the knowledge of future risks to the financial system due to nature-related risks.

76 For example, ENCORE identifies 21 different ecosystem services and 27 different drivers of environmental change. The likelihood of the occurrence of a specific scenario is challenging to determine given the complexity, non-linearity, and endogeneity of nature-related risks (Svartzman et al. 2021, Kedward et al. 2020, NGFS 2021).

References

Aizen, M. A., Aguiar, S., Biesmeijer, J. C., Garibaldi, L. A., Inouye, D. W., Jung, C., Martins, D. J., Medel, R., Morales, C. L., Ngo, H., Pauw, A., Paxton, R. J., Sáez, A., and Seymour, C. L. 2019. "Global agricultural productivity is threatened by increasing pollinator dependence without a parallel increase in crop diversification." *Global Change Biology* 25(10): 3516–3527. https://doi.org/https://doi.org/10.1111/gcb.14736

Alongi, D. M. 2008. "Mangrove forests: Resilience, protection from tsunamis, and responses to global climate change." *Estuarine, Coastal and Shelf Science* 76(1): 1–13. https://doi.org/https://doi.org/10.1016/j.ecss.2007.08.024

Banco Central do Brasil. *Report on Social, Environmental and Climate-related Risks and Opportunities.* 2021. Brasília: Banco Central do Brasil

Barker, S., Mullholland, E., and Onifade, T. 2020. *The emergence of foreseeable biodiversity-related liability risks for financial institutions - A gathering storm?* Commonwealth Climate and Law Initiative. https://ccli.ouce.ox.ac.uk/wp-content/uploads/2020/09/CCLI-Biodiversity-liability-risks-report-vFINAL.pdf

Battiston, S., Mandel, A., Monasterolo, I., Schütze, F., and Visentin, G. 2017. "A climate stress-test of the financial system." *Nature Climate Change* 7(4): 283–288. https://doi.org/10.1038/nclimate3255

BNM. 2021. *Monthly highlights and statistics in March 2020.* Bank Negara Malaysia.

BNM. 2021. *Climate Change and Principle-based Taxonomy.* Bank Negara Malaysia. https://www.bnm.gov.my/documents/20124/938039/Climate+Change+and+Principle-based+Taxonomy.pdf

BNM. 2019. *Value-based intermediation Financing and Investment Impact Assessment Framework – Guidance Document.* Bank Negara Malaysia. https://www.bnm.gov.my/-/value-based-intermediation-financing-and-investment-impact-assessment-framework-guidance-document

Cahen-Fourot, L., Campiglio, E., Godin, A., Kemp-Benedict, E., and Trsek, S. 2021. "Capital stranding cascades: The impact of decarbonisation on productive asset utilisation." *Ecological Economic Papers* 37. Vienna: Vienna University of Economics and Business.

Cahen-Fourot, L., Campiglio, E., Dawkins, E., Godin, A., and Kemp-Benedict, E. 2020. "Looking for the Inverted Pyramid: An Application Using Input-Output Networks." *Ecological Economics* 169, 106554. https://doi.org/https://doi.org/10.1016/j.ecolecon.2019.106554

Calice, P., Diaz Kalan, F., and Miguel, F. 2021. "Nature- Related Financial Risks in Brazil." Policy Research Working Paper 9759. Washington, DC: World Bank Group.

Camara, M., Jamil, N. R., and Abdullah, A. F. Bin. 2019. "Impact of land uses on water quality in Malaysia: a review." *Ecological Processes* 8(1). https://doi.org/10.1186/s13717-019-0164-x

Chen, H. L., Nath, T. K., Chong, S., Foo, V., Gibbins, C., and Lechner, A. M. 2021. "The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste." *SN Applied Sciences* 3(4): 1–15. https://doi.org/10.1007/s42452-021-04234-y

Clements, R., Sodhi, N. S., Schilthuizen, M., and Ng, P. K. L. 2006. "Limestone Karsts of Southeast Asia: Imperiled Arks of Biodiversity," *BioScience* 56(9): 733-742. https://doi.org/10.1641/0006-3568(2006)56[733:LKOSAI]2.0.CO;2\

Climate Watch. 2020. *GHG Emissions.* Washington, DC: World Resources Institute

Cunningham, S. C., Mac Nally, R., Baker, P. J., Cavagnaro, T. R., Beringer, J., Thomson, J. R., & Thompson, R. M. 2015. "Balancing the environmental benefits of reforestation in agricultural regions." *Perspectives in Plant Ecology, Evolution and Systematics* 17(4): 301–317. https://doi.org/https://doi.org/10.1016/j.ppees.2015.06.001

Dasgupta, P. 2021. *The economics of biodiversity: The Dasgupta review.* HM Treasury, London. https://www.gov.uk/government/collections/the-economics-of-biodiversity-the-dasgupta-review

Descals, A., Wich, S., Meijaard, E., Gaveau, D., Peedell, S., and Szantoi, Z. 2021. "High resolution global industrial and smallholder oil palm map for 2019 (Version v1)". Zenodo. doi:10.5281/zenodo.4473715

DOSM. 2021. *Statistics on demand.* Department of Statistics Malaysia. https://www.dosm.gov.my/v1/index.php?r=column/cone&menu_id=TWNzZjZSZS9RUzhHYzdXODhFSEhLdz09

Dunz and Power. 2021. *Climate-Related Risks for Ministries of Finance – An Overview.* Washington, DC: Coalition of Finance Ministers for Climate Action.

ERE Consulting Group. 2021. *REVIEW OF THE NATIONAL POLICY ON BIOLOGICAL DIVERSITY - Interim Report Stocktaking and Gap Analysis.* Selangor: ERE Consulting Group.

Er, H.H., Lee, L.K., Lim Z.F., Teng S.T., Leaw C.P., and Lim P.T. 2018. "Responses of phytoplankton community to eutrophication in Semerak Lagoon (Malaysia)." *Environmental Science and Pollution Research International* 25(23):22944-22962. doi: 10.1007/s11356-018-2389-0. Epub 2018 Jun 1. PMID: 29858995.

Ernst and Young. 2017. How have investors met their ESG and climate reporting requirements under Article 173-VI?. Ernst and Young.

European Commission. 2020. *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*. European Commission.European Commission. 2019. Guidelines on reporting climate-related information. Brussels: European Commission.

Field, C. B., Barros, V., Stocker, T. F., Qin, D., Dokken, D. J., Ebi, K. L., Mastrandrea, M. D., Mach, K. J., Plattner, G. K., Allen, S. K., Tignor, M., and Midgley P. M., eds. 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge and New York: Intergovernmental Panel on Climate Change.

Folke, C., Biggs, R., Norström, A. V., Reyers, B., and Rockström, J. 2016. :Social-ecological resilience and biosphere-based sustainability science." *Ecology and Society* 21(3). https://doi.org/10.5751/ES-08748-210341

Folke, C., Polasky, S., Rockström, J., Galaz, V., Westley, F., Lamont, M., Scheffer, M., Österblom, H., Carpenter, S. R., Chapin, F. S., Seto, K. C., Weber, E. U., Crona, B. I., Daily, G. C., Dasgupta, P., Gaffney, O., Gordon, L. J., Hoff, H., Levin, S. A., Lubchenco, J., Steffen, W., and Walker, B. H. 2021. "Our future in the Anthropocene biosphere." *Ambio* 50 (4). https://doi.org/10.1007/s13280-021-01544-8

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., and Townshend, J. R. G. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." *Science* 342: 850–53. https://earthenginepartners.appspot.com/science-2013-global-forest.

Her Majesty's Treasury (HMT). 2019. *Green Finance Strategy.* Her Majesty's Treasury, UK Government.

Humanitarian Data Exchange. 2021. *Malaysia - Subnational Administrative Boundaries*. OCHA Regional Office for Asia and the Pacific (ROAP). https://data.humdata.org/

IBAT - Integrated Biodiversity Assessment Tool. https://www.ibat-alliance.org/

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2020. "Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services." Bonn: IPBES. DOI:10.5281/zenodo.4147317.

International Energy Agency (IEA). 2021. *Global Energy Review 2021: CO2 emissions*. International Energy Agency. https://www.iea.org/reports/global-energy-review-2021/co2-emissions

IPBES. 2019. "The global assessment report on biodiversity and ecosystem services: summary for policymakers." Bonn: IPBES. https://ipbes.net/system/tdf/ipbes_global_assessment_report_summary_for_policymakers.pdf?file=1&type=node&id=35329

IPBES. 2016. "Summary for policymakers of the methodological assessment of scenarios and models of biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services." Bonn: IPBES. www.iisd.ca/ipbes/ipbes3/12jan.htm

IPBES/Intergovernmental Panel on Climate Change (IPCC). 2021. "IPBES-IPCC co-sponsored workshop report on biodiversity and climate change." IPBES and IPCC. DOI:10.5281/zenodo.4782538.

IPCC. 2021. "Summary for Policymakers." In Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S. L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, M., Gomis, M. I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J. B. R., Maycock, T. K., Waterfield, T., Yelekçi, O., Yu, R., and Zhou, B., eds. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge and New York: Intergovernmental Panel on Climate Change.

Johnson, J.A., Ruta, G., Baldos, U., Cervigni, R., Chonabayashi, S., Corong, E., Gavryliuk, O., Gerber, J., Hertel, T., Nootenboom, C., and Polasky, S. 2021. *The Economic Case for Nature : A Global Earth-Economy Model to Assess Development Policy Pathways.*, Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/35882 License: CC BY 3.0 IGO.

Kaza, S., Yao, L., Bhada-Tata, P., and van Woerden, F. 2018. *What a Waste 2.0 - A global snapshot of solid waste management to 2050.* Washington, DC: World Bank Group.

Kedward, K., Ryan-Collins, J., and Chenet, H. 2020. *Managing Nature-Related Financial Risks: A Precautionary Policy Approach for Central Banks and Financial Supervisors.* SSRN Working Paper.

Kim, H., Rosa, I. M. D., Alkemade, R., Leadley, P., Hurtt, G., Popp, A., Van Vuuren, D. P., Anthoni, P., Arneth, A., Baisero, D., Caton, E., Chaplin-Kramer, R., Chini, L., De Palma, A., Di Fulvio, F., Di Marco, M., Espinoza, F., Ferrier, S., Fujimori, S., … Pereira, H. M. 2018. "A protocol for an intercomparison of biodiversity and ecosystem services models using harmonized land-use and climate scenarios." *Geoscientific Model Development* 11(11): 4537–4562. https://doi.org/10.5194/gmd-11-4537-2018

Kunming Declaration. 2021. *Declaration from the High-Level Segment of the UN Biodiversity Conference 2020 (Part 1) under the theme: "Ecological Civilization: Building a Shared Future for All Life on Earth" Final Draft.* https://www.cbd.int/doc/c/df35/4b94/5e86e1ee09bc8c7d4b35aaf0/kunmingdeclaration-en.pdf

Lade, S. J., Steffen, W., de Vries, W., Carpenter, S. R., Donges, J. F., Gerten, D., Hoff, H., Newbold, T., Richardson, K., and Rockström, J. 2020. "Human impacts on planetary boundaries amplified by Earth system interactions." *Nature Sustainability* 3(2): 119–128. https://doi.org/10.1038/s41893-019-0454-4

Lade, S. J., Fetzer, I., Cornell, S. E., & Crona, B. 2021. "A prototype Earth system impact metric that accounts for cross-scale interactions." *Environmental Research Letters* 16(11). https://doi.org/10.1088/1748-9326/ac2db1

Lenton, T. M. 2013. "Environmental Tipping Points." *Annual Review of Environment and Resources* 38(1): 1–29. https://doi.org/10.1146/annurev-environ-102511-084654

Lewis, E., MacSharry, B., Juffe-Bignoli, D., Harris, N., Burrows, G., Kingston, N., and Burgess, N. D. 2019. "Dynamics in the global protected-area estate since 2004." *Conservation Biology* 33(3): 570–579. https://doi.org/https://doi.org/10.1111/cobi.13056

Mead, M. I., Castruccio, S., Latif, M. T., Nadzir, M. S. M., Dominick, D., Thota, A., Crippa, P. 2018. "Impact of the 2015 wildfires on Malaysian air quality and exposure: a comparative study of observed and modeled data." *Environmental Research Letters* 13(4):044023

Mirova. 2020. *AXA IM, BNP Paribas AM, Mirova and Sycomore AM launch joint initiative to develop pioneering tool for measuring investment impact on biodiversity.*

Moh Y. C., Manaf, L. A. 2017 "Solid waste management transformation and future challenges of source separation and recycling practice in Malaysia." *Resources, Conservation & Recycling* 116:1–14

MPOB. 2021. *Oil Palm Planted Area 2020.* Malaysian Palm Oil Board. https://bepi.mpob.gov.my/index.php/en/?option=com_content&view=category&id=115

MyBIS. 2015. *5th National Report to Convention on Biological Diversity.* Ministry of Natural Resource and Environment. Malaysia. https://www.mybis.gov.my/pb/172

MyBIS. 2016. *National Policy on Biological Diversity 2016 - 2025 / Dasar Kepelbagaian Biologi Kebangsaan 2016 - 2025, 2016.* Ministry of Natural Resources and Environment (NRE), Malaysia. https://www.mybis.gov.my/pb/590

MyBIS. 2018. *Invasive Alien Species in Malaysia.* National Committee on Invasive Alien Species Malaysia. pp. 113. Malaysia Biodiversity Information System.

MyBIS. 2021. *National Action Plan on Invasive Alien Species 2021-2025.* Ministry of Agriculture and Food Industry & Ministry of Energy and Natural Resources, Malaysia. pp. 84. Malaysia Biodiversity Information System.

