The Impact of Biodiversity Loss on the Philippine Banking System: A Preliminary Analysis

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A. Introduction

The global economy is dependent on nature. The WWF (2022) reports that half of global GDP (or US$44 trillion a year) comes from economic sectors that directly depend on the flow of goods and services generated by nature such as, food, raw materials, pollination, water filtration, and climate regulation. But the planet faces a second crisis –– nature and biodiversity loss. Menon (2022) argued that the nature crisis is no less threatening than the climate crisis, however, it is much less appreciated and much less is being done to mitigate it.

There are many definitions of biodiversity. In this study, we define the biosphere as the sum of all the ecosystems of the world. It is both the collection of organisms living on the Earth and the space that they occupy on part of the Earth's crust (the lithosphere), in the oceans (the hydrosphere), and in the atmosphere. The biosphere is all the planet's ecosystems (IPBES 2019). This simply means that biodiversity does not only include the diversity of genes and species but also embraces the diversity of ecosystems. For instance, plants, algae and many bacteria capture energy from the sun, which is why they are called primary producers. The energy they capture, along with other abiotic materials, flows through ecosystems and enables a wide range of natural processes to function, including biomass production, nutrient cycling and water dynamics. A broader concept is the natural capital that extends beyond the nature as a source of raw materials for production to include the role of the environment and ecosystems in supporting human well-being through the supply of such important goods and services as clean water, fertile soils, and genetic resources.

The degradation of nature (otherwise known as loss of biodiversity) and other nature-related risks are becoming increasingly relevant issues on the national and international policy agenda due to its relationship with first climate change agenda. Climate change contributes to nature and biodiversity loss through ocean acidification or changing the living conditions of species. At the same time, nature loss is accelerating climate-related issues as nature-based solutions such as mangroves can provide flood and storm protection (adaptation) and at the same time provide a lot of carbon sequestration (mitigation). Second, biodiversity decline is a concern for many policymakers due to its relationship between biodiversity, ecosystem services, and human welfare. For example, agricultural crops can be derived from wild species; plants are often sources of natural medicines and contribute to prescription drug development

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(e.g., the rosy periwinkle found in Madagascar is the basis for medicine treating Hodgkin's disease and childhood leukemia); wildlife provides essential nutrition and recreation; and ecosystems provide services for humans (e.g., flood control, carbon sequestration, pollination, and water filtration) (CRS 2021).

On 19 December 2022, the United Nations Biodiversity Conference (COP15) held in Montreal, Canada concluded with a landmark agreement to guide global action on nature through to 2030.[2] The COP 15 resulted in the adoption of the Kunming-Montreal Global Biodiversity Framework (GBF). Basically, the GBF aims to address biodiversity loss, restore ecosystems and protect indigenous rights. The plan includes concrete measures to help stop and reverse nature loss, including placing 30% of the planet and 30% of degraded ecosystems under protection by 2030. It also contains proposals to increase finance to developing countries.[3] Menon (2022) further argued that authorities need financing for more sustainable supply chains, less disruptive infrastructure, and better farming practices that preserve yield while minimizing land degradation. The Nature Conservancy estimates that the nature funding needs may be as high as 824 billion US dollars annually.

The Philippines is one of the 17 mega-diversity countries in the world. These countries account for almost two-thirds of the earth's biological wealth and natural capital and host 70%–80% of the world's biodiversity resources. On a per unit area, the Philippines has the greatest concentration of endemic species compared to other geographical jurisdictions in the world (Aquino-Gayao, 2014; DENR - BMB, 2014). The country hosts more than 52,177 known species, more than half of which are considered endemic (DENR – BMB, 2014). There are at least 25 genera of plant species and 49% of terrestrial wildlife which can only be found in the Philippines. Moreover, the country ranks fifth in the number of plant species, accounting for 5% of the world's flora. It also ranks fourth in bird endemism.

The country's location at the apex of the Coral Triangle, which is the global center for marine biodiversity, provides it with a rich and diverse marine ecosystem. It is host to nearly 10,000 marine species, or about one-fifth of the world's total species (Ani and Castillo, 2020). Specifically, the Philippines has 228 Key Biodiversity Areas (KBAs) which are known habitats of 855 globally important species of plants, corals, mollusks, elasmobranchs, fishes, amphibians, reptiles, birds and mammals in the country (DENR-BMD, 2016). Of these sites, 44% are classified as terrestrial, 34 percent are marine, and 22% include both terrestrial and marine (Ambal et al., 2012). These KBAs are considered

[2] United Nations Environment Programme (UNEP), Press Release on "COP 15 Ends With Landmark Biodiversity Agreement, published on 20 December 2022 at https://www.unep.org/news-and-stories/story/cop15-ends-landmark-biodiversity-agreement.

[3] The GBF also identifies 23 targets to achieve by 2030, including: (a) effective conservation and management of at least 30% of the world's land, coastal areas and oceans; (b) restoration of 30% of terrestrial and marine ecosystems; (c) reduce to near zero the loss of areas of high biodiversity importance and high ecological integrity; (d) halving global food waste; (e) phasing out or reforming subsidies that harm biodiversity by at least US$500 billion per year, while scaling up positive incentives for biodiversity conservation and sustainable use; (f) mobilizing at least US$200 billion per year from public and private sources for biodiversity-related funding; (g) raising international financial flows from developed to developing countries to at least US$ 30 billion per year; and (h) requiring transnational companies and financial institutions to monitor, assess, and transparently disclose risks and impacts on biodiversity through their operations, portfolios, supply and value chains.

as important sites for biodiversity conservation worldwide. These numbers could be underestimated as the rate of discovery of new species in the Philippines is one of the highest in the world. Between 1997 and 2016, some 120 new species of wildlife fauna and 170 species of wildlife flora have been discovered in the country. These data are still increasing given new discoveries by the academe, researchers, and by biodiversity-related funded projects.

While the Philippines is considered as biologically rich, it also ranks high as a biodiversity hotspot and a global conservation area together with the Himalayas, Polynesia-Micronesia, Atlantic Forest (i.e., Brazil, Paraguay, Argentina, Uruguay), Indo-Burma, New Zealand, Japan, Sundaland and Southwest and Eastern Australia. A large number of plant and wildlife species in the country are being destroyed and face extinction due to habitat loss, human activities, and climate change, among others (Ani and Castillo, 2020). It is estimated that there are at least 200 threatened species in the country. This could have a severe impact on economic sectors dependent on biodiversity, which is also expected to result in losses for businesses providing services to these sectors. Of course, this phenomenon can be temporary or permanent, depending on whether the environmental degradation that leads to the loss is reversible through ecological restoration/ecological resilience or effectively permanent (such as through land loss).

Moreover, several sectors rely on the availability of biodiversity for their continuity and existence, including the clothing, timber, and fisheries sectors (Deloitee, 2022). In fact, all economic activity depends on natural capital, i.e., the stock of both renewable and non-renewable resources (including biodiversity) providing a flow of ecosystem services to society. However, some studies argued that unsustainable practices of production and consumption of human beings have put nature in crisis, which has negative effects on different aspects of human wellbeing Specifically, there are also indirect effects of biodiversity loss that can negatively impact the economic sectors. Habitat destruction and general biodiversity loss increase the risk of severe droughts, newly emerging diseases, the disappearance of animal pollinators and the collapse of fisheries and agricultural yield.

