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CLIMATE-RELATED FINANCIAL RISK EXPOSURE ASSESSMENT

September 2025

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MONGOLIA **EAST ASIA PACIFIC**

CLIMATE-RELATED FINANCIAL RISK EXPOSURE ASSESSMENT

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World Bank Group[1]

[1] This joint report was written by Tatsiana Kliatskova, Rafel Moya Porcel, Nepomuk Dunz, Batmunkh Batbold (World Bank Group), Borkhuu Gotovsuren, Ganchimeg Oyunbold, Yesuunee Erdenebat and Munkhbayar Baatarkhuu (Bank of Mongolia), with valuable inputs by Biying Zhu (World Bank Group). The report is part of a broader work by the World Bank Group and the Bank of Mongolia that seeks to better understand climate risks and opportunities for the financial sector in Mongolia. The authors are grateful to Francois Lesage and Paul Xavier Gaylanan Espinosa (World Bank Group) for useful comments and suggestions.

Contents

ACRONYMS AND ABBREVIATIONS

BoM	Bank of Mongolia
CCDR	Country Climate and Development Report
CCKP	Climate Change Knowledge Portal
EAI	Expected Annual Impact
ESG	Environmental, Social, and Governance
FX	Foreign Exchange
GDP	Gross Domestic Product
GHG	Greenhouse gas
GTAP	Global Trade Analysis Project
ISIC	International Standard Industrial Classification
MNT	Mongolian Tugrik
NBFC	Non-Bank Financial Corporations
ND-GAIN	Notre Dame Global Adaptation Initiative
NDC	Nationally Determined Contributions
NFC	Non-Financial Corporations
NGFS	Network for Greening the Financial System
NPL	Non-Performing Loans
OFC	Other Financial Corporations
SDG	Sustainable Development Goals
SPEI	Standardized Precipitation Evaporation Index
UNFCC	United Nations Framework Convention on Climate Change
USD	US Dollar
VaR	Value-at-risk
WB	World Bank
WBG	World Bank Group

EXECUTIVE SUMMARY

Climate-related issues are increasingly acknowledged as significant sources of both risk and opportunity for the financial sector, including in Mongolia. Central banks, supervisors, and regulators globally have warned about the impact of climate-related physical and transition risks on financial stability. Physical risks arise from chronic and acute impacts of climate change on real assets and financial instruments, while transition risks stem from efforts to mitigate climate change, potentially creating economic adjustment costs. The financial sector is crucial in supporting the transition to a low-carbon economy and mobilizing capital for climate goals. This report assesses physical and transition risks for Mongolia's banking sector, identifying risk hotspots and informing climate risk scenarios for financial impact assessments and risk management strategies.

Mongolia's vulnerability to climate-related impacts is well established due to geographic and socio-economic factors, leading to increased extreme weather events and climate hazards. The country is highly susceptible to droughts, dzuds[2], river flooding, and flash flooding[3] that increased in their frequency and severity in the past decades. Recent years have also seen escalating challenges from desertification, sandstorms, and dust storms. Projections indicate that climate change will exacerbate these trends, worsening the impacts on Mongolia's natural resources and overall environment. At the same time, a large share of Mongolia's population is working in sectors, such as agriculture and livestock, that are highly dependent on weather and climate conditions. To mitigate the impacts of climate change, Mongolia has outlined several climate adaptation strategies, including improving irrigation, promoting sustainable pastureland use, and enhancing water efficiency.

The Mongolian economy shows a strong tendency toward carbon-intensive practices, posing a challenge for achieving its Nationally Determined Contributions (NDC). The Mongolian economy emits four times more greenhouse gas emissions (GHG) per unit of Gross Domestic Product (GDP) than China and fifteen times more than the United States, requiring climate policy action to meet its NDC targets of reducing emissions by 22-27 percent by 2030. Between 1990 and 2021, GHG emissions in Mongolia increased by 45 percent, primarily due to agriculture, energy generation, and land-use changes. The country's heavy reliance on coal mining further complicates its climate and economic development, although the mining sector could generally benefit from the global transition to zero-carbon energy sources.

The Mongolian banking sector is susceptible to climate physical risk due to the spatial and sectoral composition of its loan portfolio. The loan portfolio is highly concentrated in Ulaanbaatar area (around 74 percent of total lending) and in sectors vulnerable to climate physical risks, such as real estate, construction, agriculture, and transport (around 30 percent of total lending). Loans in municipalities prone to natural disasters, such as floods, droughts, dzuds, and heat waves, are more likely to become non-performing. The agricultural sector is particularly vulnerable to extreme weather events, increasing the likelihood of financial difficulties for borrowers.

The exposure of the Mongolian banking sector to risks stemming from floods is substantial, while heat, drought and dzud exposure seems to be more contained. Floods, particularly in Ulaanbaatar and the northern provinces, pose substantial risks to the Mongolian banking sector. Floods affect a wide range of sectors. Our estimates suggest that approximately 28 percent of the banking system's loan portfolio is at medium-to-high risk from flood-related impacts. Droughts and dzuds, on the other hand, primarily impact agriculture, while heat waves affect labor productivity and revenues, leading to decreases production and increase costs, ultimately impacting banks' lending to affected firms. Risks to the Mongolian banking sector stemming from heat, drought and dzud exposure

[2] The dzud is a Mongolian term for a severe winter disaster characterized by extreme cold, heavy snow, and frozen ground, leading to high livestock mortality due to the inability of animals to access pasture. This is a weather-related phenomenon unique to Mongolia due to the country's unusual environment that is landlocked, semi-arid, and given to swings in temperature and precipitation.

[3] River flooding occurs when a watercourse overflows its banks, while flash flooding is a rapid, intense flood, often occurring within six hours of heavy rainfall, and can be characterized by raging torrents.

seem to be more contained, with estimated 1.1-2.3 percent of loan portfolio being at medium-to-high risk. The vulnerability of banks to physical risks vary, necessitating a detailed analysis of each bank's sectoral and geographical portfolio composition to understand their specific exposures.

In Mongolia, energy-intensive sectors like mining are particularly vulnerable to climate policies. Climate policies can also affect households and firms by increasing energy costs, reducing profits, and impacting debt servicing capacity, leading to broader economic impacts such as unemployment and reduced household wealth. Carbon taxation is just one of multiple channels impacting transition risks; others include regulatory changes to tighten emissions, emission trading schemes, subsidies to low-carbon alternatives and changes in consumer preferences. Even in the absence of carbon taxes, other climate policies, both domestic and internationally, could impact Mongolia and increase the speed of the transition to a low carbon economy.

At least 14 percent of Mongolian banking system exposures in 2022 are classified as lending to sectors that are exposed to transition risk. In the period between 2018 and 2022 the transition sensitive share within Mongolian banks' portfolio showed no substantial shifts from high-carbon to less-carbon intense sectors and activities. In particular, manufacturing and mining are two sectors to monitor in Mongolia with a combined share of 12 percent of all loans. Foreign-induced transition risks, such as China's decarbonization efforts, could meaningfully reduce demand for Mongolian coal, impacting Mongolia's mining industry and potentially leading to stranded assets. This scenario underscores substantial direct and indirect impacts on the banking sector due to Mongolia's heavy reliance on coal exports.

The exposure analysis in this report is high-level due to the high spatial and sectoral aggregation of the loan portfolio data, underscoring the need for more granular data collection for more detailed future analysis. The main limitations arise from the high aggregation of bank-level data by Bank of Mongolia (BoM), available only at the provincial level for geographic distribution (ADM1)[4] and at the International Standard Industrial Classification (ISIC)[5] sections level for sectoral distribution. This prevents precise matching of loan portfolio data with the geographic distribution of climate hazards and limits detailed sectoral impact evaluation. For example, flood risk varies due to differences in built-up area density, population density, and water extent, requiring more detailed data for higher-precision analytics. Similarly, high-level sectoral data does not capture nuances within sectors like construction or mining.

To refine the exposure assessment and prepare for stress testing, BoM should improve data collection from the banking sector by increasing sectoral and geographical granularity, issuing relevant supervisory policies, providing data templates, building capacity, and engaging with banks to address data gaps. In addition to the financial data, enhancing climate data collection, including information on asset damages, geographically disaggregated physical risks, and adaptation strategies, is also crucial. Engaging with relevant ministries, climate scientists, and data providers will support comprehensive climate data collection for stress testing.

In spite of granular data limitations, the analysis in this report already highlights vulnerabilities and weak spots in banks' loan portfolios, providing a foundation for further improvements in climate risk management by BOM and other relevant national authorities. Integrating insights from climate-related financial risk analysis into supervisory and regulatory frameworks will strengthen banks' risk management and enhance the Mongolian banking system's resilience to climate-related impacts.

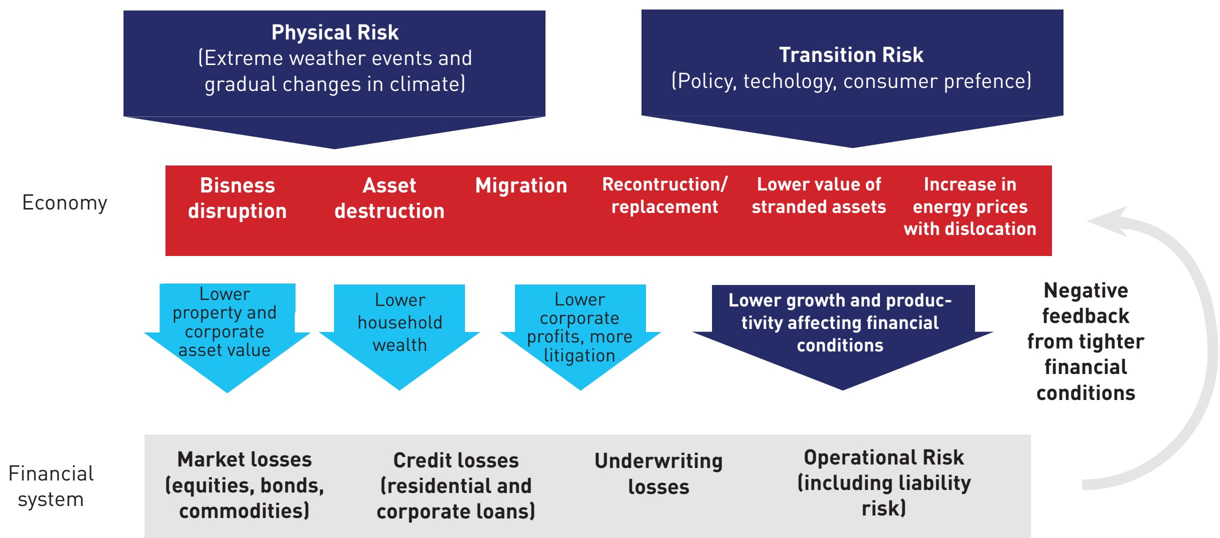
[4] Mongolia is divided into 21 provinces and one provincial municipality. Each province is subdivided into several districts.

[5] ISIC is a hierarchical classification system with four levels: sections (broad categories), divisions, groups, and classes (most detailed).

1. INTRODUCTION

Climate-related issues are increasingly recognized as important sources of risk and opportunity for the financial sector. Many central banks, supervisors and regulators globally have issued warnings on the impact of climate-related physical and transition risks on the stability of their financial systems (as illustrated in Figure 1). Physical risks stem from both the chronic (sea-level rise or temperature increases) and acute impacts of climate change and natural disasters (such as droughts, floods, or hurricanes) on the value of real assets and financial instruments held by financial institutions. Transition risks derive from efforts to mitigate climate change through policy, technological or behavioral changes, which may create economic adjustment costs in a broad range of sectors. These costs can create financial risks for firms and investors that did not anticipate the transition and can ultimately jeopardize the functioning and stability of the financial system. At the same time, there is growing recognition globally that the financial sector has a key role to play in supporting an orderly transition to a low-carbon economy, and in mobilizing capital for climate mitigation and adaptation goals.

Figure 1. Transmission channels of climate-related physical and transition risks



Source: Grippa et al. (2019).

This report provides an initial assessment of physical and transition risks for the banking sector of Mongolia that is intended to contribute to the climate-related initiatives of the BoM[6] (see Box 1). The analysis of physical risk concentrates on the risk exposure of the banking sector by examining the sectors and locations of bank loans in Mongolia. The transition risk analysis is tailored to the data availability in Mongolia and focused on the identification of exposures of banks to industrial sectors sensitive to transition risks (e.g., high GHG emitting sectors that would be disproportionately affected by the imposition of a carbon tax). This analysis provides a preliminary identification of climate-related risk hotspots and is crucial for designing climate risk scenarios, that would be the next step for Mongolia's climate risk analysis, pending on sufficient data availability and granularity. The scenarios are then intended to feed into economic and, ultimately, financial impact assessments to quantify climate risks for the Mongolian banking sector (see Figure 2) and can eventually be used to design effective financial climate risk management strategies.

[6] The report focuses on the assessment of the banking sector given its dominance in the financial sector of Mongolia (85 percent of financial sector assets in 2024) (see Annex A.2 for more details).

Box 1 – Climate-related initiatives of the Bank of Mongolia

One of the main objectives of the Government's Monetary Policy Guideline between 2019 to 2024 is to green the financial industry. In 2019, Mongolia adopted a Green Taxonomy, and an extended version of the Mongolia Sustainable Development Goals (SDG) taxonomy was approved in 2023. In 2022, Mongolia launched a climate financing strategy, and the Financial Stability Council approved the National Sustainable Finance Roadmap that outlined targets for green financing.[7]

In this context, BoM aims to promote sustainable finance opportunities as well as enhance the financial system's resilience to climate change risks in line with international standards and practices. In 2023, BoM approved methods for assessing and managing environmental, social, and governance (ESG) risks, enabling the identification of green businesses and activities and measuring related credit issuance. Per the recommendation of the Banking Supervision Committee meeting in January 2023, BoM reduced the risk weight for loans to finance green buildings from 100 percent to 75 percent (as of June 2023).

Going forward, BoM plans to establish a task force for conducting research on carbon tax policy in Mongolia and provide policy recommendations based on research findings in the long run. Additionally, BoM plans to introduce regulatory and supervisory requirements related to climate-related financial risks in line with the Basel Standards.

Figure 2. Overview of a Comprehensive Climate Risk Analysis

1. EXPOSURE ANALYSIS

Physical risk exposure
Comparing geographical and sectoral exposures with global and local hazard maps to identify hot spots of physical risk and identify transmission channels

Transition risk exposure
Comparing sectoral exposures with transition indicators per sector (for example, GHG emissions), and identify transmission channels

2.SCENARIOS

Physical risk scenario
Estimating forward-looking hazard damages based on catastrophe model outputs, historical extreme events, and climate models

Transition risk scenario
Identifying different transition pathways (for example, carbon pricing, trade policies, energy mix)

3. ECONOMIC IMPACT

Macro approach
Climate-enhanced macroeconomic models for assessing indirect physical and transition scenario impacts (for example, GDP, value add per sector/region, inflation, interest)

Micro approach
Estimating impact of scenarios on firm-level debt serviceability and probability of default

4. FINANCIAL IMPACT

Bank-by-bank
Evaluating the effects of macro or firm-level shocks on a bank's CAR, loan quality indicators (for example, NPLs, profitability) using econometric models and solvency stress tests

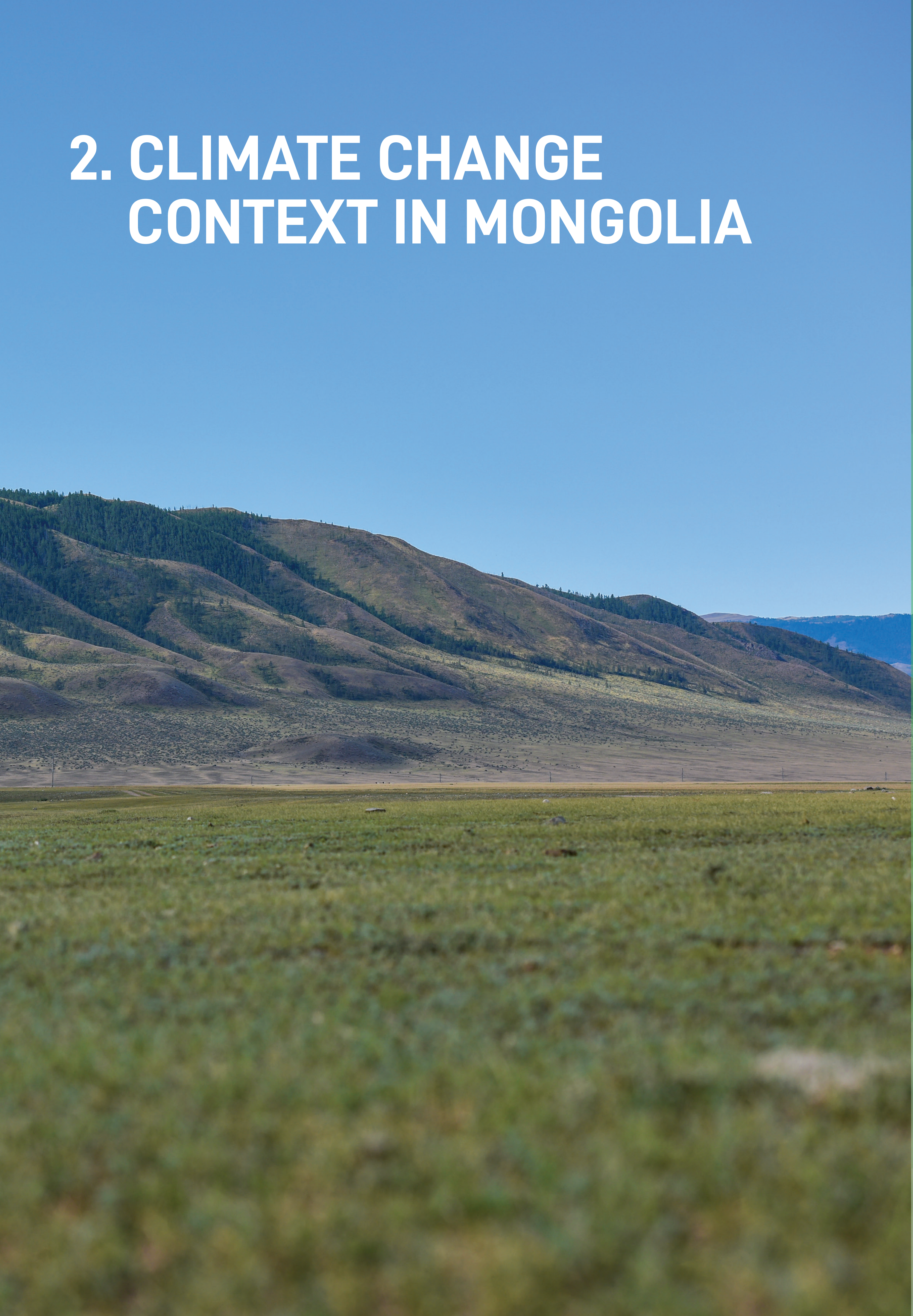
System-wide
Assessing system-wide impacts of climate risk scenarios for financial stability, accounting for heterogeneity across banks

Source: World Bank (2024b).

The structure of this report is as follows: Section 2 outlines climate context with relation to physical and transition risks in Mongolia. Section 3 provides an assessment, including a detailed methodology, of exposure of the Mongolian banking sector to the physical and transition financial risks. Section 4 discusses data and methodology limitations of the analysis. The report concludes with Section 5, which outlines ways forward for climate risk analysis in Mongolia.