NCFA and UN-WCMC. 2018. *Exploring Natural Capital Opportunities, Risks and Exposure: A practical guide for financial institutions.* Natural Capital Finance Alliance and UN Environment World Conservation Monitoring Centre (Geneva, Oxford and Cambridge).

Natural Capital Finance Alliance (Global Canopy, UNEP FI, and UNEP-WCMC) (2021). *ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure.* [On-line], [June/2021], Cambridge, UK: the Natural Capital Finance Alliance. Available at: https://encore.naturalcapital.finance. DOI: https://doi.org/10.34892/dz3x-y059.

NGFS. 2021. "Biodiversity and financial stability: exploring the case for action - Study Group interim report." *NGFS Occasional Paper.*

NGFS. 2021. *Climate-related litigation: Raising awareness about a growing source of risk.* Network for Greening the Financial System. https://www.ngfs.net/sites/default/files/medias/documents/climate_related_litigation.pdf

Norges Bank. 2019. *Responsible investment 2018*. Norges Bank. https://www.nbim.no/contentassets/e1632963319146bbb040024114ca65af/responsible-investment_2018.pdf

Oliver, T. H., Isaac, N. J. B., August, T. A., Woodcock, B. A., Roy, D. B., and Bullock, J. M. 2015. "Declining resilience of ecosystem functions under biodiversity loss." *Nature Communications* 6. https://doi.org/10.1038/ncomms10122

Oman, W., Svartzman, R. 2021. "What Justifies Sustainable Finance Measures? Financial-Economic Interactions and Possible Implications for Policymakers". *CESifo Forum* 22. 03: 03–11. Munich: ifo Institute - Leibniz Institute for Economic Research at the University of Munich.

O'Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., Mathur, R., and van Vuuren, D. P. 2014. "A new scenario framework for climate change research: The concept of shared socioeconomic pathways." *Climatic Change* 122(3): 387–400. https://doi.org/10.1007/s10584-013-0905-2

Page, S., and Rieley, J. 2018. "Tropical Peat Swamp Forests of Southeast Asia." *In The Wetland Book,* 1753-1761. Dordrecht: Springer Netherlands.

Platto, S., Zhou, J., Wang, Y., Wang, H., and Carafoli, E. 2021. "Biodiversity loss and COVID-19 pandemic: The role of bats in the origin and the spreading of the disease." *Biochemical and Biophysical Research Communications* 538.

Power, Samantha; Dunz, Nepomuk; and Gavryliuk, Olga. 2022 (Forthcoming). *Nature-Related Risks for Ministries of Finance – An Overview.* Coalition of Finance Ministers for Climate Action, Washington, DC. © Coalition of Finance Ministers for Climate Action.

Qureshi M.I., Rasli A.M., Awan U., Ma J., Ali G., Alam A., Sajjad F., Zaman K. 2015. "Environment and air pollution: health services bequeath to grotesque menace." *Environ Sci Pollut Res* 22(5): 3467–3476.

Rainforest Action Network (RAN), Banktrack, Indigenous Environmental Network, Oilchange, Reclaim Finance, Sierra Club. 2021. *Banking on Climate Chaos – Fossil Fuel Finance Report 2021.* https://www.ran.org/wp-content/uploads/2021/03/Banking-on-Climate-Chaos-2021.pdf

Ramasamy, S. V. 2017. *Logging in Ulu Muda Forest Reserve: Is Penang's Water Security under Threat?* Penang Institute Issues. https://penanginstitute.org/publications/issues/1008-logging-in-ulu-muda-forest-reserve-is-penangs-water-security-under-threat/

Ramsar Convention Secretariat (Ramsar), 2010. *Designating Ramsar Sites: Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance, Ramsar handbooks for the wise use of wetlands.* 4th edition, vol. 17. Ramsar Convention Secretariat, Gland, Switzerland.

Richards, D. R., and Friess, D. A. 2016. "Drivers of mangrove loss in Southeast Asia." *Proceedings of the National Academy of Sciences* 113 (2): 344-349. DOI: 10.1073/pnas.1510272113

Ritchie, Hanna and Roser, Max. 2020. *CO_2 and Greenhouse Gas Emissions.* Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource]

Schaphoff, S., Von Bloh, W., Rammig, A., Thonicke, K., Biemans, H., Forkel, M., Gerten, D., Heinke, J., Jägermeyr, J., Knauer, J., Langerwisch, F., Lucht, W., Müller, C., Rolinski, S., & Waha, K. 2018. "LPJmL4 - A dynamic global vegetation model with managed land - Part 1: Model description." *Geoscientific Model Development* 11(4): 1343–1375. https://doi.org/10.5194/gmd-11-1343-2018

Schipper, A., Hilbers, J. P., Meijer, J. R., Antão, L. H., Benítez-López, A., de Jonge, M. M. J., Leemans, L. H., Scheper, E., Alkemade, R., Doelman, J. C., Mylius, S., Stehfest, E., van Vuuren, D. P., van Zeist, W-J., Huijbregts, M. A. J. 2019. *Projecting terrestrial biodiversity intactness with GLOBIO 4.*

Sharma, D. D. D. 2016. *Protection of the Ulu Muda water catchment forests hinges on all to play their roles.* WWF News. https://www.wwf.org.my/?22065/Protection-of-the-Ulu-Muda-water-catchment-forests-hinges-on-all-to-play-their-roles

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., and Sörlin, S. 2015. "Planetary boundaries: Guiding human development on a changing planet." Science 347(6223), 1259855. https://doi.org/10.1126/science.1259855

Svartzman, R., Espagne, E., Hadji-lazaro, P., Salin, M., Allen, T., Berger, J., Calas, J., and Vallier, A. 2021. "A "Silent Spring" for the Financial System ? Exploring Biodiversity-Related Financial Risks in France." *Banque de France Working Paper, 826.* Paris: Banque de France

Taylor, L. H., Latham, S. M., and Woolhouse, M. E. J. 2001. "Risk factors for human disease emergence." *Philos Trans R Soc Lond B Biol Sci* 356(1411): 983–9.

ThinkHazard!. 2021. *Malaysia.* Global Facility for Disaster Reduction and Recovery (GFDRR). https://thinkhazard.org/en/report/153-malaysia.

Timbuong, J., and Tang, A. 2019. "CAP: Ban all plastic waste imports." Star Media, 29 May, viewed 18 July 2019. https ://www.thest ar.com.my/news/nation/2019/05/29/cap-ban-all-plasticwaste-imports/

van Toor, J., Piljic, D., Schellekens, G., van Oorschot, M., and Kok, M. 2020. "Indebted to nature" Issue June. De Nederlandsche Bank.

UNEP-WCMC. 2021. *Protected Area Profile for Malaysia from the World Database of Protected Areas.* UN Environment World Conservation Monitoring Centre. Available at: www.protectedplanet.net

UEBT. 2020. *UEBT Biodiversity Barometer.* Union for Ethical Biotrade. https://static1.squarespace.com/static/577e0feae4fcb502316dc547/t/5faba5647c9a080d1659515b/1605084543908/UEBT+Biodiversity+Barometer+2020.pdf

Usmani, R.S.A., Saeed, A., Abdullahi, A.M. et al. 2020. "Air pollution and its health impacts in Malaysia: a review." *Air Qual Atmos Health* 13: 1093–1118. https://doi.org/10.1007/s11869-020-00867-x

Venter, O., Sanderson, E. W., Magrach, A., Allan, J. R., Beher, J., Jones, K. R., Possingham, H. P., Laurance, W. F., Wood, P., Fekete, B. M., Levy, M. A., and Watson, J. E. M. 2016. "Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation." *Nature Communications* 7: 1–11. https://doi.org/10.1038/ncomms12558

WEF. 2020. *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy.* World Economic Forum.

WEF. 2021. *The Global Risks Report 2021.* World Economic Forum. https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf

Wicke, B., Sikkema, R., Dornburg, V., and Faaij, A. 2011. "Exploring land use changes and the role of palm oil production in Indonesia and Malaysia." *Land Use Policy* 28(1): 193-206.

WITS. 2021. *Limestone flux; limestone and other calcareous stone, of a kind used for the manufacture of lime or cement exports by country in 2018.* World Integrated Trade Solution. https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2018/tradeflow/Exports/partner/WLD/product/252100

WHO. 2017. "The cost of a polluted environment, 1.7 million child deaths a year, says WHO." https://www.who.int/en/news-room/detail/06-03-2017-the-cost-of-a-polluted-environment-1-7-million-child-deaths-a-year-says-who.

Williams, B. A., Venter, O., Allan, J. R., Atkinson, S. C., Rehbein, J. A., Ward, M., Di Marco, M., Grantham, H. S., Ervin, J., Goetz, S. J., Hansen, A. J., Jantz, P., Pillay, R., Rodríguez-Buriticá, S., Supples, C., Virnig, A. L. S., and Watson, J. E. M. 2020. "Change in Terrestrial Human Footprint Drives Continued Loss of Intact Ecosystems." *One Earth* 3(3): 371–382. https://doi.org/10.1016/j.oneear.2020.08.009

World Bank. 2021a. *The Changing Wealth of Nations 2021: Managing Assets for the Future.* Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/36400 License: CC BY 3.0 IGO

World Bank Group, Asian Development Bank. 2021. *Climate Risk Country Profile : Malaysia.* Washington, DC: World Bank Group and Manila: Asian Development Bank.

World Bank Group. 2021b. *Unlocking Nature-Smart Development : An Approach Paper on Biodiversity and Ecosystem Services.* Washington, DC: World Bank Group. © World Bank. https://openknowledge.worldbank.org/handle/10986/36047 License: CC BY 3.0 IGO."

World Bank Group. 2020. *Mobilizing Private Finance for Nature.* Washington, DC: World Bank Group. http://pubdocs.worldbank.org/en/916781601304630850/Finance-for-Nature-28-Sep-web-version.pdf

World Bank. 2019. *Terrestrial Biodiversity Indicators.* World Bank Development Data Hub.

WRI. 2021. *Aqueduct – Water Risk Atlas.* World Resources Institute.

UN System of Environmental-Economic Accounting (SEEA). 2021. *ARIES for SEEA Explorer.* https://aries.integratedmodelling.org/aries-for-seea-explorer/

Appendix

A.1 Methodology

The physical and sectoral transition risk exposure analysis presented in this report is conducted by using the ENCORE biodiversity tool.[77] ENCORE is a database that maps sector-based impacts and dependencies on ecosystem services for sectors of the economy. Box 1 in the main text outlines ENCORE's assumptions regarding the materiality of ecosystem services for businesses, both with respect to dependencies and impacts. ENCORE thus allows a detailed assessment of the interactions of the economy with the natural environment and thus an exposure analysis of the Malaysian banking sectors' commercial loan portfolio to potential nature-related physical and transition risks. ENCORE's database consists of 86 business processes and 21 ecosystem services (see Appendix Table A4), such as clean and reliable supplies of water, carbon sequestration, and pollination. It further contains 11 impact drivers on nature and ecosystem services, such as terrestrial ecosystem use and GHG emissions (See Appendix Table A5).

Data on outstanding commercial loans (unpublished) for the analysis was provided by BNM. The data covers 61 Malaysian banks (26 commercial banks, 16 Islamic banks, 10 investment banks, and 9 DFIs [6 regulated under the DFI Act and 3 not]) at the end of December 2020. The loan data is given at NACE Revision 2 at the 4-digit level. The commercial loans outstanding in the sample stands at RM 733 billion representing 90 percent of the total commercial loans portfolio. Table A1 summarizes the data sets that inform the analysis in this report.

Table A1: Underlying data for analysis in this report

Type of Analysis	Data sources
Dependencies on Ecosystem Services	• ENCORE (Natural Capital Finance Alliance 2021) • BNM commercial loans data
Impacts on Ecosystem Services	• ENCORE (Natural Capital Finance Alliance 2021) • BNM commercial loans data
Activities in key biodiversity areas	• Key biodiversity areas (IBAT) • Protected Areas (UNEP-WCMC 2021) • BNM postal-code based lending data for commercial non-residential and residential property purchase.
Physical and transition risk scenarios	• ENCORE (Natural Capital Finance Alliance 2021) • BNM commercial loans data • Interviews • Additional reports and biophysical datasets

Source: World Bank

77 https://encore.naturalcapital.finance/en/explore

The analysis follows closely the approach proposed by DNB (van Toor et al. 2020), consisting of several steps of data reclassification and remapping (Figure A1). Reclassification and remapping are needed to align sector classification of the lending data with sector classification used in ENCORE. Additionally, we extend the DNB analysis that focused on nature-related sectoral physical risk, by also assessing banks' portfolio impacts on ecosystem services and natural assets. As such we can also examine sectoral transition risk exposure of Malaysian banks, using a similar methodology. First, we reclassify the banks' lending data from NACE Revision 2 at the 2-digit level to business processes which are used in ENCORE. For the mapping we rely on the reclassification typology by DNB, as ENCORE only provides sectoral mapping from economic sectors given at the Global Industry Classification Standard to business processes. As several sectors could be linked to more than one business process, weights need to be assigned. We follow the DNB approach in assigning equal weighting according to the number of business processes. For instance, A2 "forestry and logging" would map to both, "large-scale forestry" and "small-scale forestry" and we assign each of the business processes a weight of 50 percent of lending that goes to "forestry and logging" (see Table A2).

Table A2: Weighting example for mapping economic sectors to business process

NACE REV2 Sector	Business Process	Weight
A2 – Forestry and logging	Large-scale forestry	0.5
	Small-scale forestry	0.5

Source: World Bank

Following the DNB approach, we focus the analysis on relationships between economic sectors and ecosystem services with high or very high dependencies only, as the degradation of those ecosystem services is likely to have a strong detrimental impact on firms' business processes. Likewise, we only consider linkages of economic sectors and drivers of environmental change with a high or very high impact.