Global extinction has so far been proven to be irreversible (Dasgupta, 2021). While permanent global species loss is a more dramatic phenomenon than regional changes in species composition, minor changes from a healthy stable state can have dramatic influence on the food chain. This is seen as reductions in only one species can adversely affect the entire food chain, leading to an overall reduction in biodiversity. Another concrete example might be pollination loss or soil degradation. The main channel connecting biodiversity with economic systems are the so-called ecosystem services provided by natural environments that help to sustain economic production. Examples of these services include agricultural productivity gains through soil fertility, the cleaning of water streams and rivers, or the pollination of plants and crops. The increasing use of biomass for energy production highlights how these ecosystem services could have significant implications for economic sustainability.

Recent studies lead to growing evidence that biodiversity loss could have significant economic and financial implications, because the decline of ecosystem services poses physical risks for the economic actors that depend upon them (Toronto

Centre, 2023). The Coalition of Finance Ministers for Climate Action[4] and the Network for Greening the Financial System (NGFS)[5] have both recently taken significant steps to advance their understanding of nature-related risks. Following the publication of reports acknowledging the roles of their respective members in addressing nature loss and related risks, the two groups have agreed to collaborate and share information on this important topic. Engagement on this issue from the members of these two groups will be important during the expected implementation of the post-2020 Global Biodiversity Framework following the Convention on Biological Diversity (CBD) COP15. Specifically, the NGFS has launched a Task Force on Biodiversity Loss and Nature-Related Risks as part of its 2022-2024 workplan, with the objective of mainstreaming the consideration of nature-related risks across NGFS workstreams.

Biodiversity tends to help limit climate change but is at the same time negatively affected by it (Van Toor et al., 2020). Climate change and its related rise in temperatures can affect biodiversity through multiple channels. There is evidence that species can be, for instance, physiologically vulnerable to temperature spikes, increasing the probability of extinction and massive migrations. Pörtner et al. (2023) detail why climate change and biodiversity loss are interdependent phenomena, and must be tackled together. Specifically, biodiversity loss and climate change are both drivers and consequences of one another, tightly linked to human activities or demographic change and resulting in negative impacts on among others, human health and well-being, as well as societal functioning.

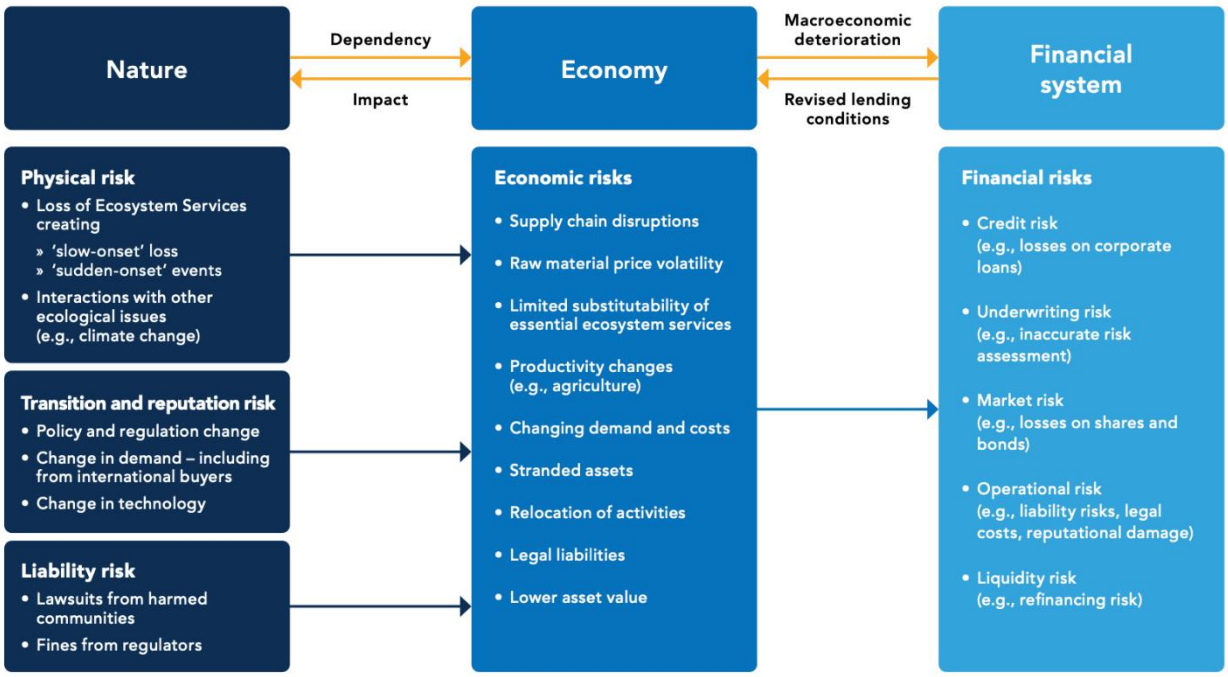
Recent studies emphasize that like climate change, biodiversity loss is an external driver of financial risk, which poses physical, transition, and reputational risks to the financial sector (Figure 1). Important components of this diagram are the dependency and impact of nature on the macroeconomy which could lead to macroeconomic deterioration and changes in lending conditions. The degradation of biodiversity could lead to physical and transition risks that could feed through the economy. This could eventually pose risks for the financial system with reinforcing macroeconomic feedback effects (Dunz and Power 2021). By financing clients with economic activities dependent on biodiversity, lending institutions are exposed to direct and indirect risks associated with biodiversity loss. Following World Bank and BNM (2022), exposure in this study is defined as the share of outstanding loans to highly vulnerable sectors or highly dependent or highly impacting sectors on biodiversity. Due to availability of data, our focus is narrower since risks related to ecosystem services and natural assets such as water and forests are yet to be included. It therefore covers only a portion of the environmental risk dimension in the Environmental, Social, and Government (ESG) framework for sustainable development.

[4] The Coalition of Finance Ministers for Climate Action is a group of 80 Finance Ministries that have committed to aligning their economies with the goals of the Paris Agreement through implementing the six Helsinki Principles. The Coalition was established in April 2019 and is Co-chaired by Finance Ministers of Finland and Indonesia.

[5] The NGFS, launched at the Paris One Planet Summit on 12 December 2017, is a group of central banks and supervisors, which on a voluntary basis are willing to share best practices and contribute to the development of environment and climate risk management in the financial sector, and to mobilize mainstream finance to support the transition toward a sustainable economy. The NGFS brings together 121 central banks and supervisors from 87 jurisdictions and 19 observers. The NGFS is chaired by Mr Ravi Menon, Managing Director of the Monetary Authority of Singapore.