[7] Mongolia Country Climate and Development Report (CCDR). World Bank (2024).

2. CLIMATE CHANGE CONTEXT IN MONGOLIA



2.1 PHYSICAL RISK-RELATED CONTEXT

Mongolia's vulnerability to climate-related impacts due to a blend of geographic and socio-economic factors is well established. In the 2023 Notre Dame Global Adaptation Initiative (ND-GAIN) Index[8], it was ranked 60 out of 181 countries, indicating its susceptibility to climate change. In the last 70 years, its average temperature has climbed faster than the world's average increase (around 1.3°C), exacerbated by its high latitude, landlocked geography, and the presence of permafrost, which amplifies warming effects. According to the Mongolia's Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), between 1940 and 2015 average temperatures in Mongolia increased on by 2.24°C and have been associated with increase in hot summer days and a decline in frost days. In addition, between 1901-1910 and 2013- 2022, average annual precipitation increased from 226 mm to 236 mm; however, more importantly the variability of precipitation increased substantially, with the standard deviation increasing from 5.8 mm to 37.4 mm. Precipitation is non- uniform, ranging from a yearly average of 350 millimeters in the north to 80 millimeters in the south. In Mongolia, glaciers have shrunk by 40 percent since the 1990s, contributing to the increasing desertification (already one quarter of Mongolia is classified as a dessert).[9,10] At the same time, a large share of Mongolia's population are working in sectors, such as agriculture and livestock, that are highly dependent on weather and climate conditions.

Climate change has already contributed to an increase in extreme weather events and climate hazards over the last decades. Mongolia ranks 116 out of 191 countries on the INFORM 2024 risk index.[11] Floods, storms and extreme temperatures are common in Mongolia (Figure 3), particularly around Ulaanbaatar (Figure 4). The combination of climate change and human activities has resulted in increased risks of disasters and environmental decline. Over the past six decades, there has been a noticeable rise in the frequency and severity of natural disasters such as dzuds (extremely harsh winters), droughts, and floods (see Annex A.1 for the list of extreme events in Mongolia in 2018-mid-2023). In the beginning of the 21st century, storms affected over 1 million people in

8 The ND-GAIN Index utilizes a scoring system to assess a nation's vulnerability to climate change and other global challenges, as well as its preparedness to enhance resilience. Source:https://gain.nd.edu/our-work/country-index/.

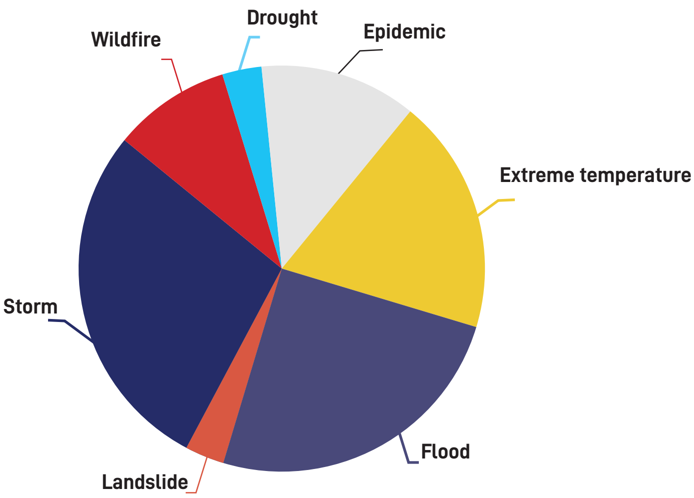
9 Mongolia. Disaster Management Reference Handbook. May 2022.

10 Mongolia CCDR. World Bank (2024).

11 The INFORM Risk Index is a global, open-source risk assessment for humanitarian crises and disasters. Source: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile.

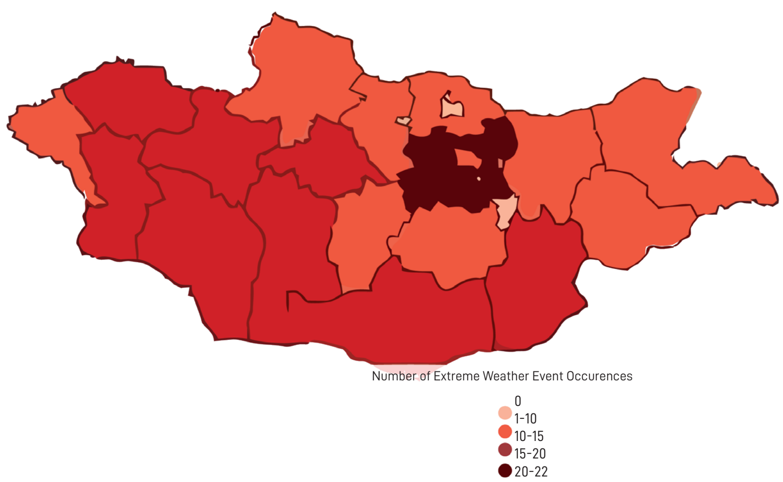
Mongolia with dire implications on public health, the economy, livelihoods, and the economic prosperity of the population.[12] Dzuds frequently affect Mongolia and negatively impact their agriculture and livestock sectors, hamper poverty reduction efforts, shock the economy, and contribute to urban migration. Frequency of extreme temperatures, particularly in winter months, intensified[13], and summers become drier and hotter, causing droughts. In 2017, Mongolia saw the hottest summer in 50 years, with two-thirds of the country stricken by drought.14

Figure 3. Average Annual Natural Hazard Occurrence for 1980-2020



Source: World Bank Climate Change Knowledge Portal, based on EM-DAT.

Figure 4. Natural Hazard Occurrence across Mongolia between 2000 and 2024



Source : WB staff calculations based on EM-DAT .

The most impactful extreme events in Mongolia are droughts and dzuds. There are two primary types of droughts – meteorological drought, typically caused by insufficient precipitation, and hydrological drought, associated with a shortage of surface and subsurface water flow, often originating in the region's broader river basins.[15] Currently, Mongolia experiences an annual median probability of severe meteorological drought of approximately 4 percent.[16] Mongolia's local drought index, as reported in its Third National Communication to the UNFCCC, reveals a prolonged period of summer drought from 2000 to 2015,

12 World Bank. Climate Change Knowledge Portal. Source: https://climateknowledgeportal.worldbank.org/country/mongolia/vulnerability#:~:text=Storms%2C%20dust%20storms%2C%20windstorms%2C,economic%20prosperity%20of%20the%20population.

13 World Bank. 2024a Mongolia Economics Update, Spring 2024.

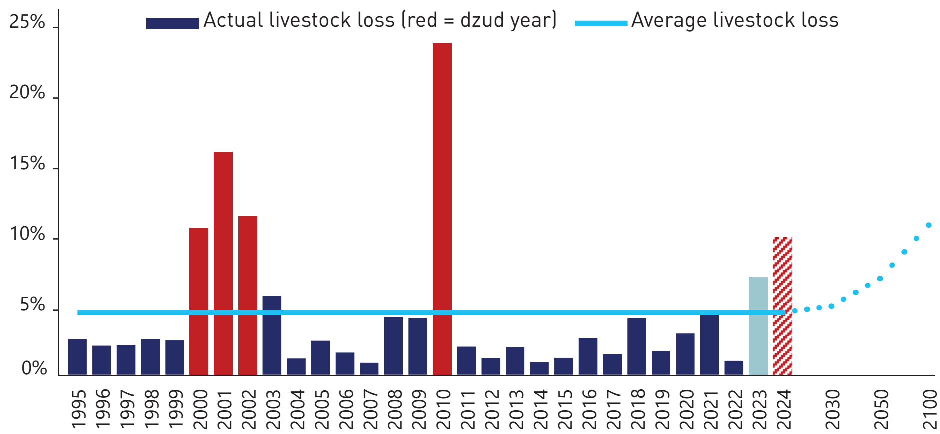
14 Mongolia. Disaster Management Reference Handbook. May 2022.

15 Climate Risk Country Profile: Mongolia (2021): The World Bank Group and the Asian Development Bank.

16 As determined by a standardized precipitation evaporation index (SPEI) of less than -2.

which surpasses any levels observed from 1940 to 2000. Further, due to dzuds (that occurred in one out of five years since 2000), Mongolia lost tens of millions of head of livestock (Figure 5), with the most severe mortality occurring in the 2000-2002 and 2010 winters.[17] Between November 2023 and April 2024, Mongolia experienced the harsh dzud, with 188,300 people being affected, 20 people died, and 7.1 million livestock, or 11.1 percent of the total, perished.[18] According to Mongolia CCDR (2024), by mid-century dzuds will occur as often as once every three years and their severity will also increase. If no adaptation measures are taken, average annual losses of the livestock will reach 5.8 of the total stock by 2050 and 9.6 percent – by 2100.

Figure 5. Livestock losses (as percent of total)



Source: Mongolia CCDR. World Bank (2024) and forecasts based on data from National Statistics Office Mongolia. Note: The dotted blue line indicates projections of livestock loss beyond 2024. The hatched red bar in 2024 indicates expected loss.

Flooding impacts, both river and flash flooding, are exacerbated by rapid urbanization. Analyzer by the World Resources Institute), considering protection measures for events occurring once every ten years, approximately 10,100 individuals are affected by annual flooding in Mongolia. The expected impact on the country's GDP is estimated at USD 37 million annually.[19] Flash flooding also poses a significant threat to life and livelihoods in Mongolia, with around 18 percent of population in the three largest cities being exposed to flooding as well as key urban infrastructure being in the flood-prone areas. Between 2004 and 2015, it accounted for 24 percent of deaths caused by natural hazards, as stated in Mongolia's Third National Communication. Especially Ulaanbaatar is grappling with a rising problem of flooding that is exacerbated by rapid urbanization, lack of effective urban planning and inadequate infrastructure. For example, a state of emergency due to flooding was declared in July 2023. In addition to the heavy rainfall, the Selbe river dam has collapsed, resulting in around 100,000 people being directly affected and 199 apartment buildings and 702 infrastructure units being damaged.[20,21]

In recent years, Mongolia has faced escalating challenges of desertification, sandstorms, and dust storms. The number of days with sandstorms in the country has more than tripled since the 1960s.[22] These sandstorms have resulted in soil erosion and degradation of vegetation, exacerbating the already limited arable land in Mongolia. The southern regions of the country have experienced an average of 20-30 sandstorms per year over the past decade, while drifting dust has been observed for 30 to 60 days annually in the southern and southwestern

17 Mongolia. Disaster Management Reference Handbook. May 2022.
18 Situation report. International Federation of Red Cross and Red Crescent Societies. Source: https://reliefweb.int/disaster/cw-2023-000262-mng
19 Climate Risk Country Profile: Mongolia (2021): The World Bank Group and the Asian Development Bank.
20 UNICEF. 2023. Mongolia Humanitarian Situation Report. https://www.unicef.org/mongolia/environment-air-pollution.
21 Situation report. International Federation of Red Cross and Red Crescent Societies. Source: https://reliefweb.int/report/mongolia/mongolia-floods-2023-dref-operation-mdrmn019
22 Mongolia. Disaster Management Reference Handbook. May 2022.

areas.[23] The sandstorms often cause extensive damage within the country and have a trans-regional impact on East Asia, including northern China, Japan, and various parts of South Korea.

Climate change and the degradation of natural resources are also increasing the impacts of chronic climate-related impacts in Mongolia.[24] Climate change factors, coupled with rapid urbanization, industrialization of mining, and low-productivity agriculture, have contributed to air pollution. Ulaanbaatar's air quality, particularly in winter, ranks among the world's worst, with daily average of PM2.5 pollution levels on the coldest days reaching 687 micrograms per cubic meter — 27 times the level World Health Organisation recommends as safe.[25] Additionally, Mongolia faces water availability issues (water stress index[26] suggests that Mongolia is under high water stress[27]) and degradation of pasturelands (with 90 percent of grassland suffering some level of desertification[28]). Climate change is set to exacerbate water usage issues in Mongolia where one out of six Mongolians still does not have access to basic drinking water services and only 70 percent have access to basic sanitation services. The warming temperatures are likely to disrupt precipitation patterns, making them less reliable. This unpredictability in rainfall, in addition to affecting agriculture, poses a potential threat to Ulaanbaatar, which accommodates over half of the country's population, within the coming decade. Furthermore, Mongolia's critical mining sector, which has been a significant driver of its recent economic growth, may encounter severe water scarcity challenges. If these issues are not reversed or controlled, they are likely to impede economic growth and negatively impact the well-being of the population in the medium to long term.

Mongolia has outlined several climate adaptation strategies to address the impacts of climate change in various sectors. World Bank analysis suggests that impacts of climate change could be reduced by a quarter by improving irrigation and protecting against floods with appropriate adaptation measures.[29] For animal husbandry and pastureland, the goal is to increase productivity while ensuring sustainable development and reducing climate change risks. This involves maintaining ecosystem balance, and a sustainable use of pastureland. In arable farming, the goal is to ensure sustainable food supply by saving water for irrigation, reducing water use and irrigation costs, protecting soil, and implementing zero-tillage technologies. For water resources, the goal is to increase efficient water use methods and enhance the adaptive capacity of the water sector through legal and institutional frameworks and appropriate technologies. Enhanced forest resources aim to create forest ecosystems well adapted to climate change to act as a carbon sink by implementing sustainable forest management. Given Mongolia's climate-related context with its extreme vulnerability to climate change mobilizing finance for adaptation will be particularly urgent. According to the Mongolia CCDR (2024), USD3.5 billion (net present value) additional investment from the private and public sectors as well as external sources, in the form of foreign direct investment and concessional financing, are needed over the next 25 years for adaptation measures.

23 Northeast Asian Conference on Environmental Cooperation, Dust storms in Mongolia. Source: https://www.env.go.jp/earth/coop/neac/neac12/pdf/021.pdf.

24 See Mongolia CCDR. World Bank (2024) for details.

25 https://www.unicef.org/mongolia/environment-air-pollution.

26 Water stress, the ratio of water demand to renewable supply, measures the competition over local water resources.

27 Aqueduct Water Risk Atlas.

28 IMF. Mongolia: Selected Issues. Volume 2019: Issue 298.

29 See Mongolia CCDR. World Bank (2024) for details.

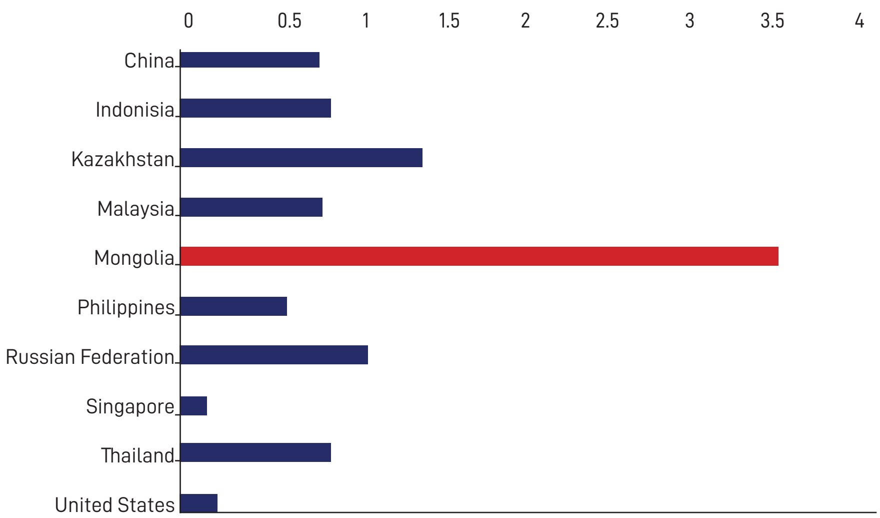
2.2 TRANSITION RISK-RELATED CONTEXT

The Mongolian economy exhibits a pronounced proclivity toward carbon-intensive practices, posing a challenge for achieving its Nationally Determined Contributions. Setting aside recent conflict areas and small island countries, Mongolia's economy is the most carbon-intensive globally. It emits quadruple the greenhouse gases per GDP unit compared to China, and fifteen times more than the United States (Figure 6).[30] Thus, the loftiness of Mongolia's NDC target, which seeks to achieve a reduction in emissions ranging from 22 percent to 27 percent below the baseline by 2030, appears notably ambitious given the current trajectory. As opposed to many other Emerging Markets and Developing Economies, Mongolia currently does not have a public commitment to a net zero emissions target, but has numerical target for GHG reductions by sector, in particular affecting energy and agriculture.[31]

30 Mongolia CCDR. World Bank (2024).

31 UNFCC, Mongolia National Action Plan on Climate Change.

Figure 6. GHG emissions per thousand USD GDP



Sources: World Bank CCDR calculations based on the EDGAR database and World Development Indicators. Excludes LULUCF emissions.

Greenhouse gas emissions in Mongolia have increased by 45 percent between 1990 and 2021 (Figure 7). The main sources of GHG emissions in Mongolia are agriculture (39 percent), energy generation (31 percent) and land-use change and forestry (28 percent).[32] Other emissions stemming from industrial processes and waste are also increasing.[33] Agricultural emissions stem mainly from animal herds. Approximately 66 percent of grazing lands have deteriorated, with 10 percent experiencing complete degradation due to increasing livestock populations and historical climate shifts. Such soil degradation significantly contributes to greenhouse gas emissions within the agricultural food sector.[34] In the energy sector, emissions stem from the use of fossil fuels, such as oil, coal, and natural gas, for electricity generation and transportation. Mongolia relies heavily on nationally sourced coal for electricity generation (96 percent of all energy production, Figure 8) and energy use per capita is high (Figure 9). This is especially true during the harsh winter months when the demand for heating rises significantly, as seen in the widespread use of coal for individual heating in

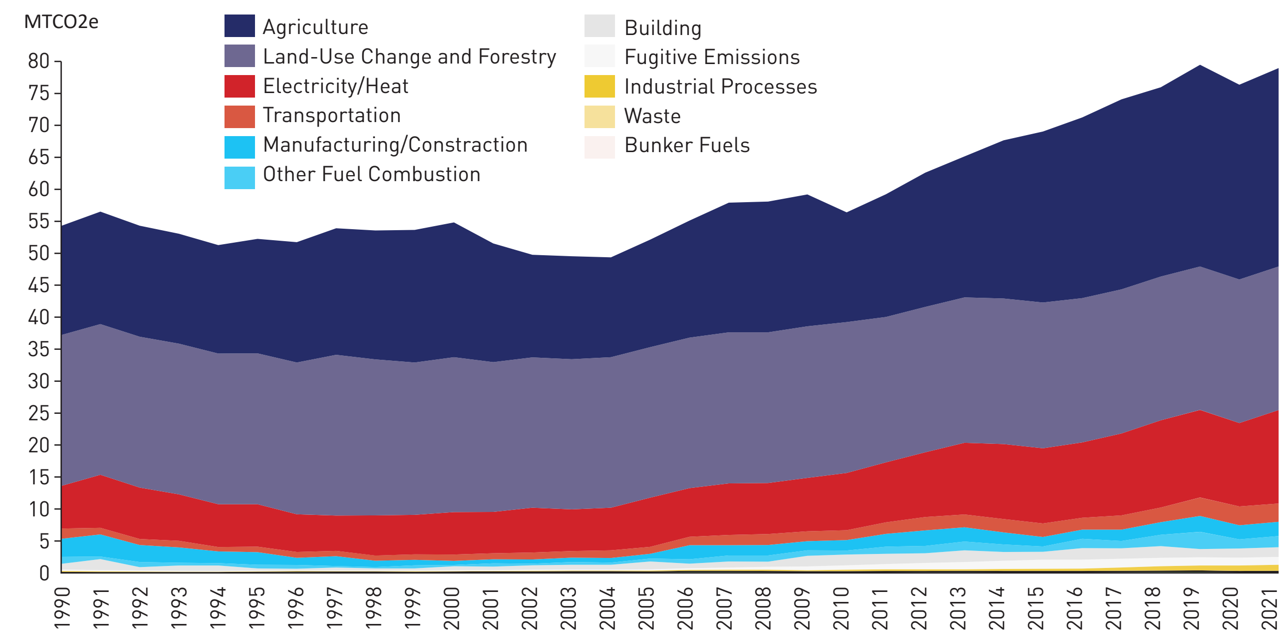
32 Until very recently, Mongolia was a net carbon sink due to its large forest stocks, but carbon sequestration has not kept pace with the rapidly increasing emissions. A large share of forest lands, which previously made the country a net carbon sink, are now overgrazed and undermanaged (Mongolia CCDR. World Bank (2024)).