Second, we map business processes to dependencies on ecosystem services (physical risk) or impact drivers on nature loss (transition risk). Several business processes depend highly or very highly on more than one ecosystem service or affect nature highly or very highly via more than one impact driver. In those cases, we use equal weighting according to the number of ecosystem services for sectors. For example, for business processes (e.g., processed food and drink production) that highly or very highly depend on two ecosystem services such as surface water supply and climate regulation, for one RM of lending, half is allocated to surface water supply and half for climate regulation (Table A3). For assessing the exposure of Malaysian banks to individual ecosystem services (Figure 13 and Figure 17), an unweighted approach is applied. This attributes one RM for every RM of lending to the respective ecosystem service. This approach, however, does not allow us to add different ecosystem service dependencies in banks' portfolios as the sum would exceed the original portfolio size.

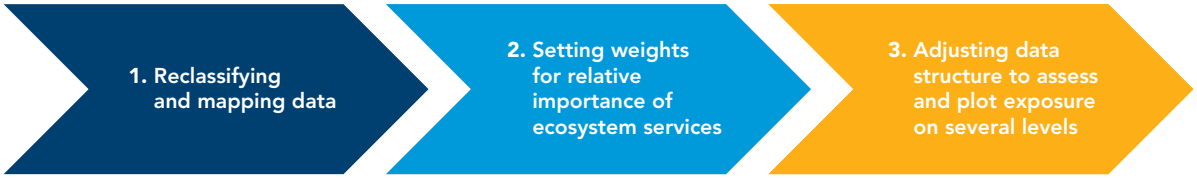
Table A3: Weighting example for mapping business processes to ecosystem services

Business Process	Ecosystem Service	Weight	
		Unweighted	Weighted
Processed food and drink production	Surface water	1	0.5
	Ground water	1	0.5

Source: World Bank

The reclassification allows us to map sectoral lending (NACE) to business processes in ENCORE which again are linked to ecosystem service dependencies (physical risk) or impact drivers (transition risk). Those, in turn, further affect natural assets such as species, habitats, and water. We show the nature-related physical and transition exposures of the Malaysian banks' commercial lending portfolio in the following subsections with respect to natural asset dependencies and impacts and ecosystem service dependencies and impacts, most exposed economic sectors in Malaysian banks' commercial lending portfolio, and the distribution exposure to impacts and dependencies amongst individual banks.

Figure A1: Practical steps to assess sectoral physical and transition risk exposure



Source: World Bank

ENCORE is a global tool and thereby subject to several caveats. Ecosystem service dependencies and the state of the natural assets differ by country and require a geographical and sectoral context to refine the assessment provided by ENCORE. For instance, the dependency of construction sectors on flood and storm protection as an ecosystem service might depend on the prevalence of floods and storms in the specific country context. As such a global average, as applied by ENCORE, could over- or underestimate the dependency and impacts of specifics sectors. Furthermore, ENCORE focuses on direct nature-related impacts and dependencies for the various sectors of the economy. Thus, ENCORE can give a comprehensive view on the key first-order nature-related impacts and dependencies at the level of sectors of the economy. Estimates provided in the previous sections should however be considered as conservative, as the ENCORE tool only includes direct reliance of sectors on ecosystem services, whereas indirect dependencies that could stem from downstream supply chains are not captured. Furthermore, the currently applied equal weighting approach in case of multiple sector- or ecosystem service linkages, strongly influences the exposure results.[78] Additional analysis is needed to contextualize and refine the analysis with respect to substitutability and adaptability options that could inform those weights by incorporating country specifics (see Table A2 and A3). The ENCORE analysis could be complementary to assessments of other key biodiversity-specific indicators at the local level and develop

78 One could argue, however, that in absence of more detailed information on the production process of Malaysian firms, this approach is conservative as it caps the exposure towards one ecosystem service to its relative share of the entire lending portfolio.

an understanding of the cross-sectoral linkages of upstream and downstream value chains amongst different sectors. This combined approach could inform potential nature-related vulnerabilities of economic sectors of the Malaysian economy, that could become sources of financial risk for the Malaysian banking sector.

The analysis in this report depicts the exposure of Malaysian banks to sectors that are potentially exposed to nature-related physical and transition risks. However, the analysis does not provide information on the potential economic and societal relevance of certain sectors. Agriculture for instance constitutes a relatively small share of GDP and even smaller share in Malaysian banks' lending; yet strongly reduced agricultural yields could have severe social implications on food security, and food imports could potentially not compensate for the decline. Social implications like this could emerge from ecosystem service collapse and could become a critical risk to the macroeconomy, but go beyond the scope of this analysis.

For the analysis of activities in KBA, we map postal code based lending data for commercial non-residential and residential property purchases (excluding household loans) to KBA (Figure A2). KBA could potentially be designated as protected in the future and it is thus relevant to see banks' financial exposure to those areas. We use the IBAT, developed by the UN Environment Program World Conservation Monitoring Centre, International Union for Conservation of Nature, Conservation International, and Birdlife International, to compare the currently protected areas in Malaysia with KBA[79] that are not yet protected. The gap between the protected areas and KBA we call "currently non-protected KBA" and is intended to provide a proxy for areas that could become protected in the future. For Malaysia as a whole, protecting those currently non-protected KBA would increase the share of protected areas of total land area to about 24 percent. However, KBA relevance is not equally distributed across Malaysian states (Figure 23). States such as Perak, Pahang, Kedah, and Selangor are biodiversity hotspots, with KBA making almost up to 50 percent of Perak's land area for instance. While Malaysia has seen ambitious efforts in stepping-up protected areas since the 2000s (UNEP-WCMC 2021), a large share of KBA in Malaysian states is currently non-protected (see light blue bars in Figure 23 as a share of dark blue bars). As such, firms currently operating in those regions could be restricted, with implications for their financing banks.

For the analysis we use (unpublished) postal code level commercial non-residential and residential property purchase lending data (excluding households) of Malaysian banks, provided by BNM. The sample comprises loans outstanding and the location of loan utilization as of December 2020 and covers about 5 percent of the overall commercial lending data sample. In the absence of geospatial datasets that could provide a postal code level resolution of areas in Malaysia, we rely on a workaround by assigning each postal code (at its centroid) a longitude and latitude coordinate[80] that we transform into a coordinate reference system, in this case the WGS84[81] format. During that exercise, some lending contracts had to be dropped, however, as no coordinates existed for the respective postal code in our dataset. We then compare if those postal code coordinates lie within the currently non-protected KBA areas to assess the financial lending exposure of Malaysian banks in those areas. This approach has limitations,[82] resulting in the below reported spatial exposures being conservative estimates.

79 KBA are defined to be sites that contribute significantly to maintain global biodiversity, in terrestrial and maritime sites (IBAT, 2021).
80 This exercise was conducted manually using the dataset provided at https://www.back4app.com/database/back4app/zip-codes-all-countries-in-the-world/malaysia-zip-code
81 The WGS84 is a widely used coordinate reference system in geospatial mapping, often used in cartography, geodesy, and satellite navigation including GPS.
82 It would benefit from the availability of postal code level shapefiles for Malaysia.

Figure A2: Practical steps to assess activities in Key Biodiversity Areas

Source: World Bank

We also explore a first non-exhaustive set of nature-related risk scenarios for Malaysia (see Table A1). This is based on interviews (the conclusions of which are summarized in Section A5), datasets such as ENCORE and the WB Terrestrial Biodiversity Indicators, and publicly and non-publicly available reports from Malaysian stakeholders.[83] They are, however, not projections of a business-as-usual scenario, but rather state the financial exposure if the affected ecosystem services of this range of identified scenarios would default. Similar to the University of Cambridge Institute for Sustainability Leadership (2021) scenario classification, we categorize scenarios according to types of risk, driver of risk, and sectors, natural assets, and ecosystem services where the risk scenario would originate. Scenario types can be classified as posing physical risk (e.g., the depletion of fisheries) or transition risk (e.g., the creation of new protected areas). Transition risk scenarios can entail policies aiming to protect biodiversity (regulatory risk), technological changes, and changes in consumer preferences (including reputational risk).

Both risk scenario types can have either local or nation-wide direct impact. Indirect impacts, which are not covered here, could induce spillovers to previously not directly affected regions. For physical risk scenarios, ENCORE provides affected natural assets and ecosystem services. This serves as a basis for assessing banking sector exposure to economic sectors that highly or very highly depend on those ecosystem services. It should be noted, however, that ENCORE only captures direct impacts from dependencies, whereas indirect impacts that could stem from supply chains or macroeconomic and financial feedback effects are not covered. Further, only impacts via affected ecosystem exposure are considered. For instance, typhoons might destroy production facilities and houses, however, this analysis only captures the exposure of the banking sector to firms that might be faced with deteriorated ecosystem services after a severe typhoon. Sectors that are likely to face a direct transition risk exposure are either classified according to ENCORE (e.g., in case of water regulation risks), according to the climate-policy relevant sector classification (Battiston et al. 2017) in case of a climate policy scenario, or with respect to informed and conservative author judgement (e.g., pesticide and fertilizer scenario).

Given the novelty of the topic some data limitations exist. Those limitations include 1) bank lending data beyond non-financial corporations (e.g., households and financial sector institutions), 2) additional financial instruments such as equity, bonds, and sukuks, 3) data on financial exposure of other financial institutions than banks such as insurance companies or pension funds, 4) a higher financial data coverage of location specific lending and investments, 5) higher granularity of spatial data ideally at asset level, and 6) input-output data for capturing indirect financial exposure of economic sectors (e.g., manufacturing via mining).

83 See Appendix Section 4 and 5 for details.

A.2 ENCORE Definitions

Table A4: List of ecosystem services included in the ENCORE database with their description

No.	Ecosystem Service	Ecosystem service description
1	Animal-based energy	Physical labor is provided by domesticated or commercial species, including oxen, horses, donkeys, goats, and elephants. These can be grouped as draught animals, pack animals, and mounts.
2	Bio-remediation	Bio-remediation is a natural process whereby living organisms such as micro-organisms, plants, algae, and some animals degrade, reduce, and/or detoxify contaminants.
3	Buffering and attenuation of mass flows	Buffering and attenuation of mass flows allows the transport and storage of sediment by rivers, lakes, and seas.
4	Climate regulation	Global climate regulation is provided by nature through the long-term storage of carbon dioxide in soils, vegetable biomass, and the oceans. At a regional level, the climate is regulated by ocean currents and winds while, at local and micro-levels, vegetation can modify temperatures, humidity, and wind speeds.
5	Dilution by atmosphere and ecosystems	Water, both fresh and saline, and the atmosphere can dilute the gases, fluids, and solid waste produced by human activity.
6	Disease control	Ecosystems play important roles in regulation of diseases for human populations as well as for wild and domesticated flora and fauna.
7	Fibers and other materials	Fibers and other materials from plants, algae, and animals are directly used or processed for a variety of purposes. This includes wood, timber, and fibers which are not further processed, as well as material for production, such as cellulose, cotton, and dyes, and plant, animal, and algal material for fodder and fertilizer use.
8	Filtration	Filtering, sequestering, storing, and accumulating pollutants is carried out by a range of organisms including, algae, animals, microorganisms, and vascular and non-vascular plants.
9	Flood and storm protection	Flood and storm protection is provided by the sheltering, buffering, and attenuating effects of natural and planted vegetation.
10	Genetic materials	Genetic material is understood to be deoxyribonucleic acid (DNA) and all biota including plants, animals, and algae.
11	Ground water	Groundwater is water stored underground in aquifers made of permeable rocks, soil, and sand. The water that contributes to groundwater sources originates from rainfall, snow melts, and water flow from natural freshwater resources.
12	Maintain nursery habitats	Nurseries are habitats that make a significantly high contribution to the reproduction of individuals from a particular species, where juveniles occur at higher densities, avoid predation more successfully, or grow faster than in other habitats.
13	Mass stabilization and erosion control	Mass stabilization and erosion control is delivered through vegetation cover protected and stabilizing terrestrial, coastal, and marine ecosystems, coastal wetlands, and dunes. Vegetation on slopes also prevents avalanches and landslides, and mangroves, sea grass, and macroalgae provide erosion protection of coasts and sediments.

No.	Ecosystem Service	Ecosystem service description
14	**Mediation of sensory impacts**	Vegetation is the main (natural) barrier used to reduce noise and light pollution, limiting the impact it can have on human health and the environment.
15	**Pest control**	Pest control and invasive alien species management is provided through direct introduction and maintenance of populations of the predators of the pest or the invasive species, landscaping areas to encourage habitats for pest reduction, and the manufacture of a family of natural biocides based on natural toxins to pests.
16	**Pollination**	Pollination services are provided by three main mechanisms: animals, water, and wind. Most plants depend to some extent on animals that act as vectors, or pollinators, to perform the transfer of pollen.
17	**Soil quality**	Soil quality is provided through weathering processes, which maintain bio-geochemical conditions of soils including fertility and soil structure, and decomposition and fixing processes, which enables nitrogen fixing, nitrification, and mineralization of dead organic material.
18	**Surface water**	Surface water is provided through freshwater resources from collected precipitation and water flow from natural sources.
19	**Ventilation**	Ventilation provided by natural or planted vegetation is vital for good indoor air quality and without it there are long term health implications for building occupants due to the build-up of volatile organic compounds, airborne bacteria, and molds.
20	**Water flow maintenance**	The hydrological cycle, also called water cycle or hydrologic cycle, is the system that enables circulation of water through the Earth's atmosphere, land, and oceans. The hydrological cycle is responsible for recharge of groundwater sources (i.e. aquifers) and maintenance of surface water flows.
21	**Water quality**	Water quality is provided by maintaining the chemical condition of freshwaters, including rivers, streams, lakes, and ground water sources, and salt waters to ensure favorable living conditions for biota.