Nevertheless, we use the schematic diagram below in identifying the risks to the financial system of biodiversity loss and nature-related risks. Physical risks occur where clients are dependent on ecosystem services. These clients are likely to experience a decline in profitability as biodiversity decreases. Reduced profitability is expected to translate into a lower ability to meet financial commitments, such as loan repayments. This means that banks might observe higher default rates, higher loan loss provisions, higher capital requirements and ultimately even lower new business rates.

Figure 1: From Nature-Related Risks (Including Biodiversity Loss) to Financial Risks



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

Transition risks include new regulations and policies aimed at creating a more sustainable future, which might lead to restrictions on certain economic activities. These restrictions might involve significant costs or loss of business opportunities for clients, leading to decreased profitability for those clients. Customer preference for greener products might also result in reduced profitability and increased risk for financial institutions. Moreover, banks and financing companies with a negative impact on biodiversity and ecosystem services also expose financial institutions to reputational risks. This means that it is important for banks to include biodiversity, the tangible transition and physical risks as well as the indirect reputational risks, in their financial risk management systems.

Risks to the financial system could come from macroeconomic risks such as supply chain disruptions, productivity changes in agriculture sector, changing demand and additional costs, among others. These risks could eventually lead to credit risk, underwriting risk, market risk, operational risk, and liquidity risk.

However, the availability of the required data to assess the expected impact of biodiversity loss remains a challenge, as the required data has often not been captured

by banks in the past. Data requirements include, for example, geographic areas where there is an increased risk of biodiversity disruption, or information concerning business activities that negatively impact biodiversity. Next to data, there is also currently a lack of understanding and methodologies to assess how nature loss can have economic and financial impacts. Translating this shock into indicators that institutions like central banks are used to work with (e.g. Gross Domestic Product, inflation) is still very nascent at this point. So even if we would have all the data, the ultimate question is what this means in economic terms. Things would be more complicated given the multiple dimensions we need to look into such as, biodiversity, soil health, water cycles, as well as to project this into the future. It is clear from the discussions that biodiversity loss will have a critical impact on financial institutions and the economy if ignored.

This paper first identifies the extent to which Philippine banks are potentially exposed to physical risks from biodiversity loss using bank-level data of universal and commercial banks and global data on biodiversity loss from 2010 to 2021. A historical perspective of banks' exposure is not entirely precise. However, we use this approach to see the variation of the impact of biodiversity loss on outstanding bank loans. We then explore the possible impact of biodiversity loss on bank solvency. We should emphasize that we have not analyzed all the risks caused by biodiversity loss due to limitations in data. Second, we focus on the initial impact of biodiversity loss on bank-level outstanding credit and the total effect on bank capital adequacy ratio through a stylized bank solvency stress test. The results in this paper therefore represent a lower boundary estimate for total exposure. The choice of the risks is based on the availability of balance sheets and biodiversity data. Moreover, we argue that the interaction between disaster or extreme weather events and biodiversity loss could reveal that the banking system is susceptible to even more exposures toward nature-related risks in general. However, the potential systemic risks created by biodiversity loss have not been analyzed in the study. Nevertheless, the findings of this study contribute to the evolving discussions about the effect of environmental changes particularly the loss of biodiversity on the financial system.

Specifically, this study poses two questions: (a) Does biodiversity loss affect the Philippine banking sector? and (b) Does the loss of biodiversity have an impact on bank solvency? The rest of the paper presents the state of biodiversity, risks, and challenges in Section B. Section C discusses the emerging findings in a survey of related literature on biodiversity and the financial system before data and empirical methodology is presented in Section D. Section E analyzes the initial results. Section F offers implications for BSP policy.

B. Recent Developments in the Philippines' Natural Capital and Biodiversity

State of natural capital assets in the Philippines. As mentioned in the previous section, an important broader concept pertains to natural capital. The Natural Capital Protocol[6] defines natural capital as the "stock of renewable and non-renewable resources that combine to yield a flow of benefits to people. Risk stemming from natural capital depletion has been gaining traction within the finance sector. Many studies observe that

[6] The Natural Capital Protocol is a decision-making framework that enables organizations to identify, measure, and value their direct and indirect impacts and dependencies on natural capital.

as natural capital is depleted, it loses its capacity to support the ecosystem services[7] that businesses, economic activities and broader society depend on. Depletion is defined in the Report as declines in the quantity and quality of stocks of natural capital assets, with indicators of depletion being selected to represent, as far as possible, variability in current relative rates of depletion in various locations. Different methodologies were applied in the terrestrial and marine environments respectively, with datasets showing actual depletion used in the terrestrial analysis and an overlay of high stocks of natural capital and high levels of human pressure used in the marine analysis. However, through responsible management of natural capital, businesses have opportunities to reduce those disruptions and associated risk in economic regions in which they operate. Financial institutions, in turn, are exposed to, and have a role in facilitating, both negative and positive outcomes associated with natural capital.

Changes in natural capital, such as declines in soil quality and provision of freshwater, as well as the loss of biodiversity, bring outcomes and potential risks for economic industries. Businesses both depend on, and impact, natural capital, and are therefore inherently linked to the depletion, maintenance and regeneration of natural capital. The 2020 World Economic Forum Nature Risk Rising report shows that over half of the world's total Gross Domestic Product (GDP) is moderately or highly dependent on natural capital.

In the Philippines, the National Economic and Development Authority (NEDA), Philippine Statistics Authority (PSA), and the Department of Environment and Natural Resources (DENR) have jointly developed and released the Roadmap to Institutionalize Natural Capital Accounting (NCA) in June 2022. The release of the Roadmap aims to provide strategic guidance on the national implementation of NCA from 2022 to 2040. It also presents the critical activities, milestones, and outputs for each planning period to fully institutionalize and integrate NCA, including valuation of ecosystem services in the government's planning, investment decisions, and policy-making process.[8] The Roadmap has six components: (a) compilation of natural capital accounts; (b) estimation of natural capital – adjusted macroeconomic indicators; (c) policy use and applications; (d) data management systems; (e) capacity development; and (f) dissemination.

The institutionalization of the NCA highlights the significant economic benefits of biodiversity and ecosystem services. In 2004, the national list of threatened faunal species was established. It included 42 species of land mammals, 127 species of birds, 24 species of reptiles and 14 species of amphibians. Additionally, the Philippines has at least 3,214 fish species, of which 121 are endemic and 76 are threatened. Among the species identified as critically endangered are the tamaraw (Bubalus mindorensis), dugong (Dugong dugon), Philippine eagle (Pithecophaga jefferyi), Philippine crocodile (Crocodylus mindorensis), and Philippine deer (Rusa marianna) (DENR, 2019). Subsequently, a national list of threatened plant species was established in 2007 through an administrative order of the Department of Environment and Natural Resources (DENR). The list classified 99 species as critically endangered, 187 as endangered, 176 as vulnerable and 64 as threatened species. These include yakal (Shorea astylosa), waling-waling (Vanda sanderiana), giant staghorn fern (Platycerium grande), tungkod-langit

[7] The Millennium Ecosystem Assessment defines the ecosystem services as "benefits people obtain from ecosystems".
[8] The Roadmap also identified the priority ecosystem sites for ecosystem accounting in the Philippines.