33 Climate Watch 2021.

34 Mongolia CCDR. World Bank (2024).

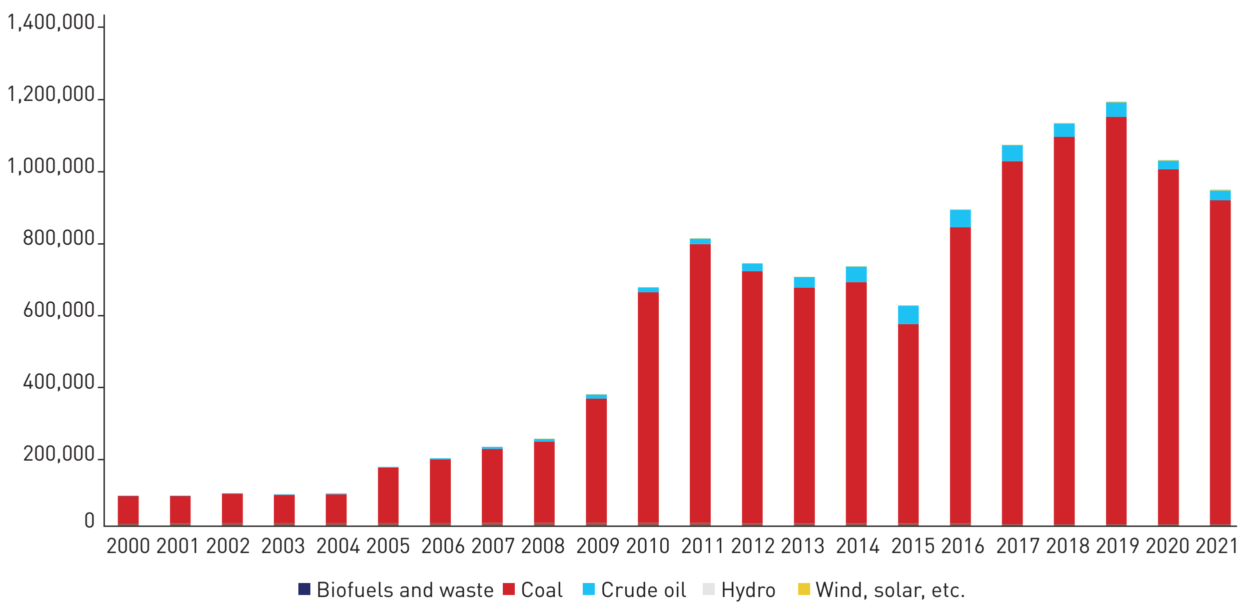
yurts, the traditional Mongolian dwellings. Changes to that main source of energy would require imports of other fossil fuels and/or a substantial investment in renewable energy infrastructure (currently 0.8 percent of energy production), in particular wind.

Figure 7. Historical Greenhouse gas emissions



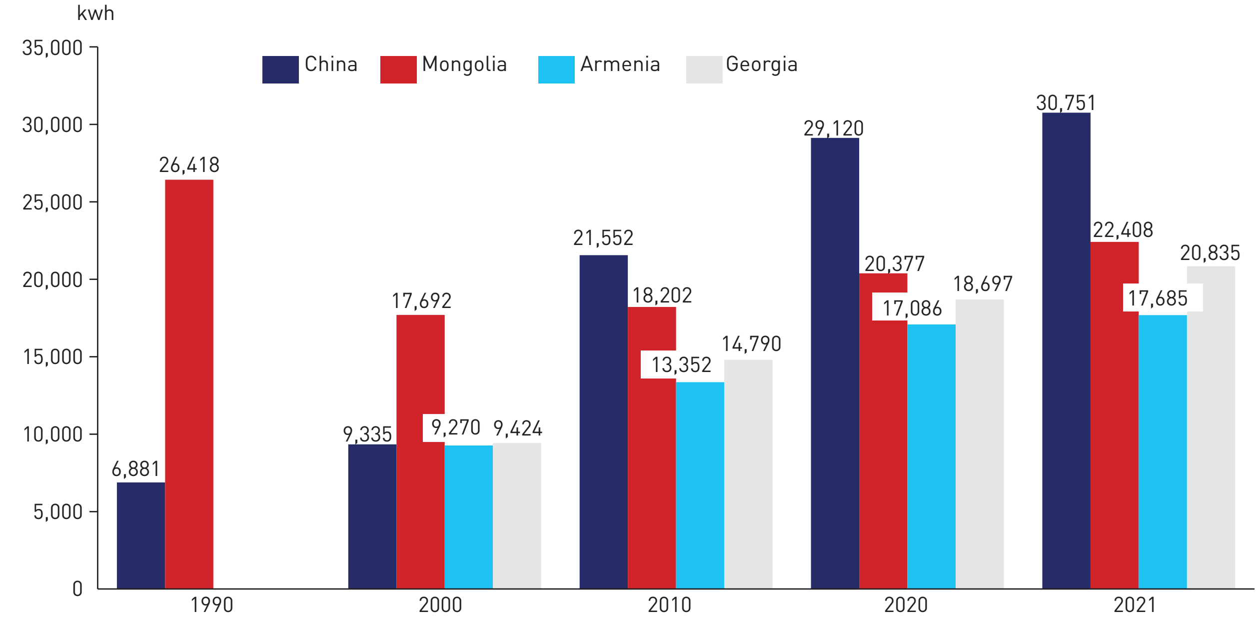
Source: WB staff calculations based on Climate Watch data.

Figure 8. Domestic Energy Production in Mongolia by source (in Terajoules)



Source: WB staff calculations based on International Energy Agency data.

Figure 9. Per capita energy use in Mongolia and selected peers (kilowatt-hours per person)



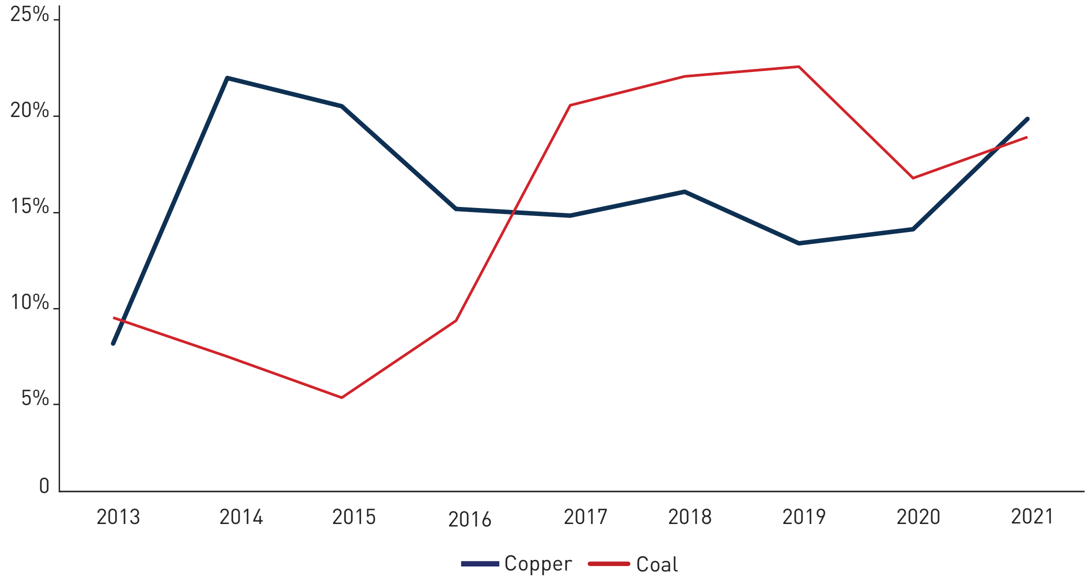
Source: WB staff calculations based on data from U.S. Energy Information Administration; Energy Institute - Statistical Review of World Energy (2024); Our World in Data.

Mongolia's heavy reliance on mining, notably coal extraction, presents additional challenges in the realms of both climate and economic development. Over the past decade, natural resource rents have consistently accounted for an average of 17.5 percent of Mongolia's GDP, constituted a substantial 78 percent of the nation's total exports[35], and contributed significantly to government revenues. While Mongolia's recent economic upswing has been largely underpinned by its mining activities, this trajectory has exposed the nation to the movements in volatile commodity prices. Furthermore, Mongolia confronts a looming prospect in the longer term: China's efforts to curtail coal consumption.[36] Such endeavors could potentially render Mongolia susceptible to a significant reduction of export revenue, given its status as a major coal exporter to China (90 percent of coal exports going to China).[37]

Simultaneously, Mongolia's extraction sector is poised to benefit from the worldwide shift towards zero-carbon energy sources. This transition presents unique opportunities for the country. Notably, global demand for copper, now recognized as a pivotal mineral, is projected to double by 2035[38], primarily driven by heightened requirements from electrified systems. Mongolia has already witnessed years where its copper exports have outpaced those of coal (Figure 10). However, the nation's reliance on China as the exclusive destination for its exports persists. Copper transportation is more feasible than coal due to its higher value-to-weight ratio, ensuring Mongolia's copper competitiveness in China and abroad despite distance. Yet, water scarcity, is a critical obstacle to expanding copper production.[39]

[35] The Atlas of Economic Complexity. (https://atlas.cid.harvard.edu/explore)
[36] IEA 2024. World Economic Outlook 2024.
[37] Mongolian coal primarily serves the steel industry, not power generation, making it less susceptible to being replaced by wind or solar energy. Nonetheless, if China rapidly decarbonizes its steel industry, Mongolia could quickly face a significant decline in coal production.
[38] S&P Global (2022). The Future of Copper.
[39] Mongolia CCDR. World Bank (2024).

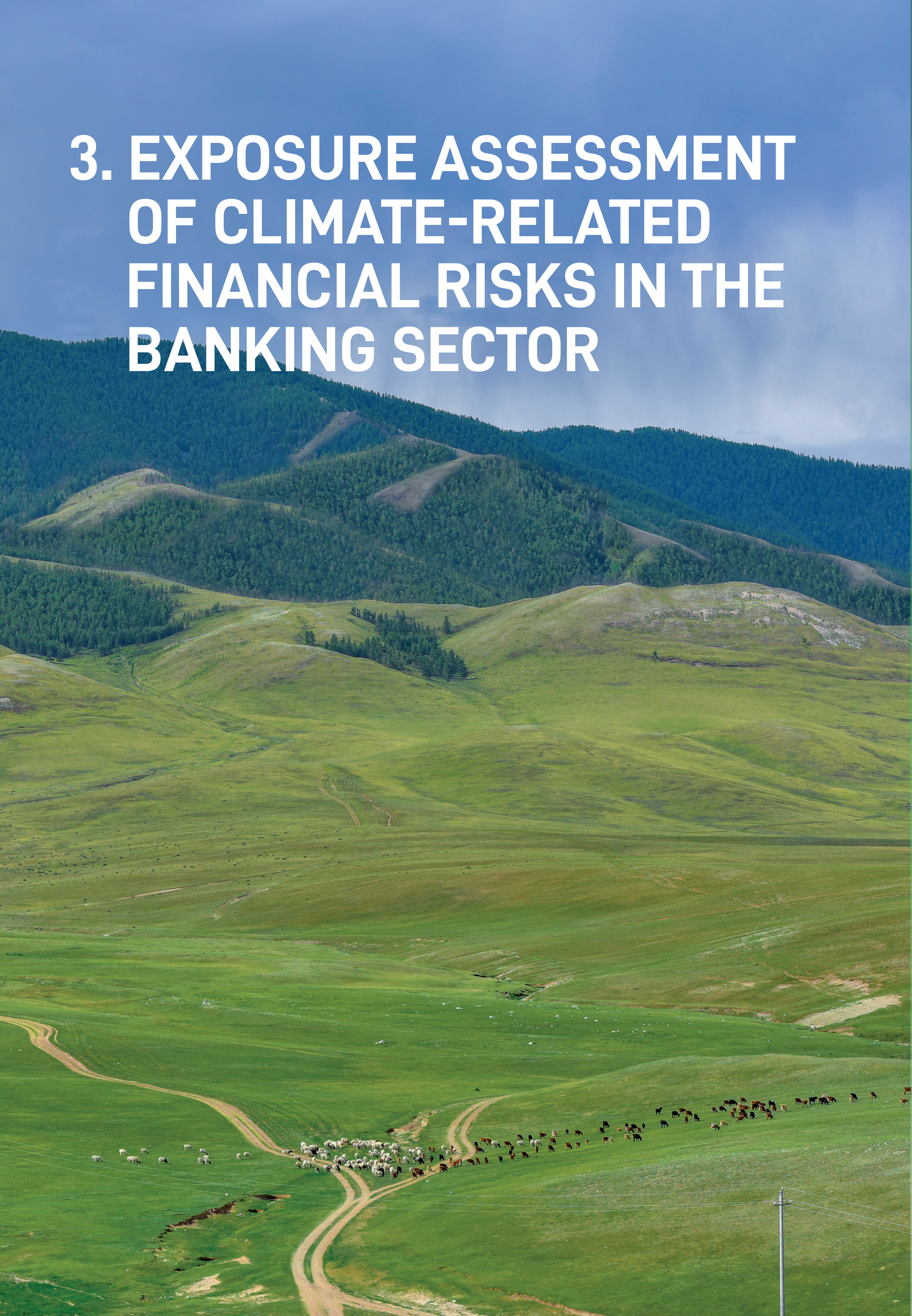
Figure 10. Exports of coal and copper (percent of GDP)



Source: WB staff calculations based on UN COMTRADE data.


Purev Battogtokh

3. EXPOSURE ASSESSMENT OF CLIMATE-RELATED FINANCIAL RISKS IN THE BANKING SECTOR



This section provides preliminary insights into climate physical and transition risk hotspots in Mongolia to inform climate risk management strategies. It emphasizes that asset vulnerability is crucial for actual risk realization, requiring further data and advanced modeling. The analysis uses academic and policy reports, global and domestic climate data, and corporate bank lending information from BoM, focusing on sectors and regions served by Mongolian banks to assess potential climate risks and shape relevant scenarios.

For a comprehensive evaluation of Mongolia's physical and transition risks, detailed modeling of key transmission channels and indirect impacts is necessary, potentially addressed in future projects. Accurate assessments of climate physical risk on the financial sector need detailed data on asset location, type, and ownership, and must consider Mongolia's adaptive measures and resilience efforts. This report particularly examines credit risk channels to the banking sector given that the financial system in Mongolia is predominantly bank-centric. The underlying presumption is that credit risk for Mongolian banks increases if climate risk drivers impair borrowers' ability to repay debt or reduce banks' ability to recover loan values in defaults.

3.1 OVERVIEW OF THE FINANCIAL SECTOR

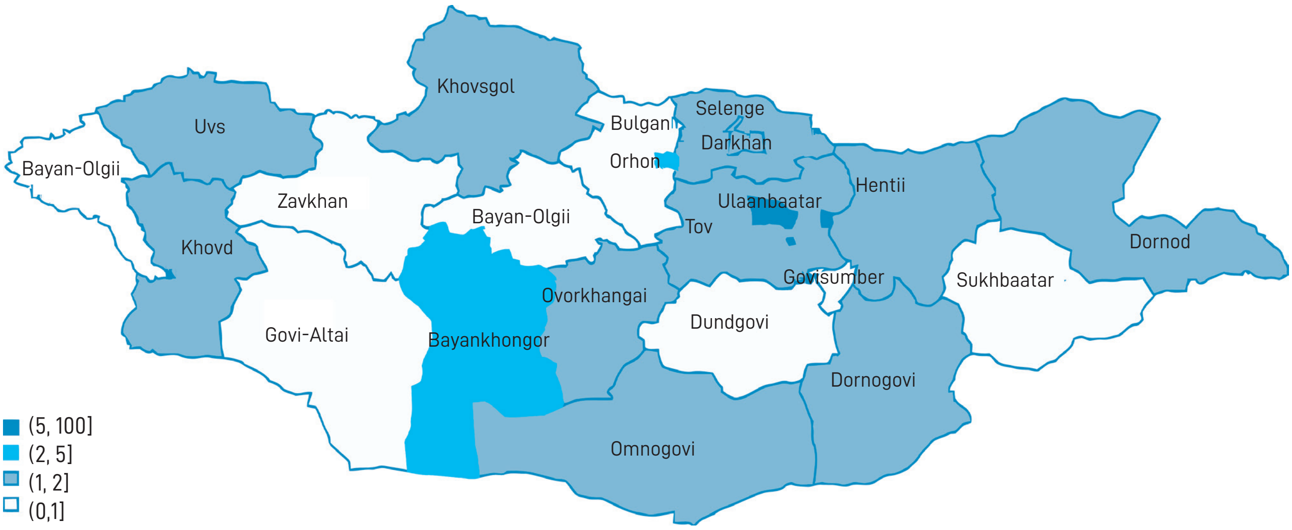
The financial sector in Mongolia is predominantly bank-centric (representing 85 percent of total assets in the financial market)[40], with the five largest banks—Khan Bank, Trade and Development Bank, XacBank, Golomt Bank, and State Bank—holding over 90 percent of the sector's assets.[41] As of the end of 2022, the sector comprised 12 banks, including one state-owned bank, which accounts for about 8 percent of total banking assets (BoM data). The banking sector is characterized by a traditional business model focused on lending, with a significant reliance on deposit funding. Loans, primarily in local currency, constitute 48 percent of total assets, with a substantial portion directed towards personal lending, including mortgages and consumption loans.

BoM's dataset for the 10 largest banks reveals a high concentration of loans in Ulaanbaatar and a large share of lending in wholesale and retail trade as well as construction. Lending in Ulaanbaatar accounts for 74 percent of the loan portfolio. The rest of the market is scattered across other provinces, none of which accounts for more than 5 percent of banks' loan portfolio. Nine out of 22 provinces account for less than 1 percent of total banks' loan portfolio (Figure 11). The geographical and sectoral distribution of loans shows significant exposure to sectors vulnerable to physical climate risks, such as real estate, construction, and to a lesser degree agriculture, and transport (Figure 12). The loan portfolio of Mongolian banks is roughly half directed to non-financial corporates, while the

[40] For more details see Annex A.2.
[41] The report is using data available up to December 31, 2022.