Source: ENCORE, Natural Capital Finance Alliance 2021

Table A5: List of impact drivers included in the ENCORE database with their description

No.	Impact Drivers	Description
1	Disturbances	Examples include decibels and duration of noise, lumens and duration of light, at site of impact.
2	Freshwater ecosystem use	Examples include area of wetland, ponds, lakes, streams, rivers, or peatland necessary to provide ecosystem services such as water purification, fish spawning, areas of infrastructure necessary to use rivers and lakes such as bridges, dams, and flood barriers, etc.
3	GHG emissions	Examples include volume of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), Sulphur hexafluoride (SF_6), Hydrofluorocarbons, (HFCs) and perfluorocarbons (PFCs), etc.
4	Marine ecosystem use	Examples include area of aquaculture by type, area of seabed mining by type, etc.
5	Non-GHG air pollutants	Examples include volume of fine particulate matter (PM2.5) and coarse particulate matter (PM10), Volatile Organic Compounds, mono-nitrogen oxides (NO and NO_2, commonly referred to as NOx), Sulphur dioxide (SO_2), Carbon monoxide (CO), etc.
6	Other resource use	Examples include volume of mineral extracted, volume of wild-caught fish by species, number of wild-caught mammals by species, etc.
7	Soil pollutants	Examples include volume of waste matter discharged and retained in soil over a given period.
8	Solid waste	Examples include volume of waste by classification (i.e., nonhazardous, hazardous, and radioactive), by specific material constituents (e.g., lead, plastic), or by disposal method (e.g., landfill, incineration, recycling, specialist processing).
9	Terrestrial ecosystem use	Examples include area of agriculture by type, area of forest plantation by type, area of open cast mine by type, etc.
10	Water pollutants	Examples include volume discharged to receiving water body of nutrients (e.g., nitrates and phosphates) or other substances (e.g., heavy metals and chemicals).
11	Water use	Examples include volume of groundwater consumed, volume of surface water consumed, etc.

Source: ENCORE, Natural Capital Finance Alliance 2021

Table A6: List of drivers of environmental change included in the ENCORE database with their description

No.	Driver of environmental change	Description
1	Diseases	Harmful pathogens and microbes that are originally found within the ecosystem(s) in question, but have become "out-of-balance" or "released" directly or indirectly due to human activities.
2	Droughts	Periods in which rainfall falls below the normal range of variation.
3	Earthquakes	Earthquakes manifest themselves by shaking and displacing or disrupting the ground. They may also cause associated events such as tsunamis, landslides, or even volcanic activity.
4	Fire	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation.
5	Flooding	Extreme precipitation events leading to the submergence of dry land.
6	Landslides	Landslide events leading to geological changes.
7	Habitat modification	Major changes in habitat composition and location, for example deforestation.
8	Human modification of genetic material	Human altered or transported organisms or genes.
9	Human movement	Migration by people from one place to another with the intentions of settling, permanently or temporarily in a new location.
10	Industrial or domestic activities	Non-agricultural human activities including non-consumptive use of resources.
11	Industrial or domestic construction	Process of constructing a building or infrastructure for industrial or domestic purposes.
12	Intensive agriculture and aquaculture	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture (includes the impacts of any fencing around farmed areas).
13	Invasive species	Harmful plants, animals, pathogens, and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities.
14	Ocean acidification	Changes to the ocean chemistry which occurs when carbon dioxide is absorbed from the atmosphere and reacts with seawater to produce acid.
15	Ocean current and circulation	Large scale movement of waters in the ocean basins.
16	Overfishing	The harvesting of aquatic wild animals or plants at a rate that is greater than their capacity for regeneration. Harvesting can occur for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; accidental mortality/bycatch are also included.
17	Overharvesting	The harvesting of plants, fungi, trees, and other woody vegetation, and other non-timber/non-animal products at a rate that is greater than their capacity for regeneration. The harvesting can occur for commercial, recreation, subsistence, research or cultural purposes, or for control reasons.
18	Overhunting	The killing or trapping of terrestrial wild animals or animal products at a rate that is greater than their capacity for regeneration. The killing or trapping can occur for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch.

No.	Driver of environmental change	Description
19	**Pests**	Harmful plants or animals that are originally found within the ecosystem(s) in question, but have become "out-of-balance" or "released" directly or indirectly due to human activities.
20	**Pollution**	Threats arising from the introduction of contaminants into the natural environment.
21	**Population changes**	Changes in species populations over time and space.
22	**Sea level rise**	Increase in global mean sea level as a result of an increase in the volume of water in the world's oceans or heat dilation.
23	**Sea surface temperature**	Periods in which sea surface temperatures exceed or go below the normal range of variation.
24	**Storms**	Extreme precipitation and/or wind events.
25	Volcanoes	Volcanic events which may lead to changes in natural capital assets.
26	Water abstraction	Changing water flow patterns from their natural range of variation due to human activities.
27	Weather conditions	Weather conditions outside of the natural range of variation.

Source: ENCORE, Natural Capital Finance Alliance 2021

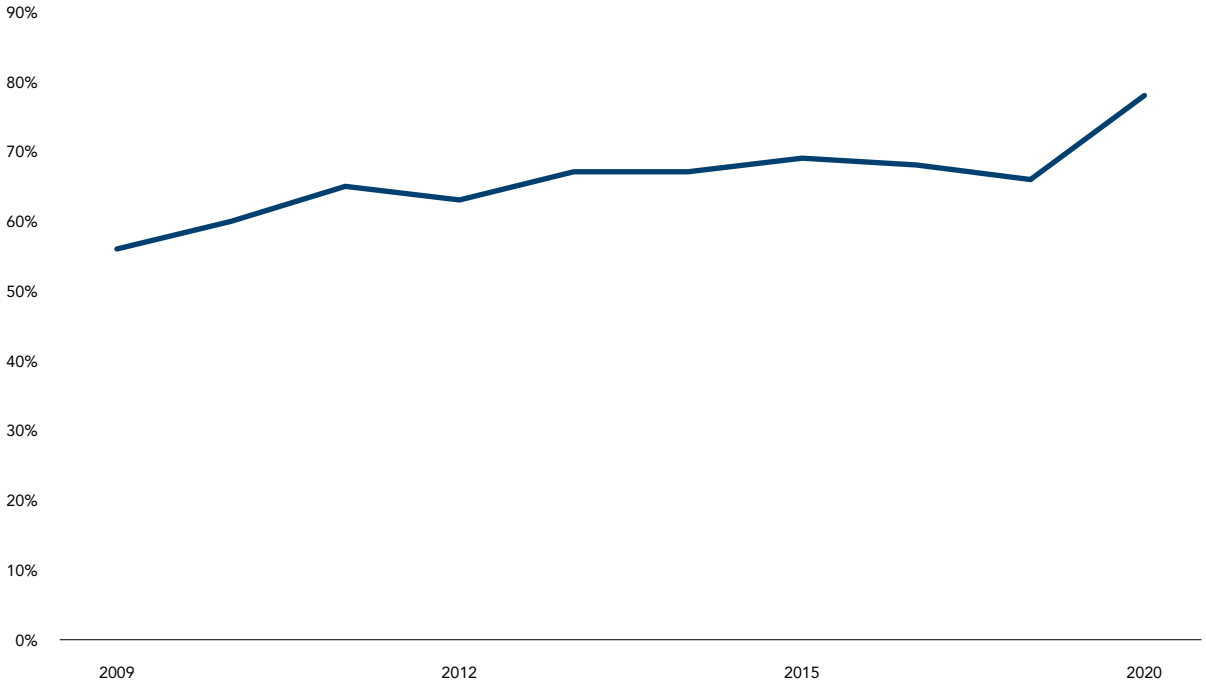
A.3 **Reputational Risk**

Malaysian banks could also be exposed to reputational risk arising from financing companies whose operations negatively impact the country's biodiversity and the ecosystem services it sustains. The UEBT Biodiversity Barometer (UEBT 2020), an annual survey on biodiversity awareness which has surveyed more than 74,000 people since 2009, shows that consumer awareness of biodiversity has increased consistently over the last decade (see Figure A3) (UEBR 2020). This trend is likely to continue as policymakers are increasingly seeking to harness the power of civil society in reversing the biodiversity loss and its impact on ecosystems, species, and people. For instance, the first target of Malaysia's National Policy on Biological Diversity 2016-2025 is to raise the awareness of biodiversity among Malaysians and the steps they can take to conserve and use it sustainably (MyBIS 2016). Reputation loss could translate into lower revenues and profits for firms engaging in controversial activities as customers might prefer more sustainable products. Most controversies with respect to biodiversity and land-use are related to agricultural products as shown by the MSCI ESG Controversies database (see Figure A4),[84] of which 7 are recorded for Malaysia, all with respect to biodiversity loss and land-use change (see Figure A5). Banks that finance controversial firms could also lose reputation themselves, impacting banks' customer and investors' relations.[85] Both firm and banks' reputation loss, could pose financial risks for Malaysian banks (NGFS 2021).

84 The MSCI ESG Controversies database records the instances of negative environmental impact resulting from a company's product or operations. See https://www.msci.com/documents/1296102/1636401/ESG_Controversies_Factsheet.pdf/4dfb3240-b5ed-0770-62c8-159c2ff785a0 for the methodology.

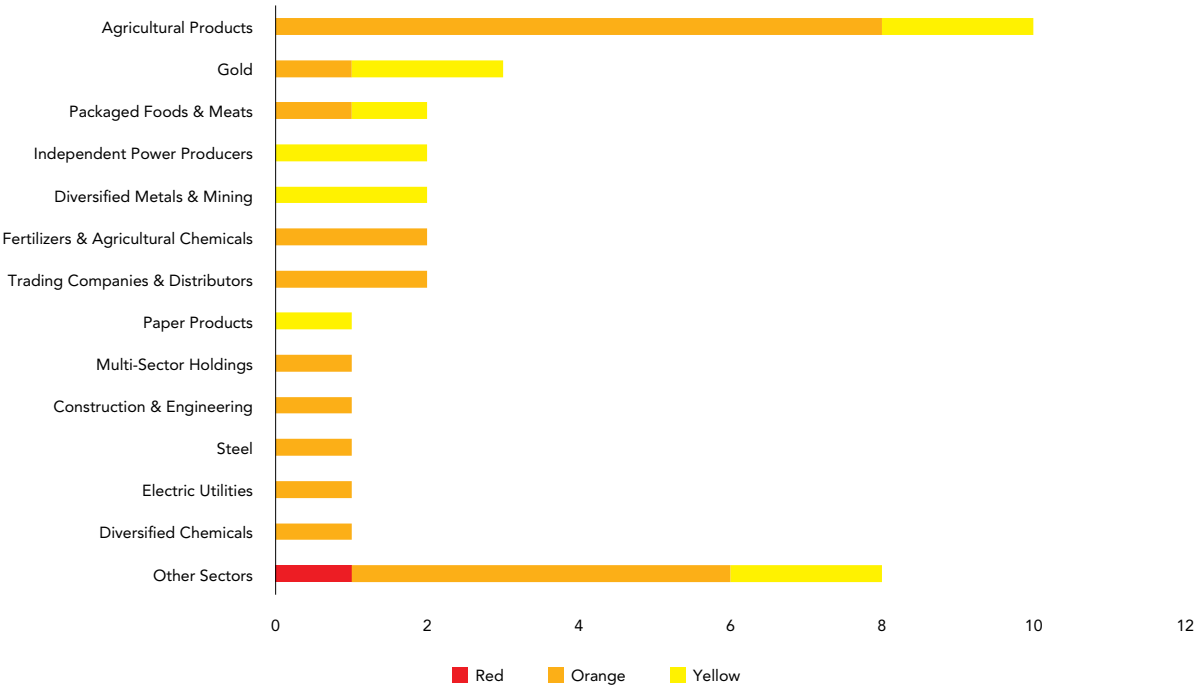
85 The annual fossil fuel finance report by a group of NGOs, which states fossil fuel financing activities of the largest banks globally and receives a lot attention, is an example of potential reputational concerns with respect to climate change (RAN et al. 2021).