(Helminthostachys seylanica), and malatubo (giant orchid; Grammatophyllum speciosum), among others (DENR, 2017).

The Philippines is an archipelago of approximately 7,641 islands and with a total coastline of 36,289 kilometers or 22,548.94 miles. More than 60% of the country's total population live in coastal areas as major cities and large industrial areas are located near the sea (DENR-BMB, 2014). Many of the country's productive natural ecosystems are on the coast and many Filipino households source their food and livelihood from these areas.

Aside from coastal areas, the Philippines also derive significant benefits from watersheds and river basins. These offer ecosystem services that support economic activities such as agriculture, forestry, ecotourism and recreation. For example, a watershed with ample forest cover provides water that irrigates lowland agriculture, prevents soil erosion and siltation of coasts and water bodies, and sustains the supply of surface and groundwater for domestic use (CBD, n.d.). Forest ecosystems likewise provide ecological services that benefit agriculture, industries, water and power needs. As a primary sector of the economy, the agriculture, fisheries, and forestry (AFF) sector derives significant benefits from biodiversity and the ecosystem services that it offers. The AFF sector is a key contributor to Philippine economic growth. Between 2010 and Q2 2022, the agriculture, fisheries and forestry sector accounted for 12.8% of the country's GDP and employed almost a third (i.e., 30%) of the total workforce.

Some studies have tried to estimate the economic value of ecosystem services in the Philippines (Mercado, 2016). Table 1 presents a compilation of the valuation of the country's ecosystem services.

Table 1: Estimated values of Philippine biodiversity and ecosystem services

Ecosystem service	In PhP billion (As of December 2016)	Share to Estimated Total Value of Ecosystem Service (%)
Timber and fuelwood production	1.1	0.05
Water provision	50.9	2.3
Ecotourism	157.0	7.0
Carbon offset	453.0	20.2
Flood prevention	41.0	1.8
Soil erosion	10.0	0.4
Fishery production	111.0	4.9
Crop production	1,416.0	63.0
Mangrove	7.4	0.33
TOTAL	2,247.40	100.00

Source: Compiled by the Biodiversity Finance Initiative (BIOFIN); Authors

Crop production generates the highest value among the ecosystem services, followed by carbon offset, ecotourism and fishery production. The value of crop production is estimated at PhP1,416 billion, equivalent to almost 63.0% of the total estimated value of ecosystem services covered in these studies. Carbon offset, which involves the reduction of greenhouse gas (GHG) emissions to counter emissions that occur elsewhere, generates a total value of PhP453 billion or 20.2% of the total value of ecosystem services. It is worth noting that the Philippines targets a 75% reduction in its

greenhouse gas emissions by 2030 as part of its commitment to the Paris Agreement on Climate Change. Ecotourism and fish production are the other ecosystem services that are largely valued at PhP157 billion (or 7.0% of the total services) and PhP111 billion (or 4.9% of the total services), respectively.

In a more recent study, Tamayo et al. (2018) assessed the value of the ecosystem services derived from the Philippine reefs. They estimated the economic values of fisheries, tourism, and biodiversity generated from reefs across the country's 15 regions. Based on their estimates, the Total Economic Value (TEV) of Philippine reefs and coastal marine resources was US$3.65 billion/year (PhP 192.1 billion)[9] or roughly US$140,000/km^2/year (PhP7.4 million/km^2/year).

We turn to the 2018 Input-Output (IO) table to get a sectoral view of the contribution of ecosystem services to the economy. We focus on three (3) key industries - the Agriculture, Forestry and Fishing (AFF); Mining and Quarrying; and Electricity, Steam, Water and Waste Management. These are economic sectors that provide various ecosystem services to other industries. Table 2 presents the distribution of output from these sectors based on the 2018 Input-Output (I-O) transactions table.

From the table, we see that the AFF sector supplied PhP2,370.6 billion of intermediate goods and services to the other industries for their production needs. This accounts for 13.0% of the total intermediate goods and services used in the economy. Looking at the AFF sub-sectors, we find that crop production reached PhP1,005.8 billion (5.5% of total intermediate demand), livestock at PhP887.1 billion (4.9%), forestry and logging at PhP7.2 billion (0.04%) and fishing and aquaculture at PhP254.2 billion (1.4%).

The AFF sector provides the largest amount of intermediate goods and services to the economy. This is unsurprising given that the AFF is a primary sector of the economy. It is a key source of raw materials and inputs used for production by the other industries in the economy. The AFF sector is connected to almost all industries either directly or indirectly. Thus, other sectors of the economy have a high dependency on the AFF.

Mining and quarrying produced PhP468.3 billion of intermediate inputs, which is equivalent to 2.6% of total intermediate demand. Steam and water supply provided 0.1% and 0.4% of total intermediate needs amounting to PhP16.3 billion and PhP74.7 billion, respectively. Overall, the AFF sector's output reached PhP3,461 billion or 9.5% of the total output in the economy. Crop production yielded PhP1,184.2 billion (3.2% of total output), while livestock generated PhP1,424.7 billion (3.9%), forestry and logging at PhP7.2 billion (0.02%) and fishing and aquaculture at PhP604.7 billion (1.7%). Mining and quarrying accounted for PhP245.2 billion (0.7% of total output) while steam contributed PhP16.5 billion (0.05%) and water supply, PhP123.0 billion (0.3%).

Another interesting aspect that is not covered in this analysis are the spatial linkages. Agricultural sector is usually more located in rural sectors, whereas the service sectors and many industries are located more in the larger cities and particularly Metro Manila. In the absence of data and information, this could be an area for future research.

[9] Based on the average peso-dollar rate for 2018 of PhP52.661/US$1.

Households are the largest consumers of AFF final output at PhP681.7 billion which is equivalent to 19.7% of the sector's total output. They also have the highest demand for water supply and steam at 37.9% and 0.7% of total output, respectively. In terms of exports, the AFF sector supplied 2.6% of its total output abroad amounting to PhP88.4 billion. Moreover, the mining and quarrying sector exported a larger proportion of its total output (32.6%) valued at PhP80.04 billion.

Nonetheless, some ecosystem services are not properly valued. The value of ecosystem services is often estimated using the amount that people are willing to pay to preserve or enhance the services. However, this may not be applicable for some ecosystem services. For instance, ecosystem services like timber or agricultural produce, are traded in the markets but some recreational activities like trekking through the woods, bird watching, deep sea diving, are not bought and sold in markets (DENR–BMB, 2016). Thus, consumers do not directly pay for many ecosystem services. The undervaluation of the ecosystem services is one of the main reasons being cited for the heedless use of biodiversity resources in the Philippines. The real value of biodiversity to the economy and society is not fully accounted for and appreciated.

Recognizing this, the NCA Roadmap puts emphasis on outlining the interactions of economic activity with the environment which will lead to more informed and better economic decisions. For example, allowing widespread logging activities could translate to higher timber production and revenues for the economy. However, the economic benefit would only be temporary and, in the long-run, healthy forestlands are crucial to a well-functioning economy.