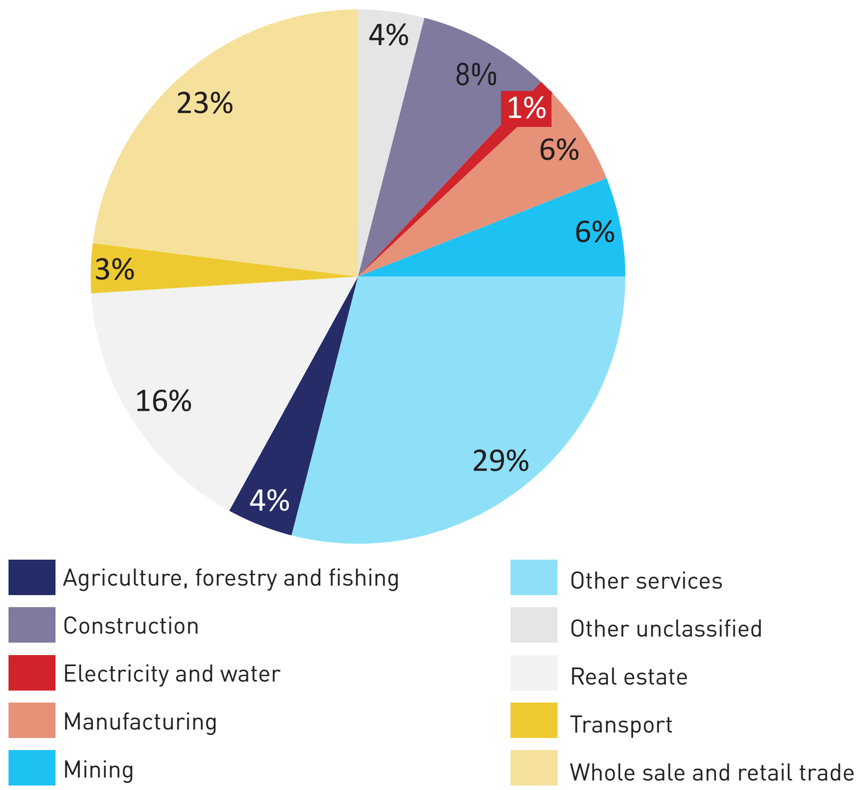
rest is distributed between personal loans (38 percent of total loan portfolio) and mortgages (14 percent). As of end-2022, the largest sectoral recipients of corporate loans are firms operating in the wholesale and retail trade (35 percent), construction (16 percent), services (15 percent), manufacturing (12 percent), and mining (10 percent).

Figure 11. Spatial mapping of banks' credit portfolio shares (percent of total) across provinces, end-2022

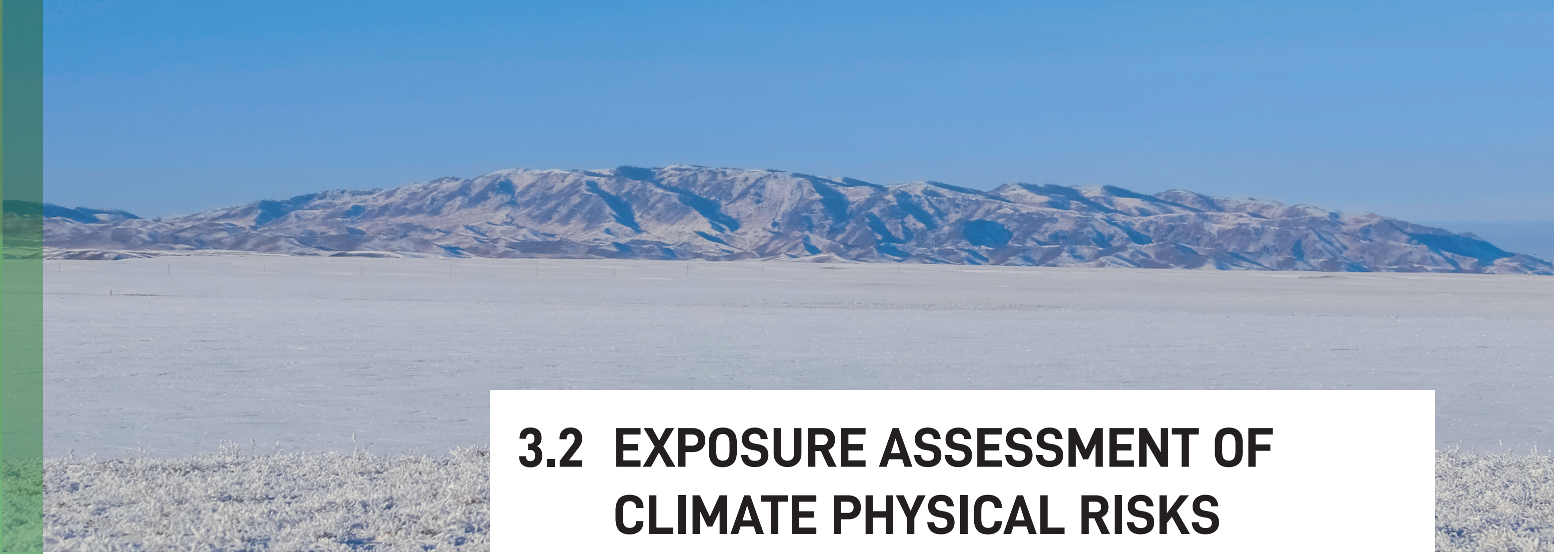


Source: WB staff calculations based on Bank of Mongolia data. Note: The map depicts % of total banks' credit portfolio in each province, ranging from high % (above 5%, dark blue color) to low % (below 1%, white color).

Figure 12. Sectoral lending share of total banks' credit portfolio (percent of total), end-2022



Source: WB staff calculations based on Bank of Mongolia data.



3.2 EXPOSURE ASSESSMENT OF CLIMATE PHYSICAL RISKS

The banking sector's exposure to physical risks is determined by the spatial and sectoral composition of its assets, or loan portfolio. Loans located in municipalities prone to natural disasters – such as floods, droughts, dzuds, and heat waves – are more likely to lose their value and turn into non-performing. At the same time, significant differences exist in the impact and damages of natural disasters across economic sectors. For example, the agricultural sector is more directly affected by extreme weather events and, therefore, borrowers in the agriculture sector have a higher probability of running into financial difficulties. As a starting point in the analyzes of physical risks in Mongolia, we discuss possible transmission channels of the physical risks, describe the methodology for exposure assessment and obtain an indication of the value-at-risk of banks' loan portfolios related to the most relevant natural disasters in Mongolia.

3.2.1 TRANSMISSION CHANNELS

Mongolia's financial sector can be impacted by climate physical risks via a diverse range of transmission channels. Climate-related extreme events, such as floods, droughts, dzuds, and heat waves, can result in both direct and indirect impacts. Direct impacts may include damage to assets (plants, business facilities, public infrastructure, inventories, among others), agricultural yields, and reduced productivity. Business disruptions may indirectly cascade to other businesses along supply chains as well as the broader economy. These impacts can be transmitted to the financial sector in the form of credit risk and market risk, or other types of risks (e.g., operational risk, liquidity risk, and reputational risk). For example, impacts of severe climate events may cause disruptions of businesses and damages to their assets, translating in firms' decreased revenues and profitability that, in turn, might increase banks' non-performing loans. In addition, direct or indirect impacts on economic growth due to extreme climate events may further affect banks' balance sheets.

Key transmission channels for flood risk (Figure 13): River flooding and flash (or surface) flooding severely affect Mongolia, in particular Ulaanbaatar and its informal settlement districts (account for 68 percent of Ulaanbaatar's population)[41] as well as the northern provinces that have higher precipitation and where the major rivers (Selenge River, Kherlen River, Tuul River) are located.[42] The severe floods in the past five years occurred every year and caused deaths of people and livestock (between 2004 and 2021 over 75,000 livestock were lost because of flooding) as well as destruction of public infrastructure. With insurance penetration being low (0.63 percent in 2022[43]) and only 10.8 percent of herding households being insured as of 2023[44], uncovered losses from floods can be substantial for affected businesses and population. In terms of sectors, floods usually affect housing (or real estate activities), construction, manufacturing, mining, agriculture, and tourism-related services the most.[45] Impacts on

[41] Flood resilience building through local community action in Ger areas of Ulaanbaatar city, Mongolia, UN-HABITAT, 23 November 2021. https://reliefweb.int/report/mongolia/flood-resilience-building-through-local-community-action-ger-areas-ulaanbaatar-city

[42] Country Risk Profile Mongolia. March 2022. Source: https://www.carecprogram.org/uploads/CAREC-Risk-Profiles_Mongolia.pdf

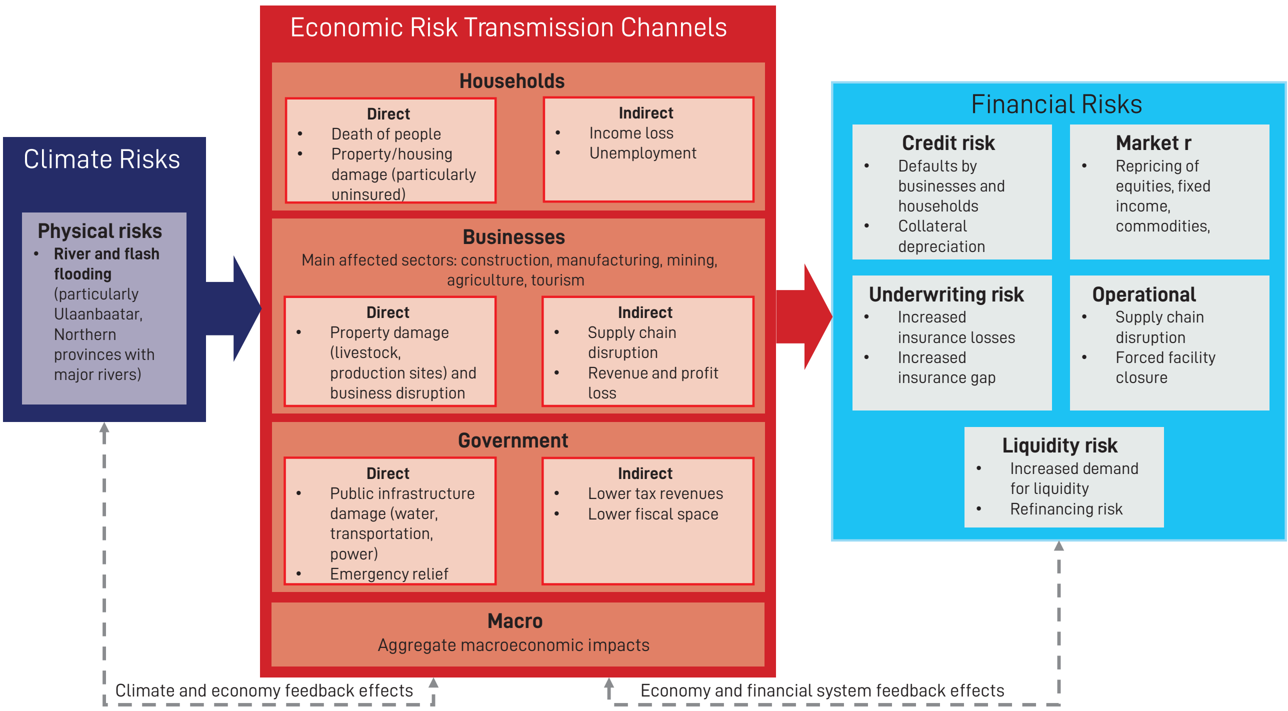
[43] Financial Regulatory Commission.

[44] National Statistical Office of Mongolia.

[45] Pietro Calice, Faruk Miguel. 2021. Climate-Related and Environmental Risks for the Banking Sector in Latin America and the Caribbean. A Preliminary Assessment.

agricultural livelihoods via damages to livestock and crops can affect the ability of farming households and enterprises to service interest or repay loans, posing credit risk to banks, particularly those with large rural or agricultural lending portfolios. Housing and construction sector are affected due to damages to the buildings and construction sites that often serve as collateral for lending. Tourism is impacted due to damages to tourism infrastructure and losses in tourism revenues. Apart from that, floods also impact infrastructure, including water, transportation, and power infrastructure, resulting in large indirect impacts beyond physical damages, with firms' production and performance being affected by disruption to infrastructure services.

Figure 13. Key transmission channels for flood risk

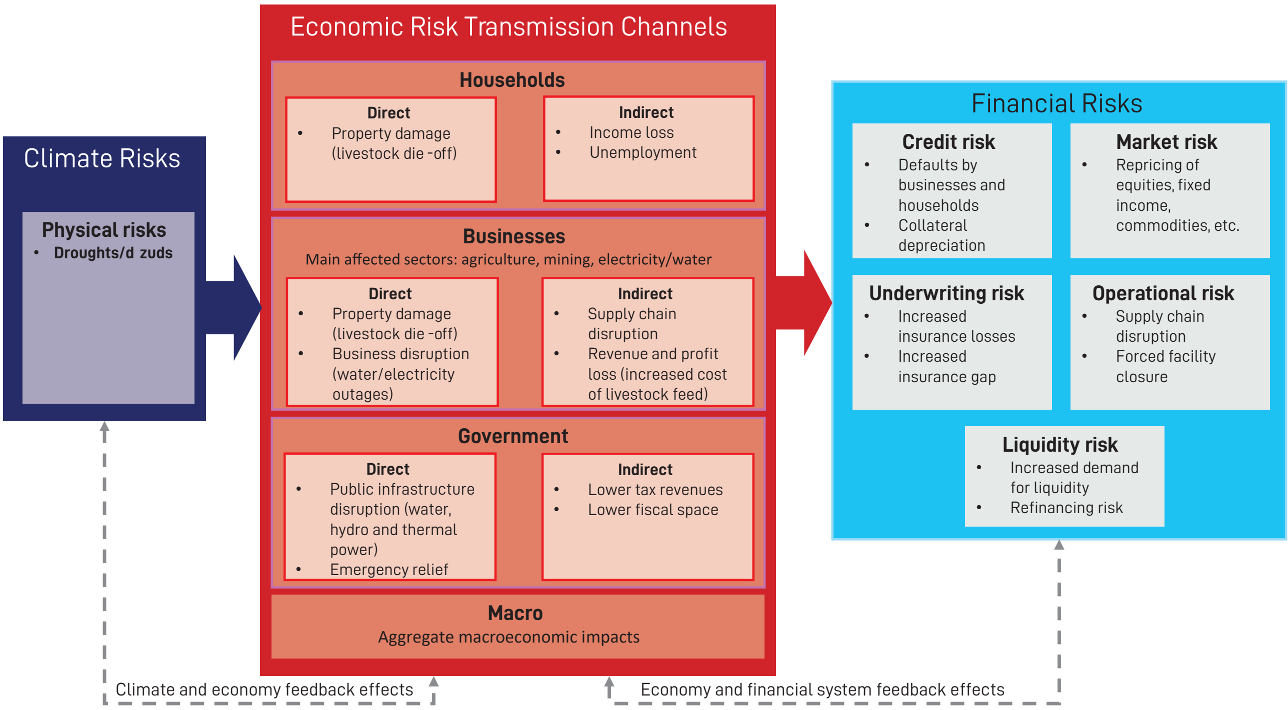


Source: WB staff elaborations based on Network for Greening the Financial System (NGFS) 2021.

Key transmission channels for droughts / dzuds risk (Figure 14): In recent years, severe droughts in Mongolia resulted in livestock die-offs and a massive migration of herders to the capital.[46] Dzuds have also led to vast numbers of livestock dying, and it is one of the main reasons for urban migration mainly in the form of informal settlements at the outskirts of Ulaanbaatar. During dzuds, humanitarian assistance is often provided to cash-strapped herders. Dzuds and droughts particularly affect the agricultural sector (that contributed 12.7 percent to GDP and 24.2 percent to formal employment in 2023, while the majority of workers involved in agriculture are herders in an informal sector)[47] with decreased production/yields, potential losses (or distressed sales) of livestock, and increased costs of livestock feed. This may result in deterioration of banks' portfolios in agricultural sector and personal loans (since majority of herders are borrowing as individuals rather than businesses). In addition, drought and water shortages can affect the electricity generation (hydro and thermal) and mining sectors that rely on water supply (e.g. for cooling) and whose performance might further decrease due to the impact of high temperatures on evapotranspiration.

46 Mongolia. Disaster Management Reference Handbook. May 2022.
47 National Statistics Office of Mongolia.

Figure 14. Key transmission channels for dzuds/drought risk

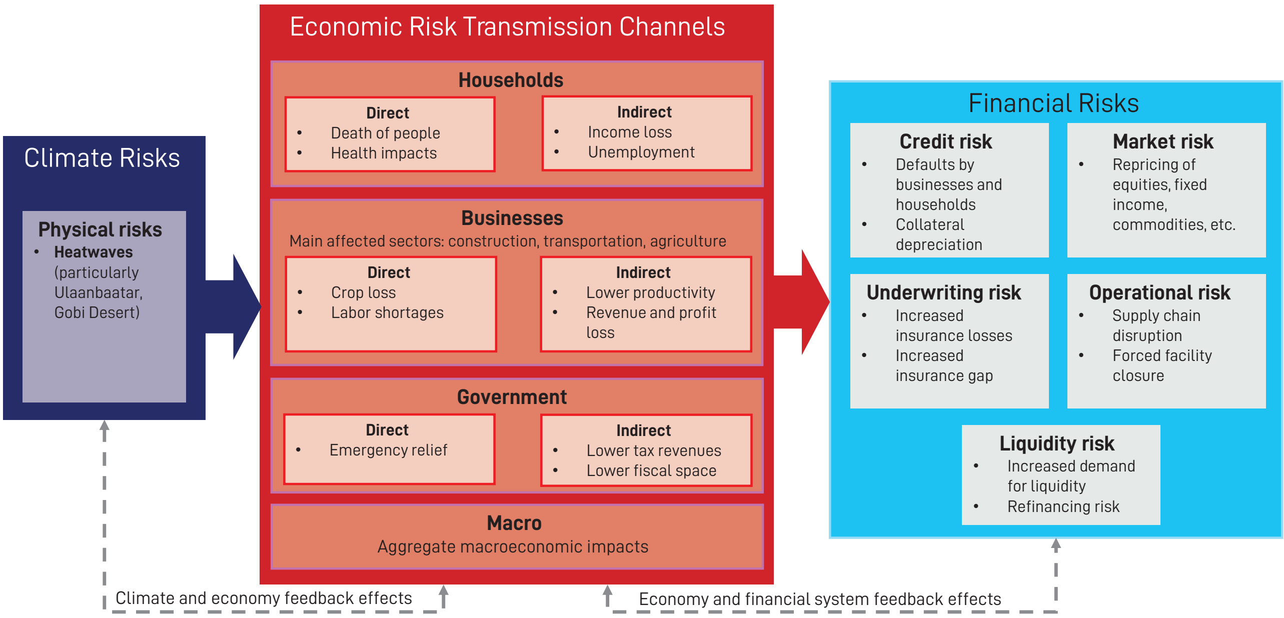


Source: WB staff elaborations based on NGFS 2021.

Key transmission channels for heat wave risk (Figure 15): Mongolia can experience high maximum temperatures, particularly in some lower altitude regions, including in the capital Ulaanbaatar, and around the Gobi Desert. The current median probability of a heat wave is around 2 percent (defined as a period of 3 or more days where the daily temperature is above the long-term 95th percentile of daily mean temperature).[48] Heat can have a broad range of impacts, including impacts on crops, as well as on human health and labor productivity. Decrease in labor productivity due to the impact of heatwaves might affect revenues of firms, with implications for banks' lending to these firms. In urban areas, the heat waves represent the highest risk for laborers working outdoors (particularly, in transportation and construction sectors). In rural areas, outdoor agricultural labor are the most affected ones.