Figure A3: Awareness of biodiversity among surveyed individuals in the UEBT Biodiversity Barometer



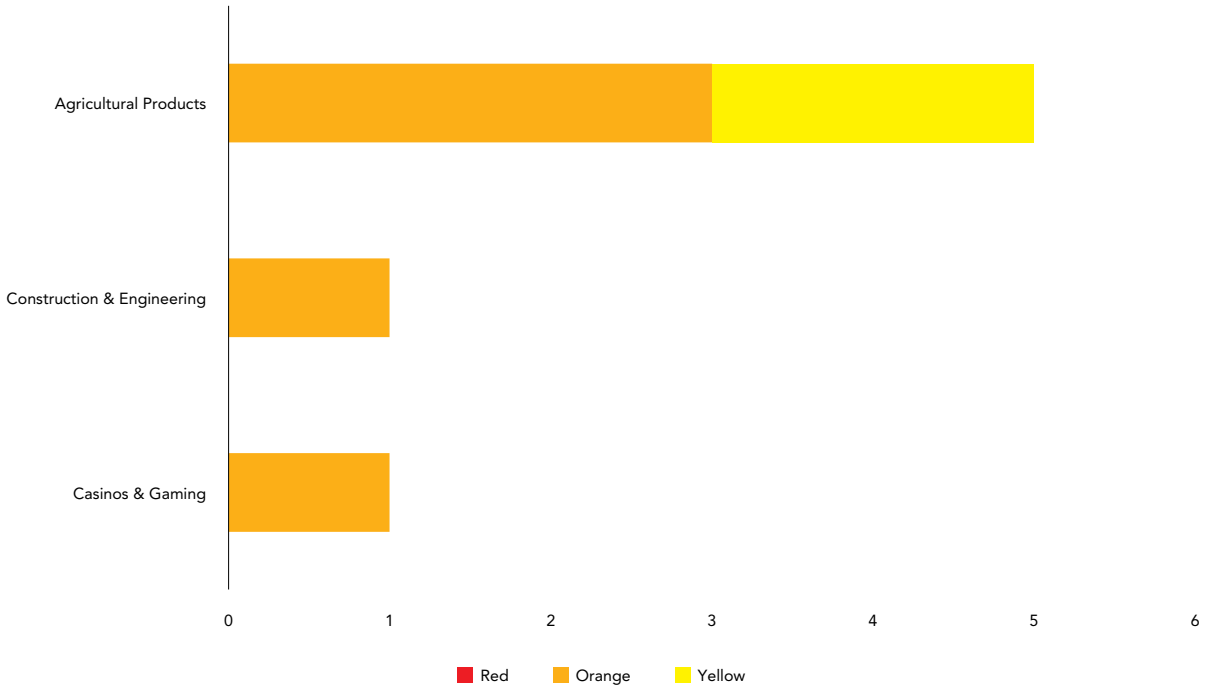
Source: Based on UEBT Biodiversity Barometer

Figure A4: Number of controversies globally as reported in MSCI ESG Controversy Database



Source: Based on MSCI ESG Controversy Database

Figure A5: Number of controversies linked to biodiversity and land use for different sectors in Malaysia as reported in MSCI ESG Controversy Database



Source: Based on MSCI ESG Controversy Database

A.4 Drivers of Nature-Related Financial Risk Scenarios in Malaysia

This section provides an overview of relevant data regarding the drivers of nature-related financial risk scenarios in Malaysia. The IPBES (2019) identifies five main drivers of biodiversity and nature loss, namely land- and sea use change, natural resource use and exploitation, climate change, pollution, and invasive species. Furthermore, governance and policy uncertainty can drive transition risk scenarios as well as physical risk scenarios. The following subsections shed a light on selected aspects of those different drivers of nature-related financial risks based on insights from stakeholder interviews as well as global and local nature and biodiversity datasets for Malaysia. This is intended to provide an initial assessment of the risk materiality of nature-related financial risks for the Malaysian banking sector.

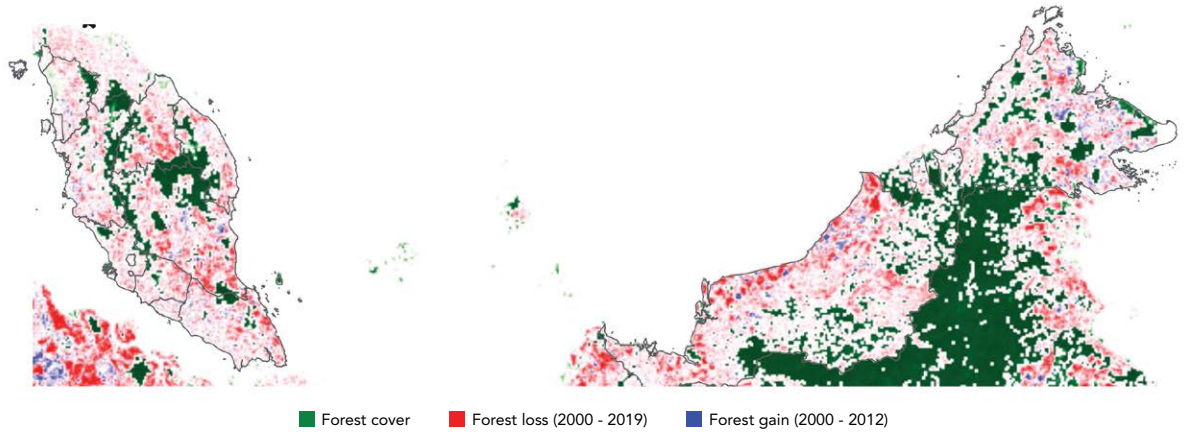
A.4.1 Land and Sea Use Change

Land use change in Malaysia strongly impacts forest and peatland cover in Malaysia. Between 2000 and 2019, large areas around the coast of Sarawak, Johor, and Pahang saw significant losses in rain forest (Figure A6)[86] often cleared to set up oil palm plantations (Figure 21). In three decades between 1975 and 2005, Malaysia lost 4.6 million hectares of forest cover, a 20 percent reduction of forest land (Wicke et al. 2011).

86 According to Global Forest Watch, Malaysia lost 29% of its tree cover between 2001 and 2020, releasing 4.82Gt of CO_2e emissions (Global annual CO_2 emissions stand at 33Gt in 2021 according to the International Energy Agency, 2021).

Further, between 1990 and 2005, about 55 percent expansion of palm oil, the biggest agricultural export of Malaysia, came at the expense of the forests- mostly species-rich and carbon-rich tropical forests (Koh et al. 2008). This widespread replacement of natural forests with monoculture palm plantations has reduced the overall plant diversity and threatened many animal species dependent on such forests including orangutans and Bornean elephants.[87] The growth in oil palm plantations has also been responsible for a considerable loss of mangroves in Malaysia, estimated to be 2.8 percent of the total mangrove habitat area between 2000 and 2012 (Richards et al. 2016). This loss of mangroves may lead to a weakened natural protection against cyclones and tsunamis (Alongi 2008). Certain regions, especially in Sarawak and Sabah, have been reforested thanks to strong efforts of private and public initiatives in Malaysia with the 100 million tree-planting campaign expected to provide another push.[88] At the same time, forests are also an important habitat for species, thus supporting biodiversity, which is typically lower in reforested areas as compared to primary forests (Cunningham et al. 2015). Agriculturally driven land-use change, especially when planting monocultures such as oil palms, could increase the risk for agricultural productivity and stability, especially with respect to pollinator dependence (Aizen et al. 2019).

Figure A6: Forest cover, forest loss, and forest gain between 2000 and 2019 in Malaysia



Source: Based on Hansen et al. 2015 and Humanitarian Data Exchange 2021

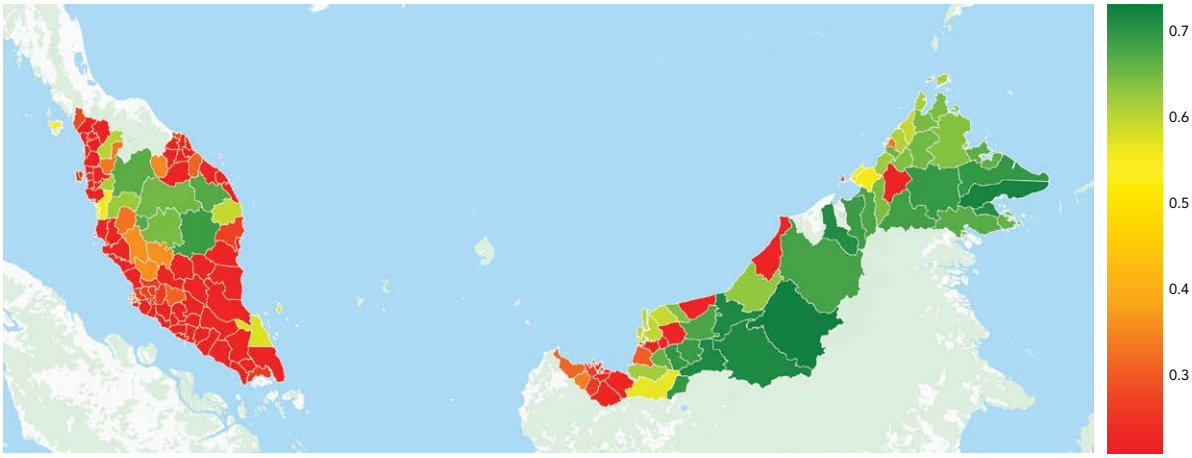
Malaysia is home to some of the world's most important biodiversity hotspots, whereas ecosystems and species are increasingly coming under pressure. Mean species abundance (MSA) is an indicator that measures the local terrestrial biodiversity intactness, for which we use estimates from the GLOBIO model (Schipper et al. 2019).[89] MSA differs strongly across Malaysian regions. Regions with intact or protected rainforest show high MSA, meaning that human pressures such as land use, road disturbance, fragmentation, hunting, atmospheric nitrogen deposition, and climate change are limited. Also, a continued growth in the quarrying of limestone has come at the cost of an excessive exploitation of karsts- biodiversity reservoirs that can restock degraded environments (Clements et al, 2006). Limestone is a key ingredient in the production of cement, of which Malaysia is the fifth largest exporter in the world (WITS 2021). Urban regions such as Kuala Lumpur and regions that have a large cultivated agricultural sector such as palm oil (e.g., Johor) show low values of MSA (Figure A7a), meaning that pressures on biodiversity are high.

87 https://www.worldwildlife.org/stories/endangered-species-threatened-by-unsustainable-palm-oil-production
88 https://www.100jutapokok.gov.my/
89 The MSA compares the actual abundance of native species in an ecosystem with the theoretical 'original state' of that ecosystem without any disturbance from human activities.

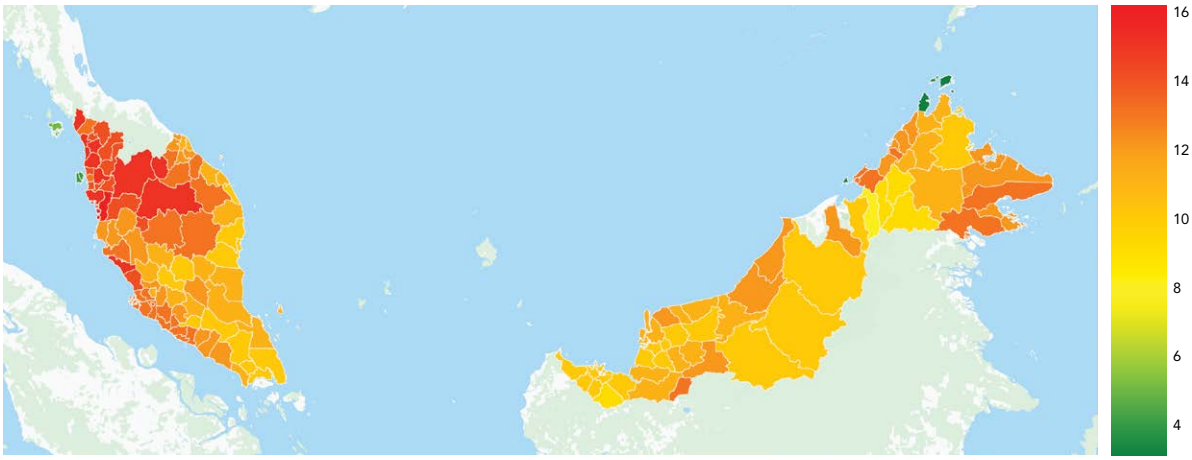
Endangered species risk, stemming from the WB's terrestrial biodiversity indicators, also differs across regions. Regions in the North of Peninsular Malaysia show highest numbers of endangered species (Figure A7b) because they host some of the most biodiverse rainforests, while at the same time facing strong land use change pressures. Land conversion from forests to crop land or oil palm plantations has been particularly high in those regions in recent years (growth in oil palm plantation area between 2018 and 2020 4 percent for Pahang, 8 percent for Kelantan, and 6 percent for Terengganu (MPOB 2021), see Figure 21 for a map of current extent of oil palm plantations in Malaysia). The rainforests in Sarawak and Sabah on Borneo are still relatively untouched, showing a high MSA and having a lower number of endangered species. Sabah also shows the largest state area share that is currently protected (Figure 22a), followed by Pahang, with large areas of its rainforests in the North being protected. In total about 13 percent of Malaysian state area is currently protected, according to data from UNEP-WCMC (2021), falling potentially short of a 30x30 goal that is currently being discussed internationally. The percentage of area protected varies across states, however. Some endangered species hotspots, such as Kedah and Kelantan, currently show only limited area protection, indicating potential regions that could see protected area expansion efforts in the future.