Table 2: Ecosystem services and economic sectors[1/]

(Based on the 2018 Input-Output Accounts of the Philippines)

In PhP million

Description	Agriculture, forestry, and fishing	Industry	Services	**Total Intermediate Demand**	Household Final Consumption Expenditure	Government Final Consumption Expenditure	Construction	Durable Equipment	Breeding Stocks and Orchard Development	Intellectual Property Products	Changes in Inventories	Valuables	Exports of Goods and Services	Imports of Goods and Services	**Total Final Demand**	**Total Output**
Agriculture, forestry, and fishing	996,184	1,341,703	32,670	**2,370,557**	681,704	4,199	0	0	395,724	88	-1,346	31	88,379	78,355	**1,168,780**	**3,460,982**
Crop production	46,278	951,044	8,489	**1,005,810**	165,535	406	0	0	7,173	38	-1,012	1	80,649	74,427	**252,789**	**1,184,172**
Livestock	707,991	174,904	4,218	**887,114**	149,727	2,222	0	0	388,368	0	-341	1	703	3,144	**540,681**	**1,424,651**
Forestry and logging	103	7,041	12	**7,155**	10	1	0	0	0	0	0	0	5	13	**17**	**7,159**
Fishing and aquaculture	28,527	206,199	19,499	**254,225**	342,787	1,425	0	0	2	50	3	29	6,490	330	**350,785**	**604,681**
Support activities to agriculture, forestry, and fishing	213,286	2,513	452	**216,252**	23,644	146	0	0	181	0	4	0	533	442	**24,508**	**240,318**
Mining and quarrying	44	466,465	1,761	**468,270**	1,250	183	0	0	0	16,255	-3,063	24	80,039	317,789	**94,688**	**245,169**
Electricity, steam, water and waste management	23,680	334,689	279,209	**637,579**	228,099	30,208	0	0	0	1,368	0	0	0	0	**259,676**	**897,255**
Electricity	20,729	273,639	249,427	**543,796**	170,376	29,397	0	0	0	400	0	0	0	0	**200,173**	**743,969**
Steam	14	16,148	175	**16,336**	119	21	0	0	0	0	0	0	0	0	**140**	**16,475**
Water supply	2,823	43,561	28,328	**74,710**	46,596	723	0	0	0	938	0	0	0	0	**48,257**	**122,967**
Sewerage, and waste management and remediation activities	114	1,343	1,280	**2,737**	11,008	68	0	0	0	30	0	0	0	0	**11,106**	**13,843**
Total Intermediate Consumption	**1,698,365**	**7,450,210**	**181,917**	**18,274,281**	**13,250,084**	**2,199,637**	**2,939,786**	**1,527,020**	**397,760**	**118,780**	**(26,944)**	**2,703**	**5,518,573**	**7,662,209**	**25,927,400**	**36,539,472**
Compensation of employees	580,692	959,037	98,666	**6,297,084**												
Gross operating surplus	1,135,500	2,283,938	265,198	**10,583,750**												
Taxes less subsidies on production and imports	46,424	245,357	47,161	**1,384,356**												
Total Primary Inputs	**1,762,616**	**3,488,331**	**411,025**	**18,265,190**												
Total Inputs	**3,460,982**	**10,938,541**	**592,942**	**36,539,472**												

[1/] The 2018 Input-Output transactions table is comprised of 16 industries. These industries were put together into the three (3) main sectors of the economy as follows: 1. Agriculture, forestry, and fishing; 2. Industry (i.e., Mining and quarrying, Manufacturing, Electricity, steam, water and waste management, and Construction); 3. Services (i.e., Wholesale and retail trade, repair of motor vehicles and motorcycles, Transportation and storage, Accommodation and food service activities, Information and communication, Financial and insurance activities, Real estate and ownership of dwellings, Professional and business services, Public administration and defense; compulsory social activities; Education; and Human health and social work activities and Other services). The I-O transactions table is as of December 2021.

Source: Philippine Statistics Authority

Biodiversity has evolved in the Philippines. BMB (2015) reported that agricultural biodiversity (or agrobiodiversity) is an important component of Philippine biodiversity. Agrobiodiversity is the result of the interaction between the environment, genetic resources and management systems and practices used by culturally diverse people**,** and therefore land and water resources are used for production in different ways (FAO, 1999). Thus, agrobiodiversity encompasses the variety and variability of animals, plants and micro-organisms that are necessary for sustaining key functions of the agro-ecosystem, including its structure and processes for, and in support of, food production and food security.

In addition, city biodiversity exposes urban residents to an environment or landscape which facilitates their appreciation for nature. It provides opportunities for recreation, health, relaxation and community cohesion. However, there are principal pressures to Philippine biodiversity. Biodiversity loss in the Philippines has been mainly attributed to the continuous destruction of habitats and ecosystems. Habitat degradation renders these unsuitable to support species and life forms. Given that tropical forests are key habitats, loss of habitat due to deforestation is a significant driver of biodiversity loss in the country (DENR–BMB, 2016). Over the past 100 years, the deforestation rates averaged at about 150,000 hectares per year (Rebugio et al., 2005). Between 1934 and 1990, it is estimated that the Philippines lost 10.9 million hectares of forest cover. The country is said to have lost almost 93% of its original forest cover since the 1900s (Ong et al., 2002). Moreover, of the 450,000 hectares of mangrove areas that the country had in the early 1900s, only 140,000 hectares were left by the turn of the century (Lim, 2014). The Philippines coral reef area is also considered as one of the largest in the world at an estimated 22,500 sq. km. However, by the 1980s, 40% of the country's coral reef cover was already in poor condition and this further increased to 53% by the mid-2000s. The area categorized as being an excellent coral cover declined to less than 1% (Lim, 2014).

The DENR–BMB (2016) has identified the key factors that contribute to the continuing destruction of habitats and deforestation. These major threats include:

a. Overexploitation typically leads to exhaustion, particularly by excessive forestry, fishing and hunting (BMB 2015). Illegal logging is a major pressure point. Although a ban has helped curb logging activities, illegal logging activities persist. Based on 2010 satellite images, the Philippines' total forest cover is estimated at 6.840 million hectares. Open forest accounted for almost 67.2 percent of the total forest cover, or 4.595 million hectares (DENR – FMB, 2012).
b. Overlapping mining claims and rights with defined protected areas (PAs) and ancestral lands, including those that are intended as conservation areas. Most of the priority conservation areas in the country have huge mineral reserves which result in conflicts with prescribed land uses and objectives. These, in turn, threaten ecological sustainability.
c. Overpopulation pressures. Given limited land base, the country's expanding population (i.e., annual growth rate of 1.31 percent as of 2021) have led to the conversion of forest areas into agricultural lands and settlements. Moreover, the lack of a comprehensive national land use policy has led to diverging land uses and indiscriminate land conversions.

d. Untenable production and consumption of medicinal and ornamental plants and overharvesting of wild animals for trade and domestic use. These activities have contributed to habitat degradation and significant reductions in species populations.
e. Introductions of invasive alien species have also taken a toll on biodiversity, particularly in wetlands.
f. Adverse effects of climate change. Changes in the timing of biological events, species distribution and plant and animal behavior as well as increased frequency and intensity of pests and diseases have been identified as direct effects of climate change. Moreover, climate change increases the vulnerability of species to extinction. It could also lead to potential losses of net productivity of ecosystems.