[48] WBG Climate Change Knowledge Portal (CCKP 2020). Mongolia. Climate Data. Projections. https://climateknowledgeportal.worldbank.org/country/mongolia/climate-data-projections

Figure 15. Key transmission channels for heatwave risk



Source: WB staff elaborations based on NGFS 2021.

The above climate-related extreme events might also affect the banking sector via broader macroeconomic impacts.[49] In case of extreme events that affect large part of the country and/or cause major disruptions to key industries and public infrastructure, the whole economy might get affected through, for example, increase in government debt, decrease in GDP, rising inflation, and increasing unemployment, which may in turn translate into impacts to the financial sector (e.g., impacting credit risk). The recent Mongolia CCDR. (2024) for Mongolia estimates impacts up to 20 percent of Mongolian annual GDP to be at risk in an adverse scenario with extreme dzuds, flooding and loss of coal export markets.[50] For example, disruptions in agricultural sector might translate into food price inflation and impact exports of key agricultural commodities. Disruption in public infrastructure caused by floods might require substantial effort from the government to restore the services and repair the disrupted infrastructure, affecting its debt. In the absence of extensive insurance coverage, damages to housing and losses in other assets caused by flood might result in deterioration of financial position of households.

[49] The macroeconomic impacts on banking sector are not accounted for in the exposure analysis presented below.

[50] Mongolia CCDR. World Bank (2024).

3.2.2 METHODOLOGY FOR PHYSICAL RISK EXPOSURE ASSESSMENT

The exposure assessment regarding physical risk of the banking sector relies on two different methodologies, which gives a more rounded picture of risk exposure. The first methodology is a value-at-risk (VaR) approach, which relies on predefined physical risk classifications provided by different data providers. It then assesses the share of the banking sector lending portfolio that is in areas and sectors classified as being at medium-to-high risk. The second methodology relies on expected annual impact (EAI) estimates that have been conducted for Mongolia in the course of the Mongolia CCDR.[51] The EAI approach combines hazard, exposure and vulnerability information on a granular level for different return periods of natural hazard occurrence. Both methodologies are presented in more detail in the following paragraphs.

[51] Mongolia CCDR. World Bank (2024).

To assess the banking sector's exposure to physical risk in Mongolia, we begin by calculating the VaR of banks' loan portfolios concerning the most significant natural disasters. This calculation is based on the geographical and sectoral distribution of the loan portfolios. VaR represents the percentage of the loan portfolio that is exposed to medium-to-high physical risk from specific natural hazards in various provinces, as defined by the data providers listed below. The assessment distinguishes between different types of sectoral lending, focusing only on those sectors identified as the most vulnerable (see subsection 3.2.1 for discussion on transmission channels in different sectors). The following information on natural hazards and the provincial and sectoral distribution of loan portfolios is used for the VaR calculation:

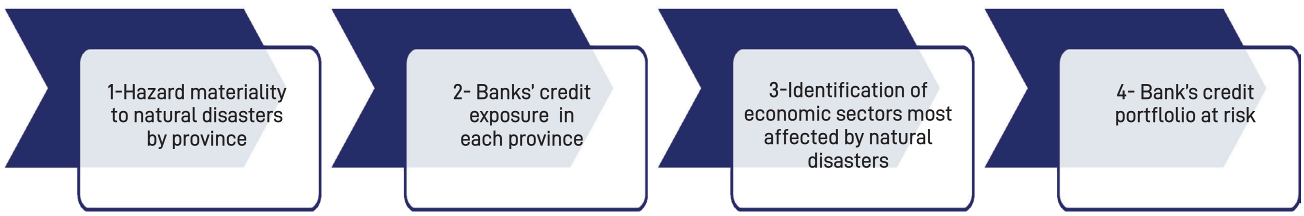
- **Provincial level risk exposure to natural hazards:** For this analysis, we focus on the most frequent natural hazards in Mongolia: floods, heat waves, droughts, and dzuds. We classify provinces (ADM1) as being exposed to medium-to-high physical risk from these natural hazards using data from various providers:
    - **Floods**: The classification of high-to-medium risk is based on the Thinkhazard methodology, which uses simulated flood depth data and expert guidance.
    - **Extreme Heat**: Similarly, the classification for high-to-medium risk is derived from the Thinkhazard methodology, utilizing simulations of long-term temperature variations and expert guidance.
    - **Droughts**: The classification of high-to-medium risk is based on the median standardized precipitation-evapotranspiration index (SPEI) from 2000 to 2024 being below -1. The SPEI is an indicator of drought severity and suggests increasing drought severity in the coming decades under most climate change scenarios.
    - **Dzuds**: The classification of high-to-medium risk is based on the frequency of dzuds from 2000 to 2013, as reported by Du et al. (2018).

- **Sectoral vulnerability to natural hazards:** The sectoral vulnerability in this report, based on an extensive literature review performed by Calice and Miguel (2021) and adjusted for the Mongolian context as specified in subsection 3.2.1. It is categorized as follows:
    - **Floods**: The sectors most affected are assumed to be agriculture, forestry, fishing and hunting, real estate activities, construction, and accommodation and food services.
    - **Extreme Temperatures**: The most vulnerable sectors are assumed to be agriculture, forestry, fishing and hunting, construction, and transport, storage, and communication.
    - **Dzuds and Droughts**: The agriculture, forestry, fishing and hunting sector is assumed to be the most impacted.

The calculation of the VaR for the banking loan portfolio involves four steps, as illustrated using the example of assessing the VaR from dzuds below (see Figure 16). These calculations are performed for the total loan portfolio whereas bank-level analysis has also been conducted but is not presented in this report.

1. **Identify Provinces at Risk**: First, we identify provinces exposed to medium-to-high physical risk from a natural hazard using the data described above. For instance, based on Du et al. (2018), seven provinces—Bayankhongor, Hentii, Töv, Omnogovi, Uvs, Övörkhangai, and Zavkhan—are at medium-to-high risk from dzuds.
2. **Calculate Loan Portfolio Percentage in Risk Areas**: Next, we calculate the percentage of the total lending to the seven provinces exposed to medium-to-high physical risk from dzuds.
3. **Identify Affected Sectors**: Then, we identify the sectors most affected by the natural hazard as indicated above. For dzuds, the agriculture, forestry, fishing, and hunting sector is assumed to be the most affected.
4. **Calculate Loan Portfolio at Risk**: Finally, we calculate the percentage of the loan portfolio in the provinces exposed to medium-to-high physical risk and directed to the most affected sectors. In our example, the VaR is defined as the banks' loan portfolio in agriculture, forestry, fishing, and hunting within the seven provinces exposed to medium-to-high risk from dzuds.

Figure 16. Estimation steps for value-at-risk



Source: Calice and Miguel (2021).

For floods and droughts, we also analyze the bivariate province-level distribution of bank credit share and exposure to natural hazards (i.e. heat map analysis). Risk is determined by three factors: the likelihood and severity of a hazard (hazard), the physical assets exposed to the hazard (exposure), and how vulnerable these assets are (vulnerability), which depends on things like building strength. The EAI is a risk measure that combines these components. Due to the lack of detailed data on physical assets in Mongolia, exposure is defined by population density. Hence, to determine the EAI for floods, this method uses the expected annual impact on the population (as a share of population).[52] For a comprehensive explanation, please refer to GFDRR (2023).[53] For vulnerability to droughts, we use a continuous risk classification as defined by SPEI. By combining both indicators in bivariate maps with provincial bank lending exposure, we can identify provinces with the highest share of credit portfolios and those most exposed to specific climate hazards. The heat maps display a bivariate province-level distribution of bank credit share (y-axis) and exposure to climate hazards—floods and droughts (x-axis). This approach balances provinces that are highly exposed to physical risk but have limited lending with those that are less exposed but have a substantial share of the lending portfolio, where a rare event could still have significant impacts.

3.2.3 BANKING SECTOR EXPOSURES

The exposure of the Mongolian banking sector to risks stemming from floods (river and urban floods) is substantial, while heat, drought and dzud exposure seems to be more contained. To estimate the physical risk exposure for Mongolian banks, we combine information on the sectoral and geographical composition of loan portfolios with the risk profile of each province and sectoral

52 Background research for Mongolia CCDR. World Bank (2024).

53 GFDRR, 2023. Climate and Disaster Risk Screening Tools. https://gfdrr.github.io/CCDR-tools/home.html

economic losses due to floods, extreme heat, droughts and dzuds as described in section 3.2.2 (VaR methodology). The resulting value-at-risk estimates show that around 28 percent of banking sector loan portfolio has medium-to-high exposure to physical risk stemming from floods (Table 1). The majority of portfolio at risk is located in Ulaanbaatar, due to an overall high concentration of the loan portfolio in Ulaanbaatar area that has medium-to-high risks of flooding. The banking sector is less exposed to physical risks stemming from extreme heat, droughts and dzuds, estimated at around 1.5, 1.1 and 2.3 percent, respectively, due to a low concentration of loan portfolios in areas having medium-to-high risks of these extreme climate conditions as well as generally low exposure to affected sectors, such as agriculture, forestry, fishing and hunting.

Table 1. Share of bank credit portfolio exposed to selected medium-to-high physical risks, end-2022 (% of total lending)

Province	River flood	Urban flood	Extreme heat	Dzud	Drought
Arxangai	0.2	0.2	.	.	.
Bayan-Olgii	0.2	0.2	.	.	.
Bayankhongor	0.9	.	0.5	0.2	0.2
Bulgan	0.2	0.2	.	.	.
Darkhan-Uul	0.3	0.3	.	.	.
Dornod	0.3	0.3	0.2	.	0.1
Dornogovi	0.3	.	0.2	.	0.1
Dundgovi	.	.	0.1	.	0.1
Govi-Altai	.	.	0.1	.	0.1
Govisumber	.	.	.	.	0.01
Hentii	0.2	0.2	.	0.1	0.1
Khovd	0.3	0.3	.	.	.
Khovsgol	0.3	0.3	.	.	.
Omnogovi	0.3	.	0.2	0.1	0.1
Orkhon	.	0.8	.	.	.
Ovorkhangai	0.4	.	0.2	0.1	0.1
Selenge	0.4	0.4	.	.	.
Sukhbaatar	0.2	.	.	.	0.1
To'v	0.4	0.4	.	0.3	0.3
Ulaanbaatar	22.5	22.5	.	.	1.0
Uvs	0.3	.	.	0.2	.
Zavkhan	0.2	0.2	.	0.1	.
Total	**27.9**	**26.4**	**1.5**	**1.1**	**2.3**

Source: WB staff analysis based on data provided by Bank of Mongolia. Climate-related data comes from ThinkHazard.org and Background research for Mongolia CCDR (2024). Note: See subsection 3.2.2 for details on the methodology.

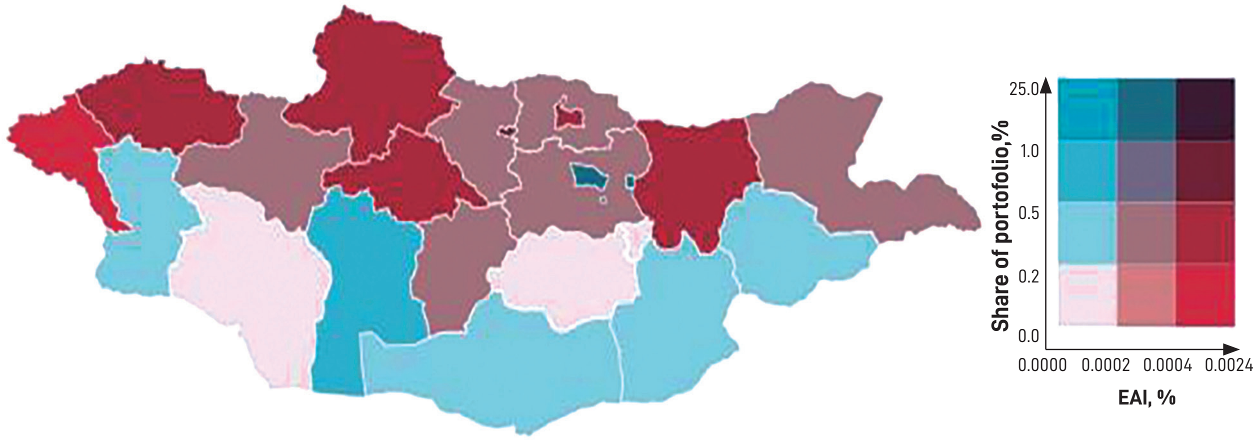
The additional heat map analysis[54] confirms the high vulnerability of the banking sector loan portfolio to physical risks stemming from floods, particularly in Ulaanbaatar. Figures 17 (a-b) show a bivariate province-level distribution of share of bank credit (y-axis) and exposures to climate hazards – floods and droughts (x-axis). Provinces that both have the highest share of credit portfolio and are the most exposed to the climate hazards have the highest vulnerability to physical risks. Figure 17a suggests that provinces in the north of the country have higher relative EAI of floods in terms of population loss. With the exception of Ulaanbaatar, these provinces however have low share in credit portfolio of the

[54] See subsection 3.2.2 for details on the methodology.

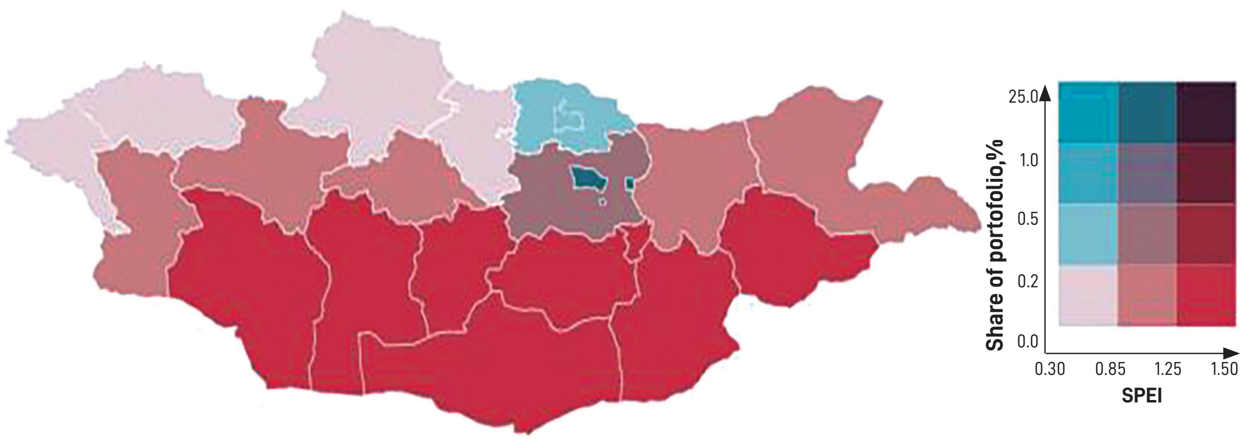
banks (less than 1 percent) to have a substantial impact on the banking sector. At the same time, Ulaanbaatar is particularly exposed to physical risks stemming from floods due to concentration of loan portfolio in the province combined with medium relative EAI of floods. For droughts (Figure 17b), provinces in the south the country are the most exposed. However, their share in total credit portfolio is relatively small. At the same time, Ulaanbaatar area that has the largest share of loan portfolio is less affected by the risk of severe droughts.

Figure 17. Bivariate province-level distribution of share of bank credit in affected sectors and

(A) relative population EAI (%) for flooding

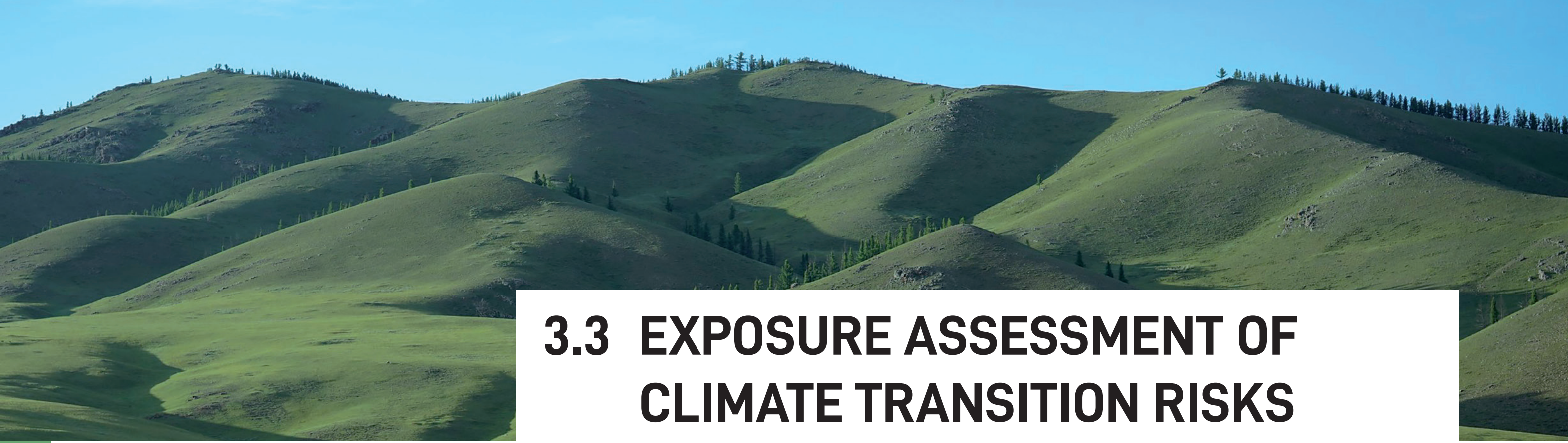


(B) drought index – SPEI



Source: WB staff analysis based on the data provided by Bank of Mongolia. Climate-related data comes from Background research for Mongolia CCDR (2024). Note: The SPEI is reversed here, meaning that a higher SPEI indicates higher probability of droughts.

Overall, natural disasters pose a non-negligible risk to banks' lending portfolios in Mongolia, requiring continued monitoring and supervision. Physical risk to banks' lending portfolio mostly stems from floods, while some banks' portfolios are also affected by other natural disasters such as dzuds, droughts, and heat waves. With climate change, occurrence and severity of the above events is expected to intensify, posing additional risks to stability of the banking sector. The banking sector should continue working on identification, assessment, and mitigation of the impacts of climate-related events on their portfolios. Regulatory guidance and cross-institutional collaboration will be essential to enhance the capacity of financial institutions to manage these risks effectively.



3.3 EXPOSURE ASSESSMENT OF CLIMATE TRANSITION RISKS

Transition risks are defined as risks that materialize as economies move towards a low carbon economy. An evolution to this new regime generally entails risks and carries costs, particularly if not managed orderly.[55] Bank transition risk analysis monitors how resilient financial institutions are to such risks. Particularly sudden and unexpected climate policies can significantly affect industries and the environment in which they operate. The most common transition risk generally considered in the academic literature and policy discourse is the implementation of carbon taxes. Additional costs to pay for carbon taxes test the resilience of non- financial corporations. The higher the GHG emissions a corporation generates in the deployment of its activities, the more that corporation is exposed to additional financial costs. Financial institutions are indirectly exposed to these incremental costs that non-financial corporations bear. A negative shock to the expense profile of companies, stemming from transition risks such as policy changes, shifts in market demand (in Mongolia for instance from a decline in coal exports to China), and technological disruptions, can significantly impact firms' cash flows, capital expenditures (CapEx), and overall debt service ability. These risks not only increase operational costs but also alter revenue streams and disrupt established business models, thereby hampering firms' ability to repay their loans. Consequently, these additional burdens translate into larger probabilities of default, directly affecting banks' credit risk. The imposition of carbon taxes, and other policies governments implement can affect market risk as well as operational risk (including litigation risk) and liquidity risk. Implementation of a carbon taxation mechanism is in its initial phase in Mongolia. A disorderly low-carbon transition could worsen the vulnerability of herders and coal miners, who will face difficulties finding new jobs as the focus shifts to sustainable livestock methods and reduces coal reliance.