Figure A7:

a) Mean species abundance in 2015 by district in Malaysia



b) Number of endangered species 2019 by district in Malaysia



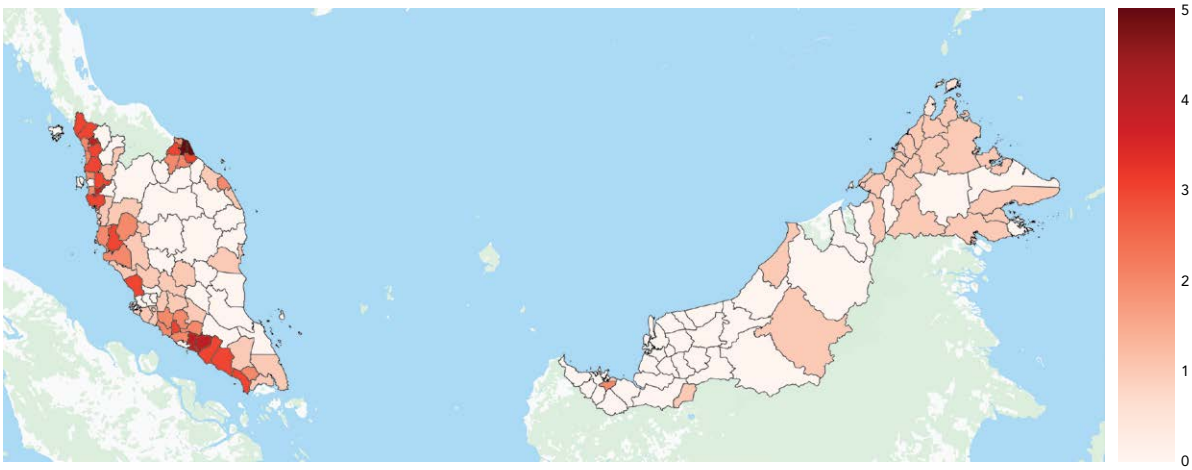
Source: Based on Schipper et al. 2019 (Globio), WB Terrestrial Biodiversity Indicators (2019), and Humanitarian Data Exchange 2021

Several nature-related financial physical and transition risk scenarios could be driven by land- and sea use change and the accompanying loss in ecosystems and species (Table A7). Scenarios with highest banking sector loan exposure are urban sprawl (44 percent) and deforestation (30 percent) by inducing ecosystem service reduction. Further, reduced availability of timber (16 percent) as well as severe flooding occurrence (10 percent) as trees and mangroves cannot provide flood and storm protection show a high exposure of Malaysian banks. Further, transition risk scenarios such as an expansion of protected areas (8.4 percent) or stronger forestry regulation (0.7 percent) show a high potential risk exposure of the Malaysian banking sector.

A.4.2 Natural Resource Use and Exploitation

Continuous overexploitation of renewable and non-renewable resources such as fisheries, timber, and mineral extraction could drive certain nature-related financial risk scenarios. By 2030, six additional inhabitants are expected in Malaysia, whereas the urbanization rate is expected to increase from 76 percent in 2017 to 86 percent in 2050 (ERE Consulting Group, 2021). In the past, population growth and urbanization, were accompanied by higher infrastructure needs and consumption levels, increasing the terrestrial footprint in Malaysia (Figure A8). Mineral extraction is also expected to increase further in the next decade to support the construction and industry sectors (ERE Consulting Group, 2021). Furthermore, Malaysia has experienced a strong growth in non-metallic mineral extraction such as sand and gravel between 2015 and 2019. Silica sand and sand, for instance, have significant impacts towards river morphology, as well as sensitive freshwater and wetland ecosystems (ERE Consulting Group, 2021). As such, those activities would need to be accompanied by careful measures for ecosystem and nature protection, to avoid the materialization of nature-related risk scenarios such as "Reduced ecosystem services due to continued high resource use, pollution, and urban sprawl". Fish stock is already relatively stretched in Malaysia with a deteriorating trend that could eventually lead to a fish stock collapse if current patterns continue.

Figure A8: Change in Malaysian terrestrial footprint between 2000 and 2013 by district.



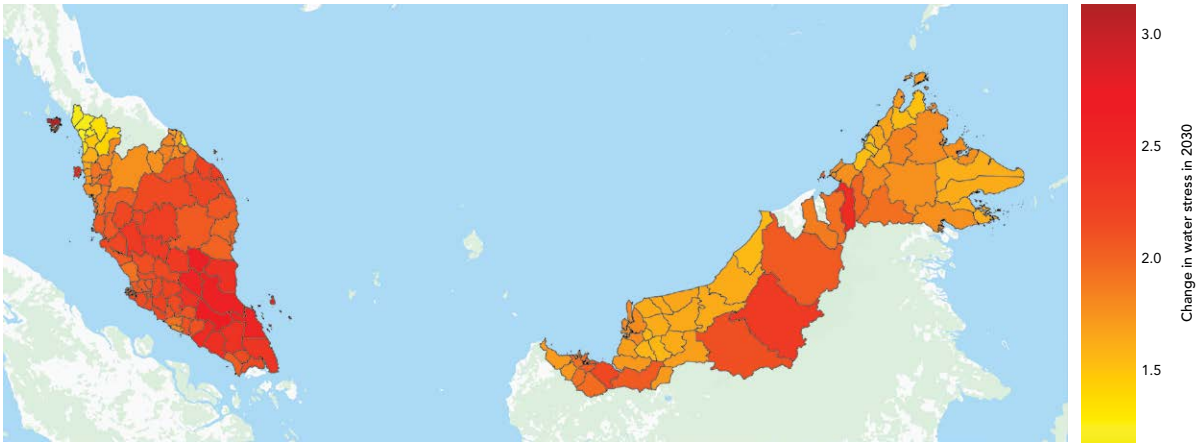
Source: Based on UN Biodiversity Lab[90], Venter et al. 2016, and Williams et al. 2020, Humanitarian Data Exchange 2021
Note: The terrestrial human footprint entails several granular and recent bottom-up survey information data sets to measure direct and indirect human pressures on the environment (built environments, population density, electric infrastructure, crop lands and pasture lands, roads, railways, and navigable waterways). Footprint scores range from 0-50, whereas here the net change between 2000 and 2013 is shown for Malaysia. A value of five thus means that the terrestrial human footprint increased by a score of five between 2000 and 2013.

90 https://unbiodiversitylab.org/

The nature-related financial risk exposure analysis shows a strong impact (about 15 percent) and high dependency (about 30 percent) on water. Similarly, a water-related financial risk scenario, either due to higher water pollution or stricter water regulation, shows a strong exposure of the Malaysian banking sector with about 17 percent of its lending portfolio. Specifically, the real estate and construction sectors strongly depend on the services provided by surface water, ground water, and water flow maintenance for operability. In recent years, Malaysia water consumption levels have steadily increased, from 6.4 million liters per day in 2015 to 6.8 million liters per day in 2019 (ERE Consulting Group, 2021). The strong use and pollution of water has implications for the water cycle that could potentially lead to an overall deterioration of its availability and usability for ecosystem services provisioning. Population growth could further increase consumption levels and growing climate change could impact currently stable irrigation patterns. In 2030, the World Resource Institute Aqueduct model projects some districts in Malaysia to have a threefold water stress level compared to today if no measures are taken (Figure A9). In response, the Malaysia government might increase water extraction and storage facilities, which could again feed back onto ecosystems and biodiversity, especially freshwater communities.

Nature-related financial physical risk scenarios that could specifically be susceptible to overexploitation of resources are urban sprawl (potentially affecting 44 percent of Malaysian bank lending) and deforestation (30 percent) by inducing ecosystem service reduction (Table A7). Further, severe timber reduction (16 percent), reduced water availability (6 percent), and reduced agricultural yields (2.5 percent) could pose financial risk exposure in case of continued overexploitation.

Figure A9: Aqueduct Malaysia water stress projections in 2030

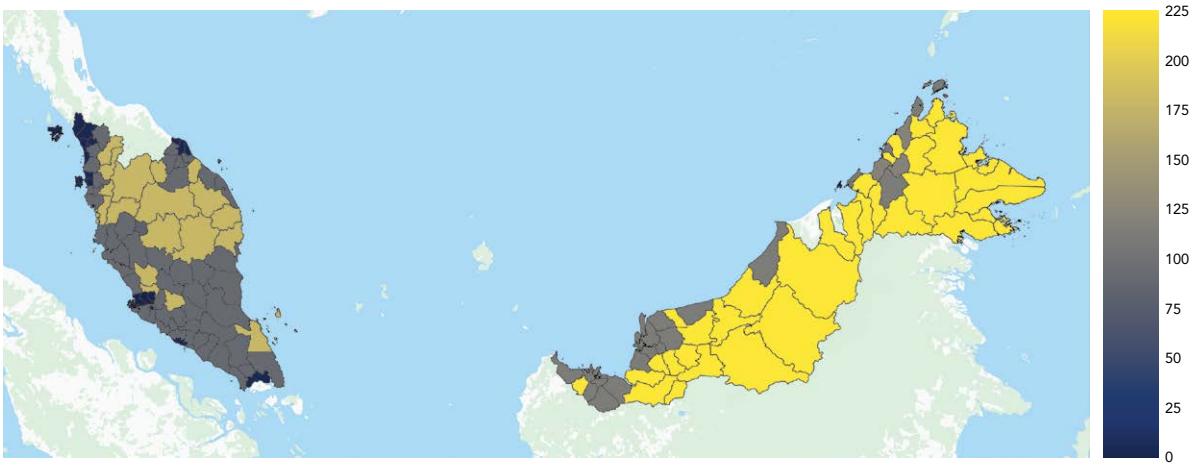


Source: Based on WRI2021, Humanitarian Data Exchange 2021

A.4.3 **Climate Change**

The rich vegetation in Malaysia also provides an important ecosystem service for climate regulation by sequestering large amounts of carbon; however, forest loss and conversion of peatlands in the past 20 years has reduced this potential. The loss of 29 percent of Malaysia's forest cover between 2000 and 2020 alone released 4.8Gt of CO_2 equivalent (CO_2e) emissions.[91] Currently about 17 percent of Malaysian banking sector's lending portfolio depends on climate regulation, thus posing a strong financial risk if this ecosystem service deteriorates. Especially the rainforests in Perak, Pahang, and Kelantan as well as on Borneo stand out as storages for carbon with their large area shares of rainforests. Further, the peatland areas of Selangor, Pahang and Sarawak are important sources for carbon storage (Page and Rieley 2018). Converted land for crops and oil palm plantations, however, has less carbon storage potential (Figure A10), especially in states such as Johor and the Southern districts of Pahang, that host some of the country's largest oil palm plantation areas.

Figure A10: Vegetation carbon storage by district in Malaysia



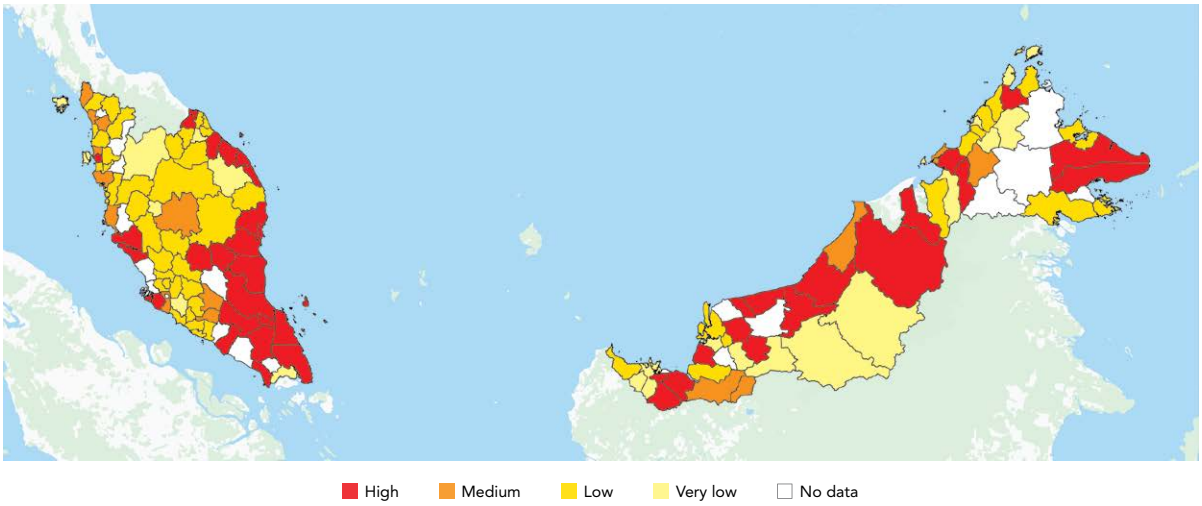
Source: Based on UN System of Environmental-Economic Accounting (SEEA) 2021[92] and Humanitarian Data Exchange 2021

Nature also plays an important role for flood and storm protection, on which more than 5 percent of commercial lending in Malaysia depends. Especially sectors such as construction, telecommunication, and electricity provision are sensitive to disruptions from extreme weather events, that could be moderated by intact rainforests and mangroves. Mangroves, covering more than half a million hectares of vast shoreline in Malaysia, offer protection from waves and tsunamis and can prevent shoreline erosion (Alongi, 2008). Flood and storm protection become even more relevant with growing climate change as it is expected to lead to higher intensity and frequency of extreme weather events such as flooding and cyclones (IPCC, 2021). According to data by the ThinkHazard! Platform developed by the Global Facility for Disaster Reduction and Recovery, large parts of Malaysia are especially prone to flooding risk, including river (Figure A11a) and urban flooding risk (Figure A11b), potentially posing a risk to the financial sector. Coastal flooding (Figure A11c) is at high risk at the Eastern Coast of Peninsular Malaysia and in South Sarawak. Already over the past decades, the frequency and extremity of flood events have increased in Malaysia, with more expected given ongoing climate change (World Bank Group/Asian Development Bank 2021). The northeastern coast of Peninsular Malaysia and the East