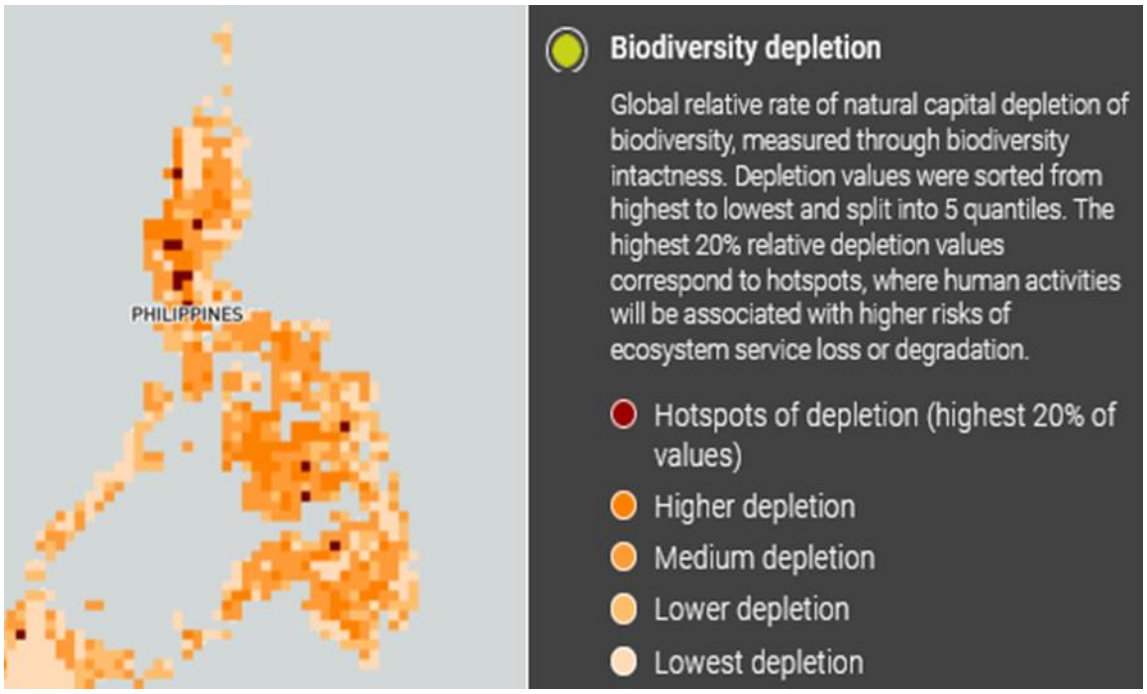
There are also indications of potential depletion of Philippine biodiversity based on global data. The UNEP-WCMC Report (2021)[10] reveals that only a handful of spots in the Philippines can be considered as hotspots of biodiversity depletion (at the top of the 20% quantile); however, a vast portion of the Philippines are categorized at a higher or medium biodiversity depletion (Figure 1). In collaboration with the UN Principles for Responsible Investment (PRI), UNEP-WCMC has developed maps to showcase global hotspots of relative natural capital depletion, made available for visualization in ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure). Among the drivers of environmental change that ENCORE includes are diseases, drought, earthquakes, fire, among others.[11]

The hotspots correspond to areas within the top 20% of relative depletion values for natural capital assets globally. This information will help investors identify potential exposures in their portfolios to natural capital depletion in certain geographies. The same Report finds that although the Philippines is not part of the largest global hotspots of biodiversity depletion, such as the Great Plains in North America, the Southern cone of South America, Southern Africa, Central Asia, and Australia, the biodiversity depletion in the Philippines poses larger challenges, which should be mindful of the market, credit and operation risks associated with the loss of natural capital in these locations. It should be noted that changes in natural capital, such as declines in soil quality and provision of freshwater, as well as the loss of biodiversity, create risks and outcomes for businesses.

[10] The UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is a global Centre of excellence on biodiversity. The Centre operates as a collaboration between the UN Environment Programme and the UK-registered charity WCMC.

[11] Other drivers ENCORE includes in the list are flooding, habitat modification, human modification of genetic material, human movement, industrial or domestic activities, industrial or domestic construction, intensive agriculture and aquaculture, invasive species, landslides, ocean acidification, ocean and current circulation, overfishing, overharvesting, overhunting, pests, pollution, population changes, sea level rise, sea surface temperature, storms, volcanoes, water abstraction, and weather conditions. (Source: ENCORE: Drivers of environmental change at https://encore.naturalcapital.finance/en/data-and-methodology/drivers)