[55] NGFS First Progress Report, October 2018.

3.3.1. TRANSMISSION CHANNELS

Direct transmission channels play crucial roles in the propagation of climate transition risks. Such direct channels can impact both, households, and firms, reducing their profits and creditworthiness which in turn increases funding costs and impacts their debt servicing capacity. For instance, a delayed and disorderly transition may lead to a surge in fossil fuel and electricity costs (e.g., via higher carbon prices) which will significantly alter both household and corporate energy expenditures and consumption patterns. A timely transition to renewable energy could help mitigate rising energy costs, while any delay in adopting renewable alternatives may fail to achieve this. Energy-intensive sectors could be particularly impacted, with mining, given its strategic importance to Mongolia, serving as a prime example.

Indirect channels include shifts in government debt, GDP impacts, labor markets, and broader socioeconomic factors. For example, the transition to a low-carbon economy could cause unemployment spikes and reduce household wealth as the adjustment takes place. Mongolia's dependency on revenues from fossil fuel exports (24 percent of the country's exports are coal and oil) may affect its fiscal capacity moving forward, increasing credit risk for banks as miners struggle with less demand and lower prices. The Financial Stability Board[56] highlights that transition risks can also cross international borders through real and financial channels, with policy measures in another country, affecting the domestic economy (e.g. China's coal demand affecting the Mongolian economy).

3.3.2 METHODOLOGY FOR TRANSITION RISK EXPOSURE ASSESSMENT

In order to tackle the existing uncertainties surrounding the evolving transition risk, this analysis uses different methods to assess Mongolia's exposure to climate transition risks. Similar to physical risk, evaluating transition risk is challenging due to the uncertainty associated climate policy ambition and implementation. By taking a comprehensive view to various data sources, this analysis seeks to shed light on vulnerabilities and offer insights that could inform further examination by Mongolian supervisory and regulatory authorities.

Emission intensities, defined as the GHG emissions per million dollars of revenue, are one way of measuring transition risks and the sensitivity of firms and sectors to carbon taxation. Highly dependent on the sector of activity**,** companies operating in high emitting sectors like mining, fossil fuel refining or transportation generate much larger emissions than those operating in other sectors of the economy (e.g. healthcare, retail or real estate) once accounting for the size of the firm. High-emission sectors are particularly at risk if lower-emission production alternatives do not exist or are expensive and as such face difficulties to decarbonize. Other currently high-emission sectors, such as the electricity sector in Mongolia, have competitive low-carbon alternatives at hand but would nevertheless require substantial investments.[57] Not only relative to the size of the firm, but in absolute terms, those high-emission sectors represent the largest GHG generators in the economy.

In the absence of specific emission data for Mongolian corporations to which banks are exposed, the sectorial breakdown of the exposures is a good proxy and can be mapped to the emission figures reported by other international corporations operating in the same sectors. With that approach in mind, this paper maps out the sectoral breakdown provided by the BoM with the emission intensity figures reported by international corporations working in similar sectors to those reported by BoM based on different data sources (Figure 18a). We align the ISIC with firm-specific Scope 1 and 2 GHG emission intensities from the 2021 Refinitiv Eikon database, encompassing 5,250 companies worldwide. Second, we look at industry-level embodied emission intensity from the 2021 OECD TeCO2 dataset, predominantly covering OECD countries. And third, we use the Global Trade Analysis Project (GTAP) dataset that contains country specific emission intensities. This three-pronged approach aims to discern the disparities across data sources to build a robust picture of the data uncertainty and the sensitive sectors to transition risks. This approach selects the top 25 percent of sectors with the highest emission intensity sector and classifies them as transition risk sensitive sectors. See Annex A.3 for more details on the Transition Risk Methodology.

Overview of Transition Risk Methodology:

1. **Measure Emission Intensities**: Uses emission intensities, defined as GHG emissions per million of Mongolian Tughrik of revenue, to assess transition risks and sensitivity to climate policies across firms and sectors.

[56] https://www.fsb.org/2020/11/the-implications-of-climate-change-for-financial-stability/

[57] IRENA 2024. Decarbonising hard-to-abate sectors with renewables: Perspectives for the G7.

2. **Identify High-Emission Sectors**: Establishes a threshold to classify sectors with the highest emission intensities. This threshold is set as the top 25 percent of sectors with the highest emission intensity and classify them as transition risk-sensitive sectors.
3. **Map Sectoral Breakdown and align data sources**: In the absence of specific emission data for Mongolian corporations, it uses the sectoral breakdown of bank exposures as a proxy. It maps the sectoral breakdown provided by BoM with emission intensity figures reported by international corporations operating in similar sectors.
4. **Analyze Data Disparities**: Uses the three-pronged approach to discern disparities across data sources and build a more robust picture of data uncertainty and sensitive sectors to transition risks.

3.3.3. BANKING SECTOR EXPOSURES

The three alternative methods used to identify the share of exposures that are susceptible to climate transition risks for Mongolian banks place the share of total lending to those sectors in a range of 14-20 percent in 2022 (see Figure 18a). While OECD, Eikon, and GTAP data sources are largely consistent, it is worth noting that not all sectors currently have emission data in the OECD and Eikon datasets. As such, Figure 19a shows there are between 19 to 38 percent of exposures that cannot be classified and only the GTAP data source contains emission data for all sectors. Most of the differences across data sources are imputable to the classification of three sectors: construction, mining and quarrying and manufacturing. Depending on the source, they are either classified as transition sensitive sectors or not. The reason why there is no common convergence across data sources is that inside those sectors there are numerous sub-sectors some of which are indisputably at risk, others are not. With more granularity, data sources are likely to converge to more consistent results.

Over the last years, exposure to transition sensitive sectors has remained relatively stable in Mongolia.[58] In the period between 2018 and 2022 the transition sensitive share within Mongolian banks' portfolio has remained broadly stable, indicating no substantial portfolio shifts from high-carbon to less-carbon intense sectors and activities. Metrics point to around 20 percent exposure to those sectors.

Mongolian banks do show some heterogeneity in the emission intensity of their loan portfolio when analyzing the exposures in greater detail. Beyond categorizing industrial sectors by their sensitivity to transition risks, a more refined analysis can elucidate the true disparities in banks portfolio. Figure 18b below shows the median emission intensity of all the exposures of the banks in the sample based on the industry in which those debtors operate, weighted by the size of the exposure. For instance, according to GTAP data, the agriculture sector has an average emission intensity of 281 (the result of dividing tons of GHG-equivalent to USD million of sales), on the other hand, the energy sector in Mongolia has an average emission intensity of 14,267. As such, the average emission intensity of the loan portfolio will be higher the larger the exposure is to the energy sector, compared to the agriculture sector.

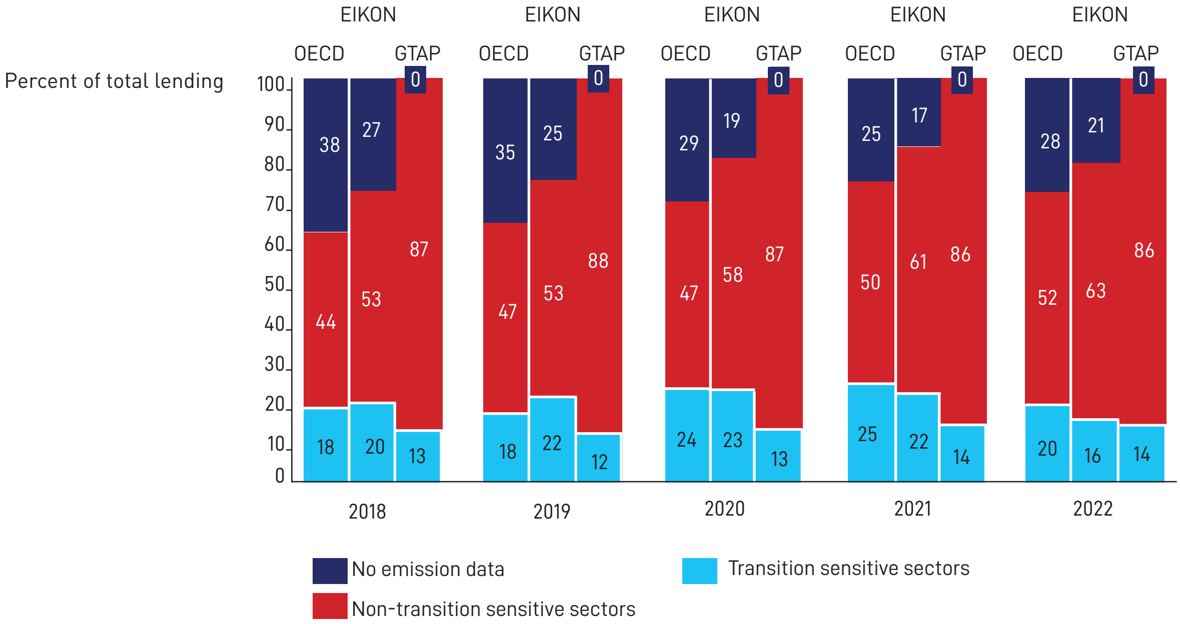
[58] Transition sensitive sectors are defined as those that are particularly exposed to transition risks measured as having high emission intensity values. Examples of sensitive sectors are electricity generation or transport.

The analysis above allows us to construct an average emission intensity of the whole bank portfolio and compare that metric across banks (Figure 18b). Banks with a higher number will, thus, be more susceptible to climate transition risks. What this analysis shows is that all Mongolian banks in the sample have an emission intensity index between around 600 and 1,200 which holds the implication that imposition of carbon taxes would affect banks heterogeneously, albeit not that significantly (other countries show larger disparity across banks which results from more heterogeneous loan portfolios).[59] One last remarkable insight is that the overall median values for that index seem to trend slightly downwards over the last 5 years while the standard deviation of the different banks tends to narrow over time. That seems to suggest that banks are converging to a similar level of climate transition risk compared to peers.

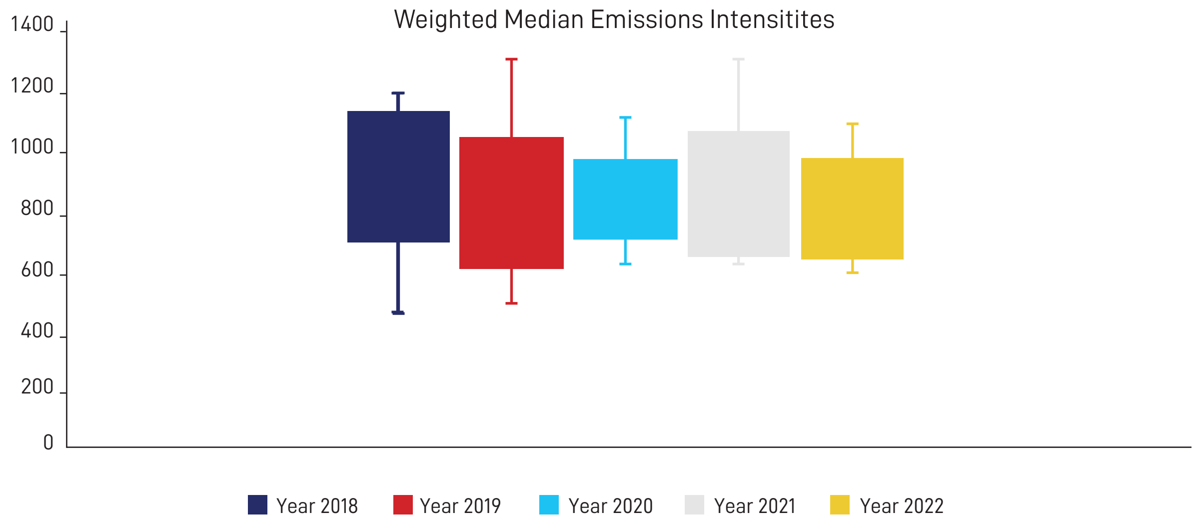
59 To put these figures into context, according to Eikon, that collects the average emission intensities of global firms, the average emission intensity of agriculture firms is around 600, while the average emission of the accommodation and food services sector is around 1,100.

Figure 18. Transition Risks in the Banking Sector

a. Aggregate Mongolian banking sector exposure to transition sensitive sectors based on different methodologies



b. Weighted-median Emission Intensities of banks' portfolio based on industry of exposures



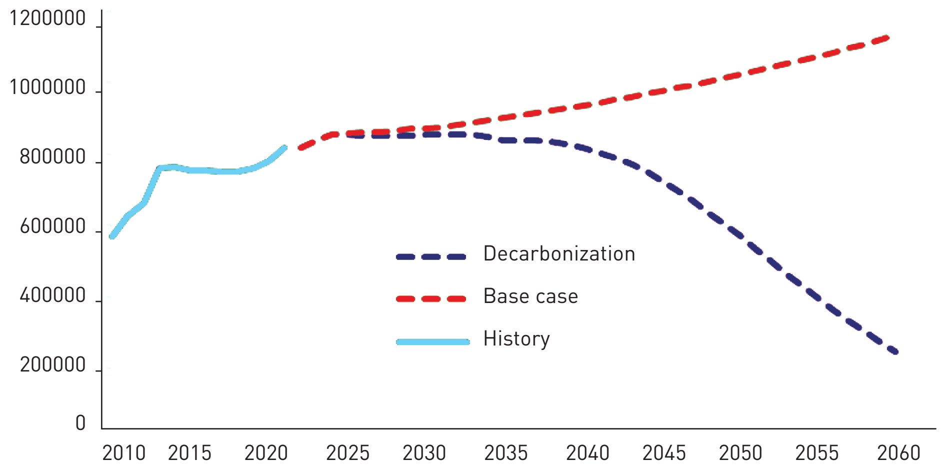
Sources: WB staff analysis based on data from Bank of Mongolia, Thomson Reuters Eikon, GTAP, OECD.

Additionally to domestic climate policies, banks in Mongolia could be exposed to foreign-induced transition risks, such as by decarbonization efforts in China. World Bank analysis[60] shows how coal demand in Mongolia could drastically drop as decarbonization could reduce coal use in Chinese steel production by 45 percent (Figure 19). This situation could affect the mining industry significantly, given that over 90 percent of Mongolia's exports of coal and copper are destined for China. If this trend continues, Mongolia's coal production could exceed its long-term capacity needs by 30 percent. While the provided data granularity does not allow for a detailed assessment of the banking sector exposure to coal-related sectors that might be affected by such as scenario (e.g. Mining), the high

[60] See Mongolia CCDR. World Bank (2024) for details.

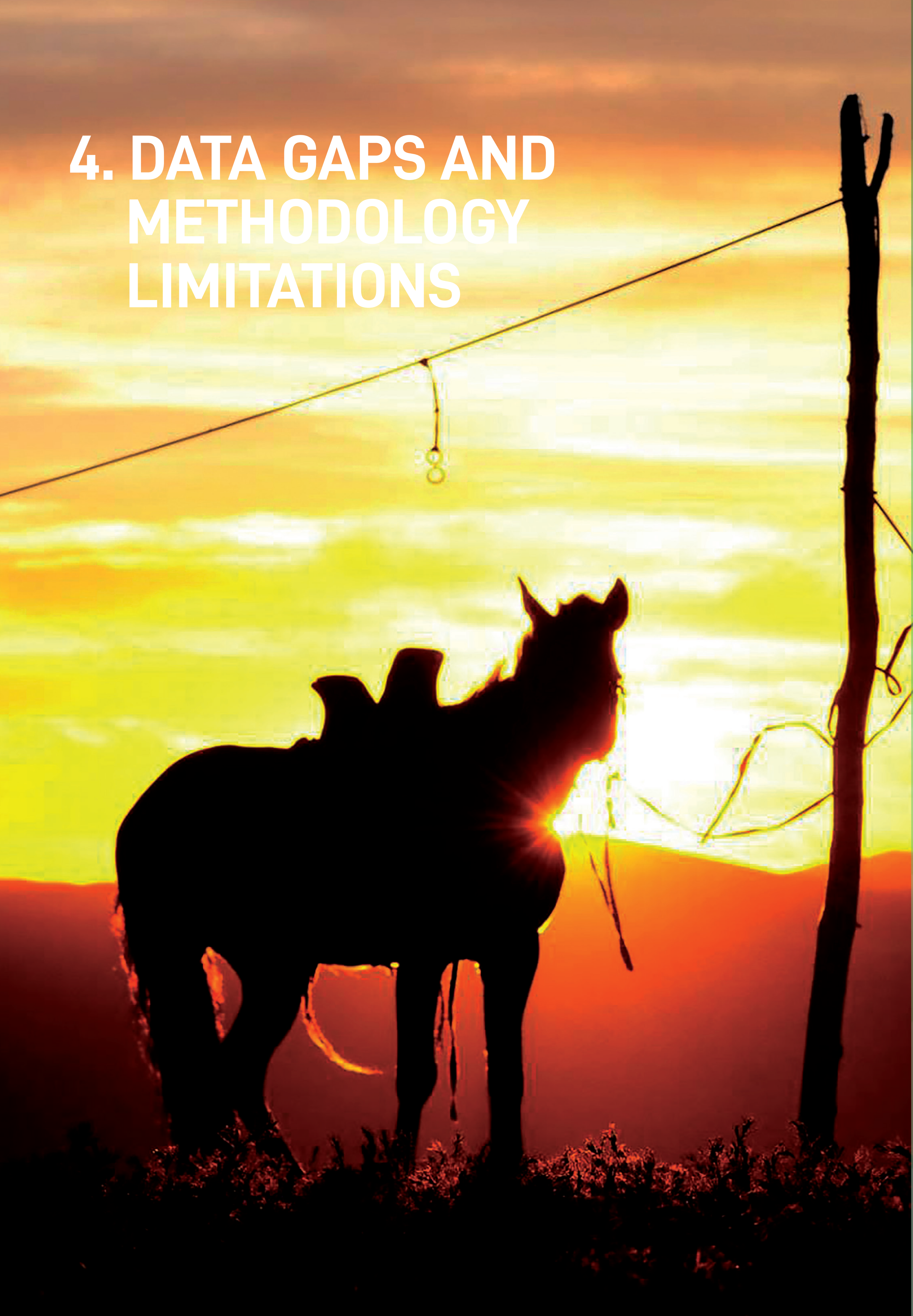
share of coal exports to GDP (Figure 10) suggest that direct and indirect impacts for the banking sector could be substantial.

Figure 19. Coal demand projections (m tonnes)



Sources: Mongolia CCDR. World Bank (2024) calculations based on the E3ME-FTT model.

4. DATA GAPS AND METHODOLOGY LIMITATIONS



The exposure analysis in this report may be biased due to the high spatial and sectoral aggregation of the loan portfolio data. The main limitations of the analysis stem from the high level of aggregation in the bank-level data collected by BoM. Lending data is only available at the provincial level for geographical distribution and at the ISIC sections level for sectoral distribution. This level of aggregation prevents precise matching of the data with the geographic distribution of climate hazards and limits the ability to evaluate sectoral impacts in a more detailed manner. Specifically, the following data limitations were identified:

- **Geographical aggregation of financial data:** The available loan portfolio data is aggregated at the provincial level (ADM1). This high level of spatial aggregation hinders precise identification of the geographic distribution of climate hazards. For instance, background research for the Mongolia CCDR indicates that different districts within Ulaanbaatar vary significantly in their expected annual impact of floods due to differences in build-up area density, population density, and water extent.