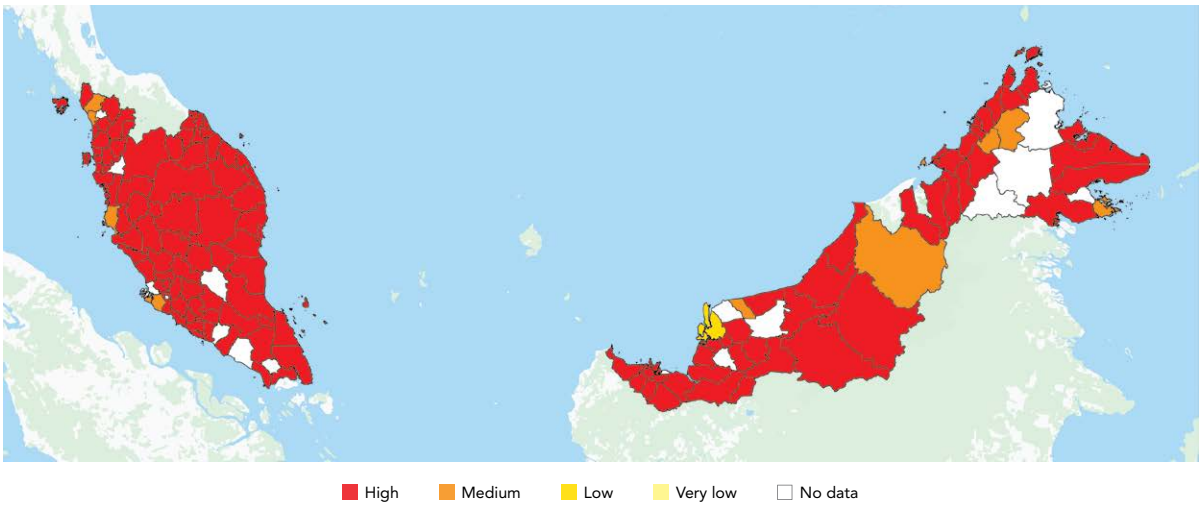
91 Global annual CO_2e emissions stand at 33Gt in 2021 according to International Energy Agency, 2021. CO2 emissions per capita in Malaysia increased from 5.2 tons CO2e in 2000 to 7.6 tons CO2e in 2018 (Climate Watch, 2020)
92 https://aries.integratedmodelling.org/aries-for-seea-explorer/

Figure A11:

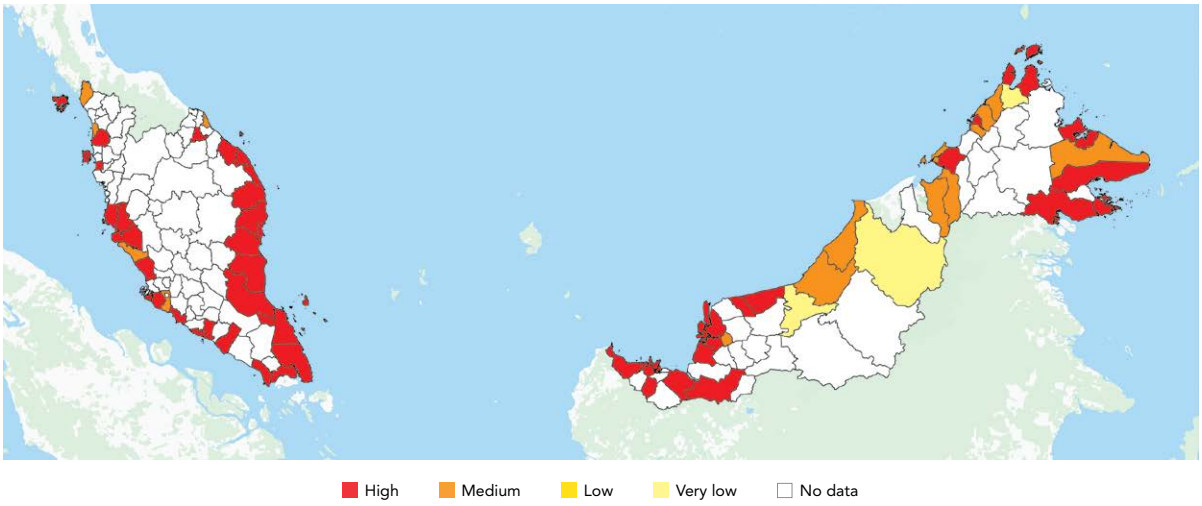
a) River flood risk in Malaysia by district



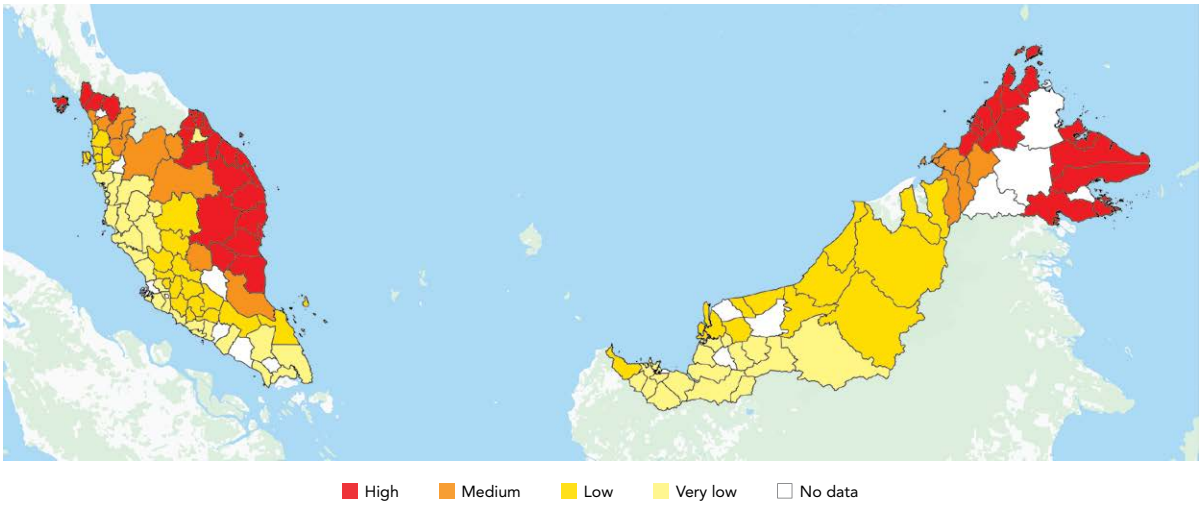
b) Urban flood risk in Malaysia by district



c) Coastal flood risk in Malaysia by district



d) Cyclone risk in Malaysia by district



Source: Based on ThinkHazard! 2021,[93] and Humanitarian Data Exchange 2021

of Borneo are also strongly exposed to cyclone risk (Figure A11d). Climate change also impacts biodiversity and ecosystems through regular coral bleaching occurrences, changes in ecosystem structure and function and altered species distribution (ERE Consulting Group, 2021).

Nature-related financial physical risk scenarios that could specifically be susceptible to climate change impacts are reduced ecosystem service (44 percent). This could be a slow but steady process (Table A7). Climate change affects ecosystems either abruptly or chronically, which could deteriorate their ability to sustain ecosystem services. As such climate change could drive nature-related financial risk scenarios such as an increase in sea surface temperature (16 percent), changed ocean current and circulation (16 percent), severe flooding occurrence (10 percent), severe cyclone occurrence (9 percent), and increased ocean acidification (8 percent).

A.4.4 **Pollution**

Pollution from run-off and pesticides from agriculture, untreated waste, industry and mining pollutants, oil spills, and plastics is an ongoing issue in Malaysia (see Figure 10), posing increasing pressures on the health of its ecosystems and a potential risk for the Malaysian banking sector. Malaysian banks have a direct exposure between 2 and 44 percent of their loan portfolio to pollution related financial risk scenarios. Ongoing pollution could thus pose a risk for the Malaysian financial sector, if certain tipping points for ecosystem health (e.g., atmosphere, forests, freshwater) are crossed. Malaysia's waste management systems are currently inadequate for dealing with the amount of waste produced (Kaza et al., 2018), particularly plastic waste (Chen et al. 2021). About 85 percent of solid waste is currently put into sanitary and unsanitary landfill sites (Chen et al. 2021). Plastic is a particular issue, especially as Malaysia is the world's largest plastic importer since 2017 (Chen et al. 2021). Plastic waste is rarely recycled, but often burned illegally, resulting in the release of toxic substances (Timbuong and Tang, 2019). The Malaysian government has introduced several policies

93 https://thinkhazard.org/en/report/153-malaysia

to address this problem, such as issuance of plastic waste import permits; however, insufficient solid waste management remains one of the main environmental problems in Malaysia (Moh and Manaf, 2017).

Water pollution in combination with increasing water consumption threatens freshwater abundance in Malaysia. Main sources of water pollution in Malaysia are urban, agricultural, and forest land use (Camara et al. 2019). Furthermore, aquaculture or fertilizer runoff can contribute to eutrophication which can lead to lower species richness and biodiversity as it affects fish and other aquatic organisms (Er et al. 2018).

Air pollution has increased in Malaysia with industrial expansion that released many harmful particles into the atmosphere (Usmani et al. 2020). Recently haze has also become a prevalent issue in Malaysia stemming from forest fires in Malaysia and Indonesia, with significant effects on air quality (Mead et al., 2018). Air pollution threatens ecosystems such as species and forests. However, it also poses a direct threat to humans, with 6.4 million deaths in 2016 attributed to air pollution worldwide (WHO 2017) and strong human health impacts in Malaysia (Qureshi et al. 2015).

Continuously high levels of pollution could eventually be a driver of nature-related financial risk scenarios with a considerable potential risk exposure for Malaysian banks. Potential scenarios could be a reduction in ecosystem services due to continued high resource use, pollution, and urban sprawl (44 percent), increased ocean acidification (8 percent), lower clean water availability due to continuously high-water pollution (7.1 percent), unmanaged waste disposal and soil pollution strongly affecting productivity of habitats (2.4 percent), and atmospheric pollution causing deterioration of ecosystem services (1.7 percent).

A.4.5 **Invasive Species and Diseases**

Invasive species are another IPBES identified driver of nature-related financial risk scenarios in Malaysia. The spread of invasive alien species can have detrimental impacts for nature, humans, animals, and plants, while also posing risks for the economy and financial sector. Globalization and accompanying trade and tourism increase, as well as growing climate change, caused higher numbers of invasive species (MyBIS 2018). Malaysia Biodiversity Information System (MyBIS) provided in its 2018 list of invasive alien species an overview of potential threats. For instance, S. molesta is a water plant that affects aquatic ecosystems by weaving themselves into a thick, floating mat, which blocks oxygen and light from the water. As a result, this pest could threaten cultivated aquatic crops and potentially clog irrigation and drinking water lines. Another example is the red palm weevil disease, which strongly impacts the Malaysian coconut industry. Infected palms need to be removed and replanted, causing high economic costs. Furthermore, some diseases such as foot and mouth disease might directly affect animals, having a devastating impact on individual farmers and the rural community. Malaysia is aware of the invasive species and disease threat and is developing strategies for containing potential risks (MyBIS 2021), however, as the example of COVID-19 demonstrated, such diseases can spread quickly around the globe. Sectors such as agriculture, forestry, and aquaculture could be strongly impacted in such scenarios, exposing the Malaysian banking sector to potential financial risk.

Nature-related financial risk exposure of Malaysian banks to potential invasive species driven scenarios such as invasive species sprawl (1 percent) and species decline due to human genetic modification (0.7 percent) is relatively low. However, in a globalized world invasive species and diseases could spread relatively quickly around the globe thus being a quite likely scenario.

A.4.6 **Governance Issues**

Governance challenges could be a driver of nature-related financial risk scenarios. Conflicting priorities across national policies and the state development agenda as well as restricted capacity and capability of enforcement and implementation could hinder effective policies to avoid physical risk materialization. Furthermore, lack of clarity around accountability and responsibility could pose transition risk as an orderly implementation of policies could be impeded. The implementation of strict forestry policies and regulation as a scenario could for instance cause severe risks for Malaysian banks (0.7 percent) in case of an uncoordinated and sudden implementation. The Malaysia 2020 Forestry Policy could serve as an example. This aims to regulate forest management in the three major regions of Malaysia; yet it currently lacks an effective implementation framework (ERE Consulting Group, 2021). Each region in Malaysia has its own administrative framework and jurisdiction which hinder effective monitoring and cross-checking to ensure parity of efforts across different regions. Sabah Forest Policy, for example, highlights specific land area commitments for conservation and protected area management, while Peninsular Malaysia and Sarawak policies provide less detail. This could result in unbalanced expectations and responsibilities to achieve the country's target of preserving at least 50 percent of total forest cover spread across the three regions (ERE Consulting Group, 2021).

Governance issues can be a driver for several nature-related financial risk scenarios with a high exposure of Malaysian banks. Those scenarios entail all transition risk scenarios such as "sudden and unexpected climate policy introduction" (38 percent), "regulatory restriction of water pollution" (17 percent), "sudden increase in the price of water (removal of subsidies / market dynamics) (17 percent)", "extension of protected areas" (8 percent), and regulatory restriction of non-sustainable pesticides and fertilizers" (7.4 percent) as the design, implementation, and enforcement of policies could be a significant driver of transition risk. In contrast, orderly introduced policies might lead to lower transition risk as firms and banks can anticipate potential policy implications.

A.4.7 **Policy Uncertainty**

Erratic and contradictory policy and regulatory signals by the government could increase policy uncertainty. Policy uncertainty is another driver of nature-related financial risk scenarios as it can impede firms from implementing transformative changes in business operations to reduce their nature impacts. Costly and long-term strategies might not be pursued, which could increase physical risk likelihood as current highly impacting business models are continued and transition risk, as no preparation has been conducted in case of sudden nature-related policy introduction.

A.5 Interviews with Experts Focused on Biodiversity in Malaysia

Engagements with local environmental specialists from government and non-governmental organizations were conducted to get a more complete understanding of nature-related financial risks impacting Malaysia's financial system. Semi-structured interviews were conducted with several key stakeholders including a government ministry, a government agency, two non-governmental organizations and a research firm.[94] The main objectives of the interviews were to obtain insights from the key stakeholders on (1) the preliminary findings of the report, (2) potential policy changes that may impact transition risk, and (3) relevant on-going research and initiatives that could further contribute to the analytical understanding of this study. The feedback received from the stakeholders is broadly summarized as follows:

- **At the policy level, focus on nature-related risks and their impacts to the economy and people is garnering increased interest at the federal-level as well as at certain state-level where nature-related businesses have a significant impact.** While policies, including legislations and regulations to manage nature-related resources can be considered comprehensive, policy implementation coordination at the ministerial-level and state-level could be deemed fragmented and hence limiting the implementation effectiveness. Malaysia's recognition as a highly biodiverse country attracts strong stakeholder activism and financial support by both local and international activists, which plays a critical role in policy implementation oversight.