Figure 1
Biodiversity depletion in the Philippines

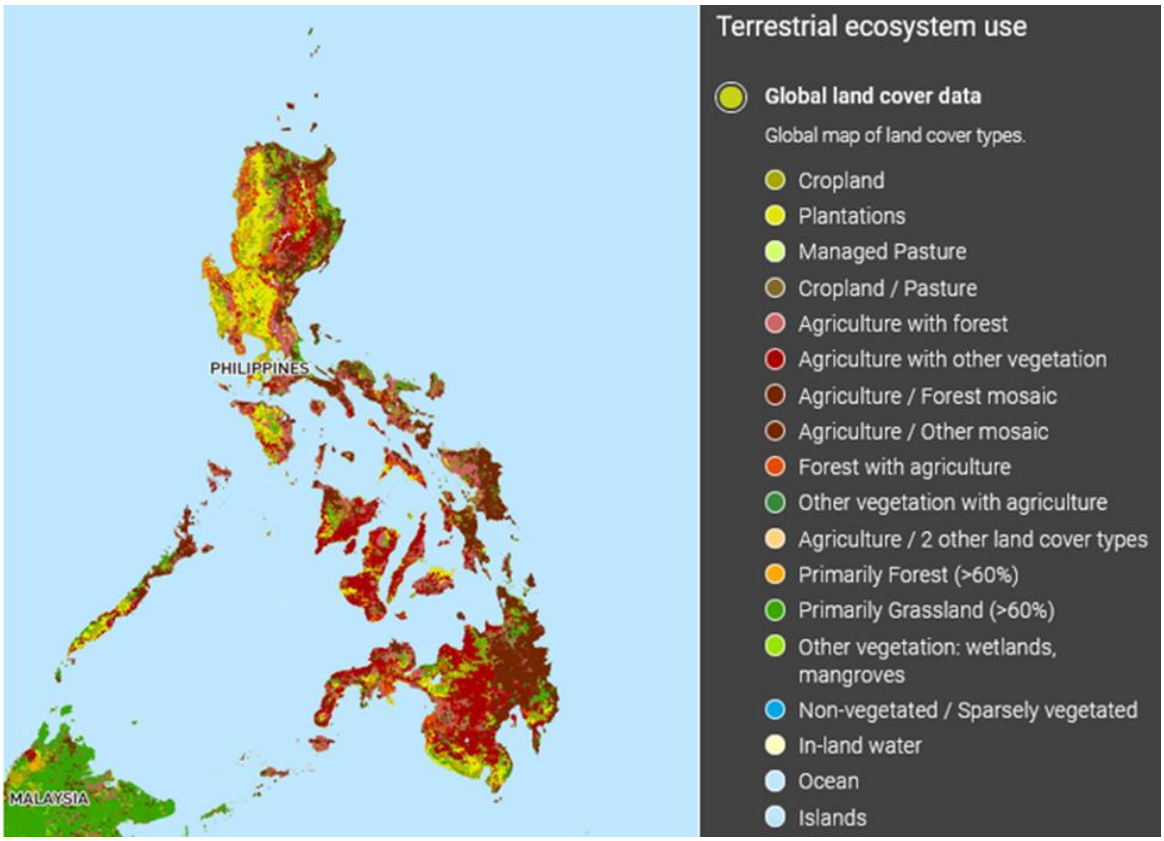


Source: ENCORE

Importantly, these hotspots appear to overlap with terrestrial biomes. The overlap of hotspots of atmosphere depletion with the different biomes are discussed in the UNEP-WCMC Report. Global hotspots of natural capital depletion span 14 terrestrial biomes, with 10 of those biomes having over 50% of their area overlapping with a hotspot of depletion for at least one natural capital asset. For instance, *Tropical and Subtropical Grasslands, Savannas and Shrublands*, one of the largest biomes in the world (over 21 million km2, found across South America, Central and Southern Africa, and Australia) had a 94% overlap with hotspots of natural capital depletion. By contrast, *Boreal Forests and Taiga* (found in Canada, Alaska, Russia and Scandinavia) had the least overlap (14%). Globally, the four biomes with the greatest overlap (*Temperate Broadleaf and Mixed Forests*; *Montane Grasslands and Shrublands*; *Mediterranean Forests, Woodlands and Scrub*; and *Tundra*) are predominantly found in the Northern hemisphere.

Moreover, Figure 2 shows the overlapping of biodiversity depletion with the terrestrial ecosystem use in the Philippines, majority of locations with medium to hotspots of biodiversity depletion are being utilized for commercial or business purposes such as croplands, plantations and various agricultural activities. Biodiversity depletion in these areas poses risks to enterprises engaged in said activities since the delivery of ecosystem services, like pollination, may adversely affect crop production (such as fruits and cereals). Likewise, these locations may provide an opportunity to investments by producing positive outcomes by stopping or mitigating such losses through a transition towards nature-positive activities.

Figure 2.
Terrestrial ecosystem uses in the Philippines



Source: ENCORE (2021)

Tables 3a and 3b present the regions that are hotspots and those that have medium and high probability of depletion. The hotspots of depletion are Regions I, II, III, VII, VIII, X and the National Capital Region (NCR). Specifically, the hotspot of depletion in Region I lies on cropland/pasture. Region II on agriculture with forest, and agriculture and other vegetation. Region III on plantations, and croplands. Region VII on agriculture with forest, and agriculture with other vegetation. Region VIII on agriculture with forest, agriculture/forest mosaic, and other vegetation with agriculture. Region X on agriculture with other vegetation. The NCR is primarily forest (>60%) and cropland.

Table 3a: Regions with Hotspot, High, and Medium Probability of Biodiversity Depletion

No	Region	Region Name	Hotspot	High Depletion Rate	Medium Depletion Rate
1	NCR	National Capital Region	X		
2	CAR	Cordillera Administrative Region		X	

3	I	Ilocos	X	X	
4	II	Cagayan Valley	X		X
5	III	Central Luzon	X	X	X
6	IV-A	CALABARZON		X	X
7	IV-B	MIMAROPA		X	X
8	V	Bicol Region			X
9	VI	Western Visayas		X	X
10	VII	Central Visayas	X	X	X
11	VIII	Eastern Visayas	X		X
12	IX	Zamboanga Peninsula		X	X
13	X	Northern Mindanao	X	X	X
14	XI	Davao Region		X	X
15	XII	SOCCKSARGEN		X	X
16	XIII	CARAGA		X	X
17	BARMM	Bangsamoro Autonomous Region in Muslim Mindanao		X	

Source: ENCORE; Authors.

On regions with locations considered as higher depletion, Table 3b shows that in Region I these spots lie on agriculture with forest, agriculture with other vegetation, and cropland/pasture. In the Cordillera Administrative Region (CAR) these locations are situated on agriculture with forest, agriculture/forest mosaic, cropland, and primarily grassland (>60%). Region II on agriculture with forest, agriculture/forest mosaic, forest with agriculture, and primarily grassland (>60%). Region III consists mainly of plantations with patches of croplands, forest with agriculture, other vegetation with agriculture, and primarily grassland (>60%). Region IV-A on agriculture with forest, and agriculture/forest mosaic. Region IV-B on agriculture with forest, and agriculture/other mosaic with patches of plantations, and other vegetation with agriculture. Region VI on agriculture with other vegetation, agriculture with forest, forest with agriculture, and plantations. Region VII on agriculture with other vegetation, agriculture with forest, plantations, and agriculture/other mosaic. Region IX on agriculture with other vegetation, forest with agriculture, agriculture/forest mosaic, plantations, and cropland. Region X is primarily grassland (>60%), plantations, agriculture with forest, and other vegetation with agriculture. The locations classified as higher depletion in the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) are situated on agriculture with forest, agriculture/other mosaic, agriculture with other vegetation, and plantations. Region XI mainly focuses on agriculture/other mosaic, and agriculture with other vegetation with portions of primarily grassland (>60%), plantations, and cropland. Region XII on plantations, cropland, agriculture with other vegetation, and primarily grassland (>60%). Region XIII on agriculture/forest mosaic, agriculture with forest, and primarily grassland (>60%).

Table 3b: Areas with Hotspot, High, and Medium Probability of Biodiversity Depletion

No	Region	Region Name	Hotspot	High Depletion Rate	Medium Depletion Rate
1	NCR	National Capital Region	Forest and cropland		
2	CAR	Cordillera Administrative Region		Agriculture with forest, agriculture/forest mosaic, cropland, and primarily grassland	
3	I	Ilocos	Cropland/pasture	Agriculture with forest, agriculture with other vegetation, and cropland/pasture	
4	II	Cagayan Valley	Agriculture with forest and agriculture, and other vegetation	Agriculture with forest, agriculture/forest mosaic, forest with agriculture, and primarily grassland	Agriculture/forest mosaic, agriculture with other vegetation, agriculture with forest, forest with agriculture, plantations, and cropland
5	III	Central Luzon	Plantations and croplands	Mainly plantations with patches of croplands, forest with agriculture, other vegetation with agriculture, and primarily grassland	Plantations, cropland, agriculture with forest, forest with agriculture, agriculture/forest mosaic, and primarily grassland
6	IV-A	CALABARZON		Agriculture with forest, and agriculture/forest mosaic	Agriculture with forest, and agriculture/forest mosaic
7	IV-B	MIMAROPA		Agriculture with forest, and agriculture/other mosaic with patches of plantations, and other vegetation with agriculture	Plantations, cropland, agriculture with forest, agriculture/forest mosaic, primarily grassland, and forest with agriculture.
8	V	Bicol Region			Agriculture with forest, agriculture/forest mosaic, agriculture with other vegetation, plantations, cropland, and