Therefore, an analysis using more granular loan portfolio data, ideally at the district level (ADM2) or even more detailed street level, would provide deeper insights into the exposure and vulnerability of bank loan portfolios to physical risks.

- **Location of financial assets:** Geographical identification of loan data is based on the place of registration of the enterprise or the address of the individual, rather than the location of their assets and operations. However, in the event of a climate hazard, the impact on a bank's portfolio will be due to damage to physical assets. For example, if an enterprise is registered in Ulaanbaatar but has factories or other physical assets in other provinces, its borrowing will be recorded as part of the Ulaanbaatar loan portfolio. If a climate hazard, such as a flood, affects other provinces but not Ulaanbaatar, and the enterprise's physical assets lose value as a result, the analysis in this report will not capture the potential impact on the bank's loan portfolio.

Therefore, it is crucial to collect information on the actual location of financial assets.

- **Sectoral aggregation of financial data:** The sectoral disaggregation of loan portfolio data is based on ISIC sections, which does not allow for sufficiently detailed analysis of physical and transition risk at a sectoral level. For instance, the construction sector includes a wide range of activities such as building construction, civil engineering, and specialized construction activities like demolition, plumbing, and electrical installation. Floods will have a particularly severe impact on civil engineering and new building construction, while other activities may be less affected. This also applies to transition risk. For example, the mining and quarrying sector encompasses various sub-activities, some of which may benefit from the low-carbon transition (e.g., copper), while others are likely to incur significant costs and potential losses (e.g., coal). However, the current level of disaggregation in the loan portfolio data does not capture these nuances.

Therefore, disaggregating the data at least to the ISIC group level would provide additional insights. Additionally, BoM might consider collecting loan data in a more country-specific disaggregation, such as 'herder loans,' whose performance is particularly dependent on natural hazards.

- **Financial data frequency:** The currently collected data is at a quarterly frequency for the period of 2018-2021, and monthly frequency for the period starting 2022 onwards. The short time span does not allow to estimate the historical impacts of large climate events (e.g., drought of 2017, flood of 2023, etc.) on banking sector portfolios. In addition, monthly frequency is advisable for stress-testing exercise to observe the dynamics of loan portfolio performance after the natural disasters.

Therefore, BoM might consider mandating banks to collect longer time series of data at a monthly frequency.

- **Financial risk indicators:** Bank financial risk indicators at the corresponding sectoral level are crucial for climate stress testing because they provide a detailed understanding of the financial health and resilience of borrowers within specific sectors. This granularity allows to estimate and calibrate historical relationships between economic variables (e.g. sectoral value added) and bank risk indicators, in order to assess forward-looking scenario-based impacts.

While the scenario-based analysis is not part of this assessment, collecting sectoral data on financial risk indicators corresponding at least to the ISIC group level would be necessary for climate stress-testing.

- **Other relevant financial data:** Insurance data helps assess the extent to which borrowers and their assets are protected against climate-related events, providing insights into potential financial losses and recovery capabilities. Flood risk insurance, for example, indicates the level of preparedness and risk mitigation in flood-prone areas. Additionally, data on financial inclusion aspects, such as access to financial services and credit, highlights the resilience of vulnerable populations and sectors. This information is essential for understanding the broader socio-economic impacts of climate risks and ensuring that stress testing models accurately reflect the diverse financial landscapes and potential disparities in risk exposure and recovery capacity.

While the above analysis is not part of this assessment, working with the insurance sector and potentially other government institutions to collect such information and data would provide additional insights for climate stress-testing.

- **Information on the vulnerability of physical assets to climate hazards, such as flood zones and building resilience:** Such information is crucial for climate stress testing because it directly impacts the potential severity and frequency of financial losses. Understanding asset vulnerability allows banks to identify which assets are most at risk from specific climate events, such as floods or extreme temperatures. This data helps assess the potential damage and associated costs, enabling more accurate modeling of financial impacts under various climate scenarios. This data is often available either by insurance companies (proprietary) or by government agencies and ministries. If not available, publicly available proxies could be used, however, usually being less context specific.

While this data was not available for this assessment, engaging and working with government institutions or insurance companies on obtaining the data would be important for climate stress-testing.

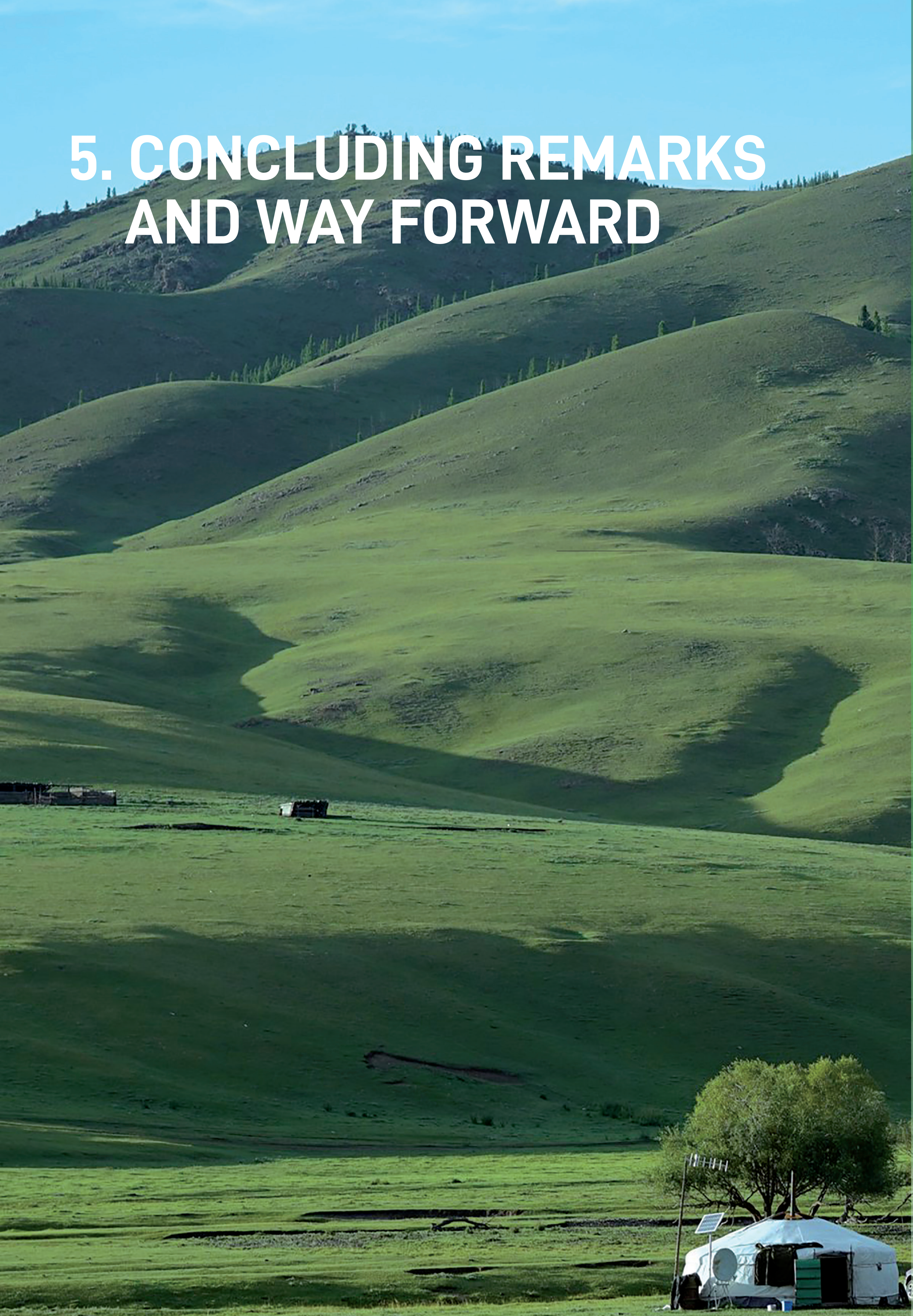
To further refine the exposure assessment and prepare for stress testing, BoM can consider improving banking-level data collection by increasing the sectoral and geographical granularity. BoM should work with banks on addressing remaining data gaps that limit the ability to measure climate risk exposures and run climate stress tests and scenario analysis exercises as described above. As such, BoM may consider the following: (i) issue relevant policies and regulations on disclosure and reporting requirements for banks to address the identified data gaps (e.g. by following ISSB S1 and S2 disclosure guidelines); (ii) provide data templates for supervisory exercises to help improve the standardization of data across institutions; (iii) provide capacity building to banks to help them build institutional expertise on climate-related data collection and climate risk financial analysis; and (iv) engage with banks to modify their current systems (IT, governance, operational processes, etc.) that will help address identified data collection gaps and prepare them for subsequent climate risk financial analysis and modelling.

In addition to the identified financial sector data gaps, it is also important to address climate data gaps. Analysis in this report uses highly aggregated data on natural hazards that is available in a public domain. To refine the analysis and prepare for climate stress-testing exercise, climate data collection needs to be further enhanced. First, it is essential to obtain information on damages to assets and associated losses incurred by financial institutions due to extreme weather events. This includes identification of physical assets owned by borrowers, their geographical location, and historical losses in value caused by natural hazards. Second, geographically disaggregated data on physical risks and vulnerabilities stemming from natural hazards (such as floods, dzuds, droughts, etc.) and their projections, including severity, frequency and probability distribution, will be essential to deepen the analysis and conduct stress testing exercise. It is worth mentioning that scenarios over long time frames (often spanning over several decades) are subject to uncertainties and therefore projections to climate data should ideally consider several alternative scenarios. Finally, it is also important to account for adaptation and mitigation strategies implemented by borrowers, including protection of assets by insurance, to more precisely evaluate sensitivity of banks' balance sheets to climate hazards.[61] BoM should consider engaging with relevant ministries, climate scientists, academic and research institutions, and data providers to initiate climate data collection that can be used for climate stress testing. The collected data should also be provided to banks to conduct their analysis.

The exposure analysis can be further refined to address some of its methodological uncertainties and limitations. Apart from data limitations, the exposure analysis presented in this report is based on World Bank methodologies used across client countries and Mongolia context in identification of the impact of climate hazards on particular sectors. A more refined approach will include identification of impacted sectors through the historical analysis. The historical analysis will require historical financial data to identify impact of large natural hazards on banks' Non-Performing Loans (NPLs) and capital. Additionally, the analysis does not consider macroeconomic impacts of the climate hazards, spillover effects between sectors, as well as combination of transition and physical risks that would require more sophisticated modeling. Further considerations that could be incorporated into refinements of the exposure analysis include the role of insurance and potential adaptation measures that may help reduce risk to the banking sector.

[61] United Nations Environment Programme. 2024. Navigating Data Challenges: A Guide to Data Collection for Climate Stress Testing, Geneva.

5. CONCLUDING REMARKS AND WAY FORWARD



The preliminary assessment of climate-related risks in Mongolian banking sector highlights significant exposures of the sector to physical and transition risks. The risk might further manifest themselves as the frequency and severity of extreme weather events is expected to increase with climate change which can potentially lead to significant stress for the Mongolian banking sector. Similarly, economic adjustment costs during the transition towards a greener economy will affect the Mongolian banking sector. The main findings are summarized below:

- **Physical risks.** The most severe physical risks for the banking sector in Mongolia stem from floods (around 28 percent of total portfolio is exposed). A significant share of banks' portfolios (>70 percent) is located in Ulaanbaatar that is highly affected by floods that cause damages and disruptions in business activities, provision of essential services, as well as major infrastructure. With predicted increase in frequency and intensity of extreme rainfall events by 2090s, economic losses from these events will likely increase, affecting borrowers' collateral and debt servicing capacity. The exposure of the banking sector to other natural hazards, such as droughts and dzuds, is limited (1-3 percent of total portfolio), particularly given that only a small share of the banking sector loans goes to the agriculture, forestry, fishing and hunting sector (around 4 percent).[62] Increase in frequency and severity of dzuds and droughts causes migration of the rural population to Ulaanbaatar and can cause changes in structure of economic activities in the future. The macroeconomic impacts (including, for example, possible change in food prices) of these changes are however not accounted for in this analysis.

- **Transition risk.** Transition risks are not negligible in Mongolia. Banks show sizeable exposures to industrial sectors that are sensitive to changes in climate change policy adjustments like carbon taxation. At least 14 percent of banking system exposures are classified as lending to these risky sectors in 2022.[63] In particular, manufacturing and mining are two sectors to monitor in Mongolia with a combined share of 12 percent of all loans. Unfortunately, lack of more granular data impedes a more precise analysis of transition risks. For instance, manufacturing or energy, are very broad sectors, the subsectors of which stand to either win or lose from the transition to a low carbon economy. While most energy generation in Mongolia is powered by fossil fuels, any exposure to renewables cannot currently be disentangled from the rest of the energy sector. Additionally, foreign-induced transition risks, such as China's decarbonization efforts, could strongly reduce coal demand, impacting Mongolia's mining industry and potentially leading to stranded assets.

Going forward in proceeding with a comprehensive climate risk analysis, BoM might consider a number of actions. As described in Section 4, BoM should work with banks on enhancing financial data collection, aiming to improve geographical and sectoral data granularity. In addition, establishing detailed climate data collection in collaboration with other ministries, academia and data providers will be important to proceed with a more sophisticated analysis.

The results of the exposure analysis can be used to inform the design of physical and transition risk scenarios for stress testing. The analysis of physical financial risk exposure reveals that the most significant risks for Mongolia are likely to arise from pluvial and fluvial flooding. This is particularly concerning for the

[62] Additional bank-level analysis indicated varying degrees of exposure to physical risks due to differences in the sectoral and geographical composition of their portfolios. For confidentiality reasons, this bank-level analysis cannot be included in this report.

[63] Additional bank-level analysis indicated limited heterogeneity of exposure to transition risks across banks. For confidentiality reasons, this bank-level analysis cannot be included in this report.

Ulaanbaatar area, where the majority of banking sector assets are concentrated. However, it is important to note that this concentration may be influenced by the registration of loans in Ulaanbaatar, even though the economic activities occur in other regions of the country. Therefore, it is also pertinent to consider scenarios involving dzuds and droughts, which can have severe impacts on herders and the livestock sector, necessitating a dedicated scenario to thoroughly assess these effects. Regarding transition risks, it is advisable to consider the consequences of a disorderly climate policy, especially for the energy, transport, and agricultural sectors, due to their substantial share of emissions and high emission intensity. Additionally, a scenario should account for a potential decline in coal demand from China, given the strong dependence of Mongolia's mining sector on this demand.

The next step in the analysis should be to provide a quantification of the materiality of these exposures as risks to the banking sector in terms of their impacts on capital adequacy, non-performing loans, and other financial risk-related indicators. For the physical risk, there will be a need to estimate the forward-looking hazard damages to the banks' balance sheets, including from tail events, using catastrophe model outputs, historical extreme events, and climate models. For transition risks, a more granular sectoral disaggregation will allow for a more precise evaluation of transition risks and potentially, some analysis of carbon taxation impacts. The effectiveness of scenario analysis hinges on the careful design of scenarios, which should be informed by insights gained from exposure analysis.

Climate change is causing physical and transition risks to become more interconnected, increasing the likelihood of their simultaneous occurrence due to insufficient global climate action, as recognized by the NGFS. Compound scenarios, where macroeconomic impacts of physical risks are amplified by transition risks, can lead to non-linear escalation of effects. This has been demonstrated in the Philippines and Mexico, where combined natural disasters and economic shocks resulted in disproportionately greater impacts. In Mongolia, certain regions and sectors are already vulnerable to both physical and transition risks, potentially exacerbating risks for the banking sector, making it crucial to consider scenarios that encompass both risks simultaneously. For instance, recent World Bank analysis suggests that the risks to Mongolia are substantial and can put up to 20 percent of Mongolia's GDP is at risk under a plausible worst-case combined transition and physical risk scenario.[64]

BoM might consider promoting capacity building in the banking sector to understand and manage climate-related risks. Capacity building programs will raise awareness across the financial sector on the potential risks and opportunities created by climate change and encourage institutions to align their activities with climate goals. In addition, encouraging disclosures and enhancing reporting requirements by banks will be important to proceed with climate stress-testing and eventual integration of climate risk in bank supervision.

Overcoming existing data limitation and developing internal modeling capability will support the ambitious objective of conducting a climate stress test in Mongolia. The modalities of such stress test need to be discussed as climate stress tests are a novel field with multiple angles. Most authorities target either top-down or bottom-up climate stress tests, or a combination of the two. Financial impact of the climate change on the banking sector might be evaluated bank-by-bank or system-wide, including projected impacts of natural hazards on banks' capital and asset quality through different transmission channels, accounting for direct and indirect macro- and borrower-level shocks.

[64] See Mongolia CCDR. World Bank(2024) for details.

A. ANNEXES

A.1 EXTREME EVENTS IN MONGOLIA, 2018-MID-2023

Disaster	Affected provinces	Time period
Storm	Naranbulag, Zavkhan, Ulgii, Umnugovi, Sagil, Tarialan, Ulaangom, Khovd (Uvs province), Ulgii, Altantsugts (Bayan-Ulgii), Darvi, Tsetseg, Munkhkhairkhan, Must, Jargalant, Chandmani, Zereg, Erdeneburen (Khovd), Bugat, Tonkhil, Tugrug, Khukhmorit (Govi-Altai)	2018/11/25-2018/11/28
	Khentii, Tuv, Dornogovi, Umnugovi, Bayankhongor, Uvurkhangai, Govi-Altai provinces	2019/5/10-2019/5/11
	Bayankhongor, Bulgan, Govi-Altai, Dornogovi, Dornod, Zavkhan, Uvurkhangai, Sukhbaatar, Selenge, Tuv, Uvs, Khovd, Khuvsgul, Khentii, Dundgobi, Arkhangai, Darkhan-Uul provinces	2020/1
	Dundgovi, Uvurkhangai, Bulgan, Umnugovi, Govi-Altai, Bayankhongor, Arkhangai, Tuv, Khentii, Dornod, Sukhbaatar, Dornogovi, Govisumber, Umnugovi, Zavkhan, Uvs, Khuvsgul, and Khovd provinces	2021/3/14-2021/3/15
Flood	Arkhangai, Bulgan, Dornogovi, Umnugobi, Sukhbaatar, Selenge, Tuv, Khovd, Bayan-Ulgii, Zavkhan, Uvurkhangai, Khuvsgul provinces, Bayanzurkh (Ulaanbaatar)	2018/7/3-2018/7/5
	Ulaanbaatar; Tuv province	2019/6/15-2019/6/19
	Ulaanbaatar, Ömnögovi,Töv, Khövsgöl, Khentii Provinces	2020/7/2-2020/7/4
	Arkhangai, Orkhon, Tuv, Uvs, Khuvsgul, Khentii, Darkhan-Uul, Dornod, Govi-Altai, Tuv, Selenge, Umnugovi provinces.	2020/7/8-2020/8/15
	Sergelen District (Töv province) and Govisümber Provinces	2020/6/21-2020/6/25
	Arkhangai, Umnugovi, Orkhon, Dornogovi, Govi-Altai, Uvurkhangai, Tuv, Zavkhan, Dornod, Selenge, Khuvsgul, Bayan-Ulgii, Uvs, Khovd provinces; Songinokhairkhan, Bayangol, Bayanzurkh, Sukhbaatar, Chingeltei districts (Ulaanbaatar)	2021/6/28-2021/7/29
	Arkhangai, Bulgan, Khuvsgul, Orkhon, Darkhan-Uul, Selenge provinces; Bayanzurkh, Songinokhairkhan, Chingeltei, Bayangol, Sukhbaatar, Khan-Uul (Ulaanbaatar)	2022/6-2022/7/26
	Ulaanbaatar	2023/8/5
	Ulaanbaatar, Selenge, Töv provinces	2023/7/3-2023/7/14

Extreme tempera-tures	Arkhangai, Bayankhongor, Darkhan, Dornogobi, Umnugobi, Tuv, Uvs provinces	2018/1-2018/2
	Bayan-Ulgii, Uvs, Khovd, Govi-Altai, Zavkhan, Bayankhongor, Uvurkhangai, Arkhangai provinces	2019/1/11-2019/2/20
	Arkhangai, Bulgan, Govi-Altai, Dundgovi, Uvurkhangai, Sukhbaatar, Khovd, Khentii, and Zavkhan provinces	2020/1
	Govi-Altai, Dundgovi, Uvurkhangai, Tuv, Bayankhongor, Umnugovi, Khovd, Zavkhan, Arkhangai, Bulgan, Bayan-Ulgii, Uvs, Khuvsgul, Orkhon, Selenge, Dornogovi, Govisumber, Darkhan-Uul, Dornod provinces	2021/1
	Arhangai, Bayanhongor, Bayan-Ölgii, Dornogovi, Dundgovi, Govi-Altai, Khovd, Ömnögovi, Övörkhangai, Sükhbaatar, Töv, Uvs, Zavkhan provinces	2022/11/28-2022/12
	Dornod, Dornogovi, Dundgovi, Govi-Altai, Khentii, Ömnögovi provinces, Sükhbaatar (Ulanbaatar)	2023/5/19-2023/5/22

Source: EM-DAT, CRED; MONGOLIA, Disaster Management Reference Handbook, MAY 2022.