- **Quantification and modelling of economic costs of nature-related loss to the economy and people are limited.** One of the key action plans under the National Biodiversity Action Plan 2016-2025, is establishing the necessary tools and mechanisms to facilitate the recognition of the economic value of biodiversity and ecosystem services. From the reported 456 studies that estimated economic values 86 percent of them are in relation to the forest ecosystem.[95] Implementation of payment for ecosystem services (PES) is also limited with one example being payment for watershed services implemented in the state of Perak. In terms of scenario validation, nature and climate-related events are being monitored by relevant ministries but are yet to be used in any economic modelling for policy decision-making purposes.

- **Limited data availability and data sharing amongst key stakeholders may hamper the development of a more robust multidisciplinary research program that is necessary for Malaysia's capacity building.** Local nature-related data are mostly proprietary in nature generated by both public and private actors. However, the availability of these data to the public differs greatly by type of ecosystems. For example, data on forest ecosystems are more widely available compared to water services.

Based on the observations above, addressing nature-related financial risks may present unique challenges to financial sector players, particularly with respect to understanding the complex and multidisciplinary nature of the subject. Closer engagement with key stakeholders would be imperative to facilitate meaningful progress in managing nature-related financial risks by the financial sector players.

94 Interviews were conducted with the Ministry of Energy and Natural Resources, the World Wildlife Fund, Forests and Finance, PE Research and Akademi Sains Malaysia.
95 https://www.dosm.gov.my/v1/uploads/files/7_Publication/Technical_Paper/MyStats/2017/1(a)-2_Prof_Awang_Noor_Abd_Ghani.pdf

A.6 **Full List of Explorative Nature-Related Risk Scenarios**

Table A7: List of possible nature-related financial physical and transition risk scenarios

Risk scenario	Source	Driver	Type of risk	Affected natural assets	Affected ecosystem services/ economic sectors	Share of total lending	Number of sectors affected (unconditional)
Animal disease outbreak	ENCORE	Overexploitation, Changing use of sea and land	Physical risk	Species	Animal-based energy, fibers and other materials, pollination	**0.80%**	**5**
Severe drought occurrence	ENCORE	Climate change, Changing use of sea and land	Physical risk	Habitats, Soils and sediments, Species, Water	Buffering and attenuation of mass flows, Fibers and other materials, Mass stabilization and erosion control, Soil quality, Animal-based energy, Pollination, Water quality	**3.70%**	**13**
Severe wildfire occurrence	ENCORE	Climate change, Changing use of sea and land	Physical risk	Habitats, Soils and sediments	Fibers and other materials, Mass stabilization and erosion control	**1.70%**	**7**
Severe flooding occurrence	ENCORE	Climate change, Changing use of sea and land	Physical risk	Habitats, Land geomorphology, Soils and sediments, Species, Water	Buffering and attenuation of mass flows, Fibers and other materials, Flood and Storm protection, Mass stabilization and erosion control, Soil quality, Pollination,	**9.60%**	**16**
Pest outbreak	ENCORE	Overexploitation, Changing use of sea and land	Physical risk	Species	Fibers and other materials, pollination	**0.70%**	**5**
Severe storm occurrence	ENCORE	Climate change, Changing use of sea and land	Physical risk	Habitats, Soils and sediments, Species, Water	Buffering and attenuation of mass flows, fibers and other materials, flood and storm protection, maintenance of nursery habitats, mass stabilization and erosion control, pollination, water quality, Dilution by atmosphere and ecosystems	**9.40%**	**37**
Ecosystem service deterioration due to continued high rates of deforestation	ENCORE	Overexploitation, Changing use of sea and land	Physical risk	Atmosphere, Habitats, Land geomorphology, Minerals, Soils and sediments, Species, Water	Climate regulation, mediation of sensory impacts, pollination, soil quality, water flow maintenance, bio-remediation, buffering and attenuation of mass flows, fibers and other materials, filtration, flood and storm protection, maintenance of nursery habitats, pest control, water flow maintenance, soil quality, disease control, Ventilation, ground water	**30.40%**	**42**
Species decline due to human genetic modification	ENCORE	Invasive non-native species	Physical risk	Species	Fibers and other materials, Genetic materials, Pollination	**0.70%**	**5**
Reduced ecosystem services due to continued high resource use, pollution and urban sprawl	ENCORE	Pollution, Climate Change, Overexploitation, Change and sea and land use	Physical risk	Atmosphere, Habitats, Land geomorphology, Ocean geomorphology, Soils and sediments, Water	Dilution by atmosphere and ecosystems, buffering and attenuation of mass flows, Climate regulation, flood and storm protection, maintenance of nursery habitats, mass stabilization and erosion control, surface water	**44.10%**	**49**

Risk scenario	Source	Driver	Type of risk	Affected natural assets	Affected ecosystem services/ economic sectors	Share of total lending	Number of sectors affected (unconditional)
Reduced agricultural yields and water pollution due to intense agri- and aquaculture	ENCORE	Overexploitation	Physical risk	Soils and sediments, Species, Water	Buffering and attenuation of mass flows, soil quality, disease control, fibers and other materials, maintenance of nursery habitats, pest control, pollination	**2.50%**	**6**
Invasive species sprawl	ENCORE	Invasive non-native species	Physical risk	Species, Water	Bio-remediation, Fibers and other materials, Maintenance of nursery habitats, Pollination, Water quality	**1%**	**10**
Increased ocean acidification	ENCORE	Climate change, Pollution	Physical risk	Habitats, species, water	Flood and storm protection, maintenance of nursery habitats, mass stabilization and erosion control, water quality	**8%**	**19**
Changed ocean current and circulation	ENCORE	Climate change	Physical risk	Habitats, water	Climate regulation, maintenance of nursery habitats, dilution by atmosphere and ecosystems, water quality	**15.90%**	**26**
Severe reduction in available fish stock	ENCORE	Overexploitation	Physical risk	Species	Fibers and other materials, maintenance of nursery habitats, pollination	**0.70%**	**5**
Severe reduction in available timber	ENCORE	Overexploitation, Changing use of sea and land	Physical risk	Soils and sediments, Species	Climate regulation, fibers and other materials, pollination	**16.20%**	**22**
Species decline due to excessive hunting	ENCORE	Overexploitation	Physical risk	Species	Pest control, pollination	**1.70%**	**13**
Atmospheric pollution causing deterioration of ecosystem services	ENCORE	Pollution, Climate Change	Physical risk	Atmosphere	Mediation of sensory impacts, pollination, soil quality, water flow maintenance	**2.40%**	**15**
Unmanaged waste disposal and soil pollution strongly affecting productivity of habitats	ENCORE	Pollution	Physical risk	Habitat, species, soils and sediments	Bio-remediation, fibers and other materials, filtration, maintenance of nursery habitats, mediation of sensory impacts, soil quality, water flow maintenance, pollination, water quality	**2.40%**	**15**
Lower clean water availability due to continuously high water pollution	ENCORE	Pollution	Physical risk	Water	Dilution by atmosphere and ecosystems, ground water, maintenance of nursery habitats, mediation of sensory impacts, pollination, soil quality, water flow maintenance, water quality	**7.10%**	**29**
Increase in sea surface temperature	ENCORE	Climate Change	Physical risk	Habitats, soils and sediments, species, water	Climate regulation, fibers and other materials	**16%**	**22**
Lower water availability for other ecosystem services	ENCORE	Pollution, Climate Change, Overexploitation, Change and sea and land use	Physical risk	Water	Ground water, water flow maintenance, dilution by atmosphere and ecosystem	**6%**	**29**
Regulatory / market backlash against non-sustainable forestry	Interviews	Governance, Policy uncertainty, Consumer sentiments	Transition risk		Forestry and logging, Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, Manufacture of furniture	**0.70%**	**3**

Risk scenario	Source	Driver	Type of risk	Affected natural assets	Affected ecosystem services/ economic sectors	Share of total lending	Number of sectors affected (unconditional)
Extension of protected areas	Interviews	Governance, Policy uncertainty	Transition risk		Forestry and logging, Crops and animal production, hunting and related service activities, Fishing and Aquaculture, Extraction of crude petroleum and natural gas, Mining of metal ores, Other mining and quarrying, Mining Support Service Activities, Manufacture of food products, Manufacture of beverages, Manufacture of tobacco products, Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, Manufacture of furniture	**8.40%**	**10**
Regulatory restriction of non-sustainable pesticides	ENCORE	Governance, Policy uncertainty	Transition risk		Crops and animal production, hunting and related service activities, Fishing and Aquaculture, Manufacture of food products, Manufacture of beverages, Manufacture of tobacco products, Manufacture of chemicals and chemical products	**7.40%**	**6**
Regulatory restriction of non-sustainable fertilizers	ENCORE	Governance, Policy uncertainty	Transition risk		Crops and animal production, hunting and related service activities, Fishing and Aquaculture, Manufacture of food products, Manufacture of beverages, Manufacture of tobacco products, Manufacture of chemicals and chemical products	**7.40%**	**6**
Regulatory restriction of water pollution	Interviews	Governance, Policy uncertainty	Transition risk		Manufacture of food products, Crops and animal production, hunting and related service activities, Accommodation, Other manufacturing, Manufacture of rubber and plastic products, Manufacture of fabricated metal products, except machinery and equipment, Manufacture of other non-metallic mineral products, Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, Manufacture of textiles, Water transport, Manufacture of paper and paper products, Manufacture of basic metals, Electricity, gas, steam and air conditioning supply, Mining support service activities, Mining of metal ores, Water collection, treatment and supply, Waste collection, treatment and disposal activities; materials recovery, Manufacture of beverages, Manufacture of chemicals and chemical products, Other mining and quarrying, Extraction of crude petroleum and natural gas, Forestry and logging, Manufacture of wearing apparel, Manufacture of tobacco products, Manufacture of leather and related products, Mining of coal and lignite, Fishing and Aquaculture, Remediation activities and other waste management services, Sewerage	**16.80%**	**29**

Risk scenario	Source	Driver	Type of risk	Affected natural assets	Affected ecosystem services/ economic sectors	Share of total lending	Number of sectors affected (unconditional)
Sudden and unexpected climate policy introduction	ENCORE	Governance, Policy uncertainty	Transition risk		Crops and animal production, hunting and related service activities, Forestry and logging, Fishing and Aquaculture, Mining of coal and lignite, Extraction of crude petroleum and natural gas, Mining of metal ores, Manufacture of beverages, Other manufacturing, Manufacture of furniture, Manufacture of other transport equipment, Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of machinery and equipment n.e.c., Manufacture of electrical equipment, Manufacture of computer, electronic and optical products, Manufacture of basic metals, Manufacture of other non-metallic mineral products, Manufacture of rubber and plastic products, Manufacture of basic pharmaceutical products and pharmaceutical preparations, Manufacture of textiles, Manufacture of leather and related products, Manufacture of paper and paper products, Manufacture of chemicals and chemical products, Manufacture of coke and refined petroleum products, Manufacture of wearing apparel, Mining support service activities, Water collection, treatment and supply, Electricity, gas, steam and air conditioning supply, Sewerage, Waste collection, treatment and disposal activities; materials recovery, Construction of buildings, Civil engineering, Wholesale and retail trade and repair of motor vehicles and motorcycles, Land transport and transport via pipelines, Water transport, Air transport, Warehousing and support activities for transportation, Postal and courier activities, Accommodation, Financial service activities, except insurance and pension funding, Insurance, reinsurance and pension funding, except compulsory social security, Activities auxiliary to financial services and insurance activities, Real estate activities	**37.60%**	**30**

Risk scenario	Source	Driver	Type of risk	Affected natural assets	Affected ecosystem services/ economic sectors	Share of total lending	Number of sectors affected (unconditional)
Sudden increase in the price of water (removal of subsidies / market dynamics)	Interviews	Governance, Policy uncertainty	Transition risk		Manufacture of food products, Crops and animal production, hunting and related service activities, Accommodation, Other manufacturing, Manufacture of rubber and plastic products, Manufacture of fabricated metal products, except machinery and equipment, Manufacture of other non-metallic mineral products, Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, Manufacture of textiles, Water transport, Manufacture of paper and paper products, Manufacture of basic metals, Electricity, gas, steam and air conditioning supply, Mining support service activities, Mining of metal ores, Water collection, treatment and supply, Waste collection, treatment and disposal activities; materials recovery, Manufacture of beverages, Manufacture of chemicals and chemical products, Other mining and quarrying, Extraction of crude petroleum and natural gas, Forestry and logging, Manufacture of wearing apparel, Manufacture of tobacco products, Manufacture of leather and related products, Mining of coal and lignite, Fishing and Aquaculture, Remediation activities and other waste management services, Sewerage	**16.80%**	**29**

CONNECT WITH US

WORLD BANK GROUP
Inclusive Growth & Sustainable Finance Hub in Malaysia

wbg.org/Malaysia

@WorldBankMalaysia

@WB_AsiaPacific

http://bit.ly/WB_blogsMY

BANK NEGARA MALAYSIA
CENTRAL BANK OF MALAYSIA

www.bnm.gov.my

@bnm.official

@BNM_official

@banknegaramalaysia

BNM Official

Bank Negara Malaysia