A.2 FINANCIAL SECTOR BACKGROUND

The financial sector in Mongolia is dominated by banks (Table A1), concentrated around the five largest banks. As of the end of 2022, there were 12 banks constituting more than 90 percent of total financial sector assets and a small (in terms of assets) nonbank financial sector.[65] There is one state-owned bank in Mongolia (around 8 percent of total banking sector assets), while the rest of the banks are majority private-owned (collectively by Mongolian and foreign investors). Concentration in the Mongolian banking sector is high, with the five largest banks, namely Khan Bank, Trade and Development Bank, XacBank, Golomt Bank, and State Bank, controlling over 90 percent of the banking sector assets.

[65] Nonbank financial sector is represented by 513 nonbank financial institutions, 196 saving and credit cooperatives, 18 insurance companies, 63 insurance intermediary companies, 25 insurance loss-adjuster companies, and 2,376 insurance representatives operating in Mongolian financial sector.

Table A1. Mongolia's financial sector composition

	Total asset portfolio of financial market	2023	%	2024	%
1	Capital market				
a	Securities companies	331.5	0.5%	470.6	0.6%
b	Investment management	74.1	0.1%	153.8	0.2%
c	Agricultural commodity	5.6	0.0%	4.7	0.0%
d	Custodian banks	1357.8	2.1%	3179	3.8%
2	Insurance market	551.40	0.8%	662.85	0.8%
3	NBFIs	4,672.23	7.2%	7,127.28	8.5%
4	SCCs/ Savings and credit cooperatives	306.48	0.5%	356.78	0.4%
5	Credit guarantee fund	295.60	0.5%	305.20	0.4%
6	Real estate brokers	242.80	0.4%	224.60	0.3%
7	Dealers in precious metals and stones	64.10	0.1%	82.00	0.1%
8	Virtual asset service providers market	55.70	0.1%	77.92	0.1%
9	Bank	57,069.69	87.8%	71,404.96	85.0%
	TOTAL	65,027.00	100%	84,049.68	100%

Banks follow a traditional business model based on lending and a high reliance on deposit funding. The asset side of the banks' balance sheet is dominated by credit that accounted for 48 percent of total assets in 2023 (Table A2). Loans provided to the private sector mainly focus on mortgages and consumption loans, thereby diminishing the proportion of financial intermediation available for business financing. Credit to individuals accounted for 53 percent of total credit, while credit to the private sector accounted for 33 percent. Curtailing of the government-subsidized credit programs and heightened risk aversion over concerns of asset quality contribute to banks' preference to personal lending, mostly to salaried individuals. Majority of loans (>95 percent) are in local currency. Small and medium enterprises continue to face challenges in obtaining financial support to expand their businesses. These challenges can be attributed to several factors, including strict collateral requirements imposed by banks, high interest rates, and short loan maturities. Claims on government represent an insignificant part of the banks' asset side. The liability side of banks' balance sheets consists mostly of deposits (41 percent), current accounts (27 percent) and foreign liabilities (11 percent). The majority of deposits are time and saving deposits (85 percent). The deposits in foreign currency account for about 20 percent of total deposits.

Table A2. Banks' balance sheet as of end-2023

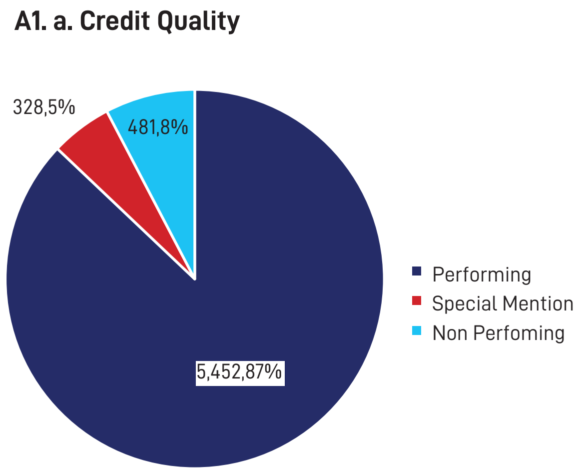
Balance sheet item	(Mln MNT)	%		(Mln MNT)	%
Total Assets	57,069,693	100%	Total liabilities	50,887,379	89%
Bank reserves	9,658,438	17%	Current Accounts	13,794,587	27%
CB Bills	8,744,959	15%	Deposits	21,111,994	41%
Foreign Assets	3,870,609	7%	Demand Deposits	3,213,135	6%
Claims on government	1,558,132	3%	Time and Saving Deposits	17,898,859	35%
Securities (Net)	1,641,464	3%	Liabilities to Banks and OFC	3,827,128	8%
Domestic credit (Net)	25,432,361	45%	Credits from the BoM	2,105,619	4%
Domestic Credit	27,416,892	48%	Foreign Liabilities	5,531,458	11%
Loans on NFC and individuals	26,666,257	47%	Liabilities to General Gov't	1,844,852	4%
Loans on NBFC	178,302	0%	Other Liabilities	2,671,741	5%
Accrued interest receivables	572,334	1%	Capital	6,182,313.80	11%
(Provisions for loan losses)	-1,984,531	-3%			
Claims on Banks and OFC	2,437,709	4%			
Fixed Assets	2,274,756	4%			
Other Assets	1,451,265	3%			

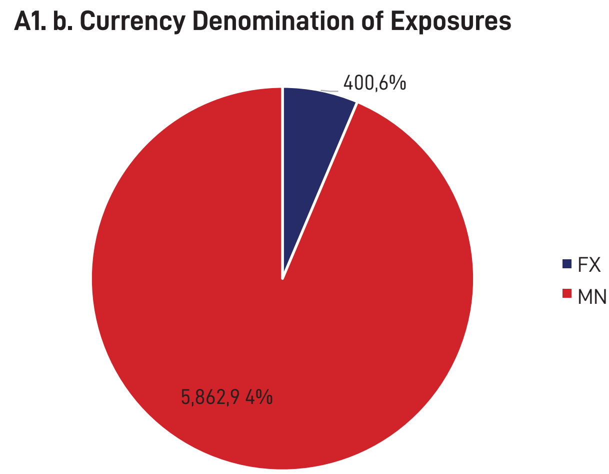
Note: CB = Central Bank, OFC = Other financial corporations, NFC = Non-financial corporations, NBFC = Non-bank financial corporations. Source: Bank of Mongolia, World Bank (WB) calculations.

While the banking sector remains broadly stable, vulnerabilities persist. Non-performing loans accounted for 6.3 percent of total loans in 2023. Special mention loans represented 4.6 percent of total loans. NPLs in mining, construction and manufacturing were above the banking sector average. Provisioning for loan losses is relatively high, accounting for 115 percent of NPLs. Capital adequacy ratio is above the regulatory minimum and was 16.1 percent in May-2023, down from 17.4 percent in 2022. While banks remain profitable and liquid, foreign exchange (FX) liquidity risk has risen for some banks due to deteriorating net FX positions (IMF, 2023). Rising NPLs in corporate sector as well as declining private sector credit growth might weigh negatively on future banks' profitability.

Recently BoM produced an exhaustive dataset of exposures for the 10 largest banks in the country and their industry and geographical composition, which forms the basis for the assessment in this report. The dataset is aligned with ISIC at the highest level of aggregation (Section level), while the geographical composition is at the provincial level (ADM1). While insightful as an initial step for the assessment of climate risks, the high level of aggregation hinders the precision of the risk exposure analysis. The dataset contains around 6.2 billion USD-equivalent worth of exposures for end-2022. Over 90 percent of those exposures are denominated in Mongolian Tugrik (Figure A1.b) and its NPL ratio is approximately 8 percent (Figure A1.a).

Figure A1. Summary Statistics (in USD-equivalent mln and percent of total exposures), end-2022



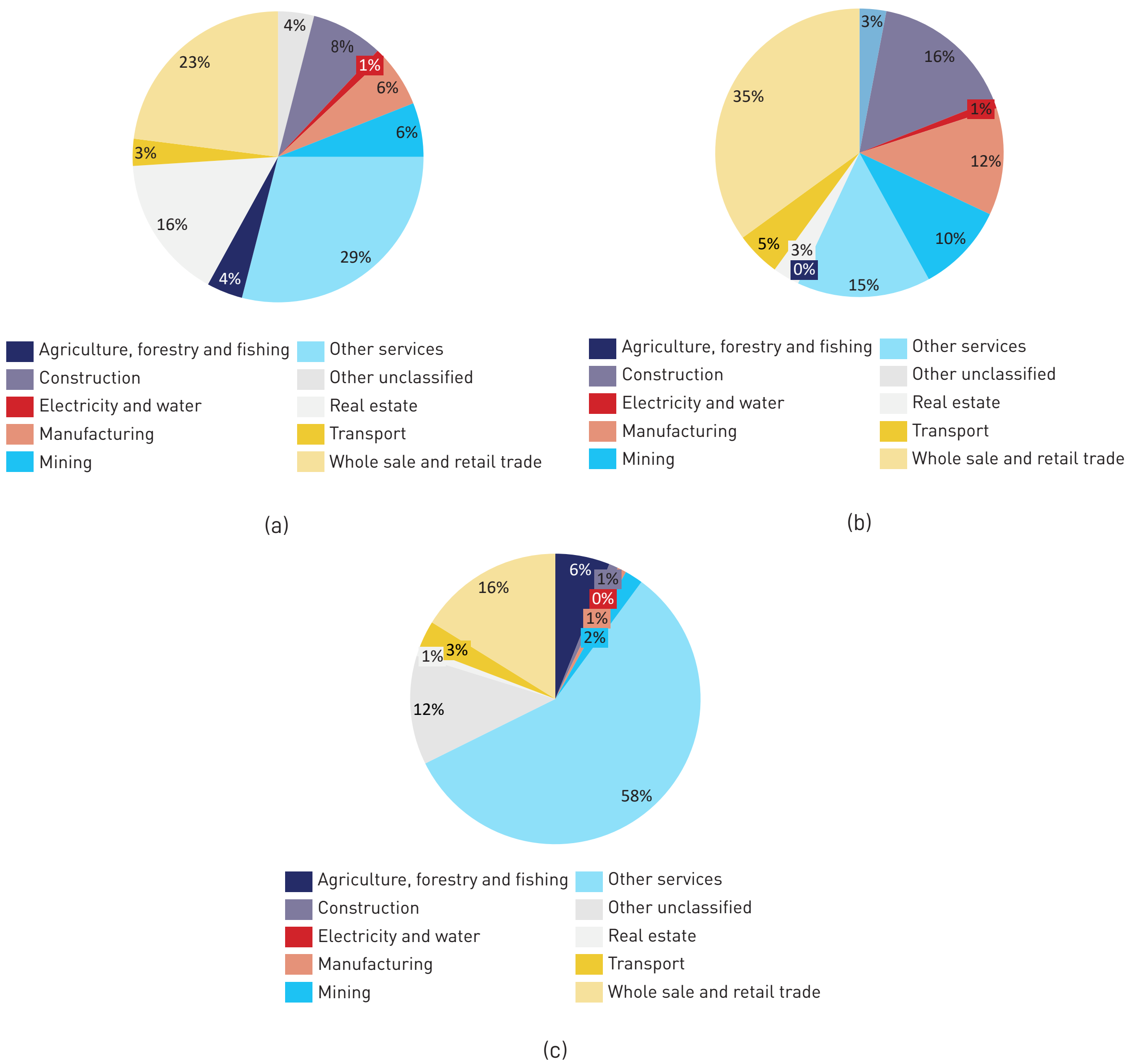


Source: WB staff analysis based on Bank of Mongolia data.

The majority of the banks' loan portfolio is highly concentrated in Ulaanbaatar. As of end-2022, loans were mostly directed to Ulaanbaatar, accounting for around 74 percent of banks' loan portfolio. The rest of the market is scattered across other provinces, none of which accounts for more than 5 percent of banks' loan portfolio. Nine out of 22 provinces account for less than 1 percent of total banks' loan portfolio. The geographical distribution of loan portfolio can, in part, be explained by concentration of economic activity, with Ulaanbaatar being the major economic center and contributor to the country's GDP. Across banks, the geographical distribution of lending portfolio is rather similar. Eight out of 10 banks have their portfolios highly concentrated in Ulaanbaatar (more than 70 percent of total portfolio), with two banks operating solely in Ulaanbaatar. Majority of banks operate only in selected provinces, with fourteen out of 22 provinces being served by 3-4 biggest banks only.

Banks' loan portfolio is widely distributed across major economic sectors. The loan portfolio of Mongolian banks is roughly half directed to non-financial corporates, while the rest is distributed between personal loans (38 percent of total loan portfolio) and mortgages (14 percent). As of end-2022, the largest sectoral recipients of corporate loans are firms operating in the wholesale and retail trade (35 percent), construction (16 percent), services (15 percent), manufacturing (12 percent), and mining (10 percent) (Figure A3). The distribution across economic sectors in Ulaanbaatar is similar to the country level allocation. While credit to wholesale and retail trade sector is prevalent across all provinces, some provinces have higher credit concentration in, for example, agriculture (e.g., Selenge, To'v, Bulgan) and transport (e.g., Omnogovi). Across banks, distribution of credit across sector also exhibits some variation, with some bank being particularly exposed to sectors vulnerable to physical climate risk, such as construction, agriculture, and transport, among others.

Figure A2. Sectoral mapping of banks' credit portfolio shares (percent of total) for (a) all loans, (b) loans to non-financial corporations, and (c) personal loans, end-2022



Source: WB staff analysis based on Bank of Mongolia data.

A.3 ADDITIONAL INFORMATION ON METHODOLOGY FOR TRANSITION RISK EXPOSURE ASSESSMENT

BoM produced a bank dataset that contains loan exposures of the largest 10 banks to individual industrial sectors (ISIC Level 1). For the purpose of estimating climate transition risk exposure, the sectors included in the BoM dataset were matched with three different data sources to estimate emissions and emission intensities of Mongolian banks: 2021 Refinitiv Eikon database, 2021 OECD TeCO2 dataset, and Global Trade Analysis Project (GTAP). See Table A3 below for source details.

After the matching is conducted, industrial sectors are ranked based on their emission intensities from each data source and the top 25 percent of sectors with the highest emission intensities are flagged as transition risk sensitive. These sectors are expected to be most significantly impacted by carbon curtailment policies (e.g. carbon taxes, carbon caps).

Table A4 presents the classification of sectors based on different data sources. As shown, various datasets identify different climate-sensitive sectors. The reason why there is no common convergence across data sources is that inside those sectors there are numerous sub-sectors some of which are indisputably at risk, others are not. With more granularity, data sources are likely to converge to more consistent results. There is, nonetheless, broad agreement on some sectors like Electricity Generation and Transport. To better understand the discrepancies across sources, the figures in the main text present data from all three sources rather than relying on a single perspective. This approach facilitates the reader's appreciation for marginally different estimations depending on the data source.

Table A3. Summary of Emissions Datasets

	Data Source	Description	Details
1	Refinitiv Eikon	A dataset of emission intensities (Scope 1 and 2) for individual international companies, consolidated from multiple sources including the CDP project, annual sustainability and financial reports.	Based on over 5,000 global companies. Scope 1 and 2 GHG emission intensities. 2021 data.
2	OECD TeCo2	The Trade in Embodied CO2 (TECO2) database is derived from the 2021 edition of OECD's Inter-Country Input-Output (ICIO) tables, combined with resident principle converted CO2 emissions from fossil fuel combustion, as reported by the International Energy Agency (IEA).	Predominantly covering OECD countries. The TECO2 indicators cover 66 economies and the rest of the world for 1995-2018.

3	Global Trade Analysis Project	A comprehensive database providing globally consistent data on consumption, production, international trade, energy, and carbon dioxide emissions. Its is composed of input-output table statistics contributed by members of the GTAP Network. The emissions data in GTAP are particularly detailed, covering greenhouse gas emissions such as carbon dioxide, methane, nitrous oxide, and fluorinated compounds by country and sector.	The GTAP-E Data Base provides carbon dioxide (CO2) emissions data distinguished by fuel and by user for each of the 160 countries/regions is extended with energy balances compiled by the International Energy Agency (IEA).

Table A4. Classification of Climate Sensitive Sectors based on reference datasets

Sector (BoM Data)	ISIC Code	OECD	Eikon	GTAP
Agriculture, forestry, fishing and hunting	A	Y	N	N
Mining and quarrying	B	Y	Y	N
Manufacturing	C	Y	N	N
Electricity, thermal energy and water supply	D	Y	Y	Y
Water supply; sewage, waste management and remediation activity	E	N	Y	N
Construction	F	N	N	Y
Wholesale and retail trade, repair of motor and vehicle	G	N	N	N
Transport storage and communication	H	Y	Y	Y
Accommodation and food services	I	N	Y	Y
Communication	J	N	N	N
Financial and insurance activity	K	N	N	N
Real estate activity	L	N	N	N
Professional, scientific and technical activities	M	N	N	N
Administration and support services activities	N	N	N	N
Public administration and defense; compulsory social security	O	NA	NA	N
Education	P	NA	N	N
Human health and social work activities	Q	NA	N	N
Arts and entertainment	R	NA	N	N
Other service activities	S	NA	Y	N
Hired help household activities	T	NA	NA	N
Activities of international organizations and permanent representatives	U	NA	NA	N
Others		NA	NA	N

* NA: No Emissions Available.

Source: WB staff analysis based on Thomson Reuters Eikon, GTAP, OECD.

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