					primarily grassland
9	VI	Western Visayas		Agriculture with other vegetation, agriculture with forest, forest with agriculture, and plantations.	Agriculture/forest mosaic, agriculture with other vegetation, agriculture with forest, plantations, and cropland
10	VII	Central Visayas	Agriculture with forest, and agriculture with other vegetation	Agriculture with other vegetation, agriculture with forest, plantations, and agriculture/other mosaics.	Agriculture with other vegetation, agriculture/forest mosaic, agriculture with forest, plantations, cropland, and primarily grassland
11	VIII	Eastern Visayas	Agriculture with forest, agriculture/forest mosaic, and other vegetation with agriculture		Agriculture/forest mosaic with enclaves of agriculture with forest, primarily grassland and plantations
12	IX	Zamboanga Peninsula		Agriculture with other vegetation, forest with agriculture, agriculture/forest mosaic, plantations, and cropland.	Agriculture with other vegetation, agriculture with forest, agriculture/forest mosaic, primarily grassland and plantations
13	X	Northern Mindanao	Agriculture with other vegetation	Primarily grassland, plantations, agriculture with forest, and other vegetation with agriculture.	Agriculture with other vegetation, and agriculture/forest mosaic, managed pasture, and primarily grassland and forest with agriculture
14	XI	Davao Region		Mainly on agriculture/other mosaic, and agriculture with other vegetation with portions of primarily grassland, plantations, and cropland.	Agriculture with other vegetation, and agriculture/forest mosaic with patches of cropland, plantations,

					agriculture with forest, and primarily grassland
15	XII	SOCCKSARGEN		Plantations, cropland, agriculture with other vegetation, and primarily grassland	Agriculture with other vegetation with portions of plantations, croplands, agriculture with forest, and agriculture/forest mosaic
16	XIII	CARAGA		Agriculture/forest mosaic, agriculture with forest, and primarily grassland	Agriculture/forest mosaic, agriculture with other vegetation, agriculture with forest, primarily grassland and plantations
17	BARMM	Bangsamoro Autonomous Region in Muslim Mindanao		Agriculture with forest, agriculture/other mosaic, agriculture with other vegetation, and plantations	Agriculture with forest, agriculture/forest mosaic, and primarily grassland

Source: ENCORE; *Authors*.

For regions with locations categorized as medium depletion, Table 3b shows that such spots in Region II are situated on agriculture/forest mosaic, agriculture with other vegetation, agriculture with forest, forest with agriculture, plantations, and cropland. Region III on plantations, cropland, agriculture with forest, forest with agriculture, agriculture/forest mosaic, and primarily grassland (>60%). Region IV-A on agriculture with forest, agriculture/forest mosaic, plantations, and primarily grassland (>60%). Region IV-B on plantations, cropland, agriculture with forest, agriculture/forest mosaic, primarily grassland (>60%), and forest with agriculture. Region V agriculture with forest, agriculture/forest mosaic, agriculture with other vegetation, plantations, cropland, and primarily grassland (>60%). Region VI on agriculture/forest mosaic, agriculture with other vegetation, agriculture with forest, plantations, and cropland. Region VII on agriculture with other vegetation, agriculture/forest mosaic, agriculture with forest, plantations, cropland, and primarily grassland (>60%). Region VIII mainly on agriculture/forest mosaic with enclaves of agriculture with forest, primarily grassland (>60%), and plantations. Region IX on agriculture with other vegetation, agriculture with forest, agriculture/forest mosaic, primarily grassland (>60%), and plantations. Region X on agriculture with other vegetation, and agriculture/forest mosaic, managed pasture, and primarily grassland (>60%), and forest with agriculture. BARMM on agriculture with forest, agriculture/forest mosaic, and primarily grassland (>60%). Region XI mainly focuses on agriculture with other vegetation, and agriculture/forest mosaic with patches of cropland, plantations, agriculture with forest, and primarily grassland (>60%). Region XII primarily on agriculture with other vegetation

with portions of plantations, croplands, agriculture with forest, and agriculture/forest mosaic. Region XIII on agriculture/forest mosaic, agriculture with other vegetation, agriculture with forest, primarily grassland (>60%), and plantations.

The identification of hotspots of depletion and how these hotspots overlap with the terrestrial ecosystem not only indicate areas where investors should be particularly mindful of the market, credit and operational risks associated with loss of natural capital, but also where investment could have a positive outcome through a transition to nature-positive activities. On one hand, biodiversity depletion in these areas poses risks to enterprises engaged in said activities since the delivery of ecosystem services, like pollination, may adversely affect crop production (such as fruits and cereals). Pollinators (e.g., bees, wasps, butterflies, bats, and birds) generate much needed biological activities to sustain biodiversity and food production, a decline therein would threaten pollination-dependent crops and adversely affect the diversity of plant species (ASEAN Center for Biodiversity, 2017).[12] On the other hand, these locations may provide an opportunity to investments by producing positive outcomes by stopping or mitigating such losses through a transition towards nature-positive activities.

These considerations can feed into further research and analyses required by central banks and financial regulators to understand the regeneration potential for stocks of these natural capital assets or how biodiversity could be protected, the relevant potential indicators of both natural assets and biodiversity and risks associated with these indicators, future policy implications for central banks and financial supervisors.

C. A Survey of Literature in Assessing Potential Financial Impacts from Biodiversity Loss

Recent studies on nature-related risks such as biodiversity loss, deforestation among others, remain relatively scant. Francia (2020) observes that biodiversity is declining at its fastest rate in history and the said decline can be traced to factors such as land conversion, pollution, and human-induced climate change. There is also the study by Johnson et al. 2021, which develops the framework for the first global nature-economy model. The framework integrates select ecosystem services into a computable general equilibrium (CGE) model. The framework allows an assessment of the link between the decline of select ecosystem services—pollination of crops by wild pollinators, climate regulation from carbon storage and sequestration, provision of food from marine fisheries and provision of timber—and the performance of key sectors that rely on these services, such as agriculture, forestry, and fisheries sectors, and related industries.

Moreover, the primary channel linking biodiversity and the economic system are called ecosystem services, which provide the natural environment to help drive economic activities. Showing the exposure of Dutch financial institutions' indirect dependency on ecosystem services, Van Toor et al. (2020) discover that €510 billion (or 36% of the Dutch

[12] ASEAN Center for Biodiversity (2017) "ASEAN Biodiversity Outlook 2," ASEAN Center for Biodiversity.

financial institutions' total portfolio) in investments by the Netherlands' financial institutions are considered as highly or very highly dependent on one or more ecosystem services. Due to the association between biodiversity losses and financial stability, the Banque of France (2021) estimates physical risk on the measure of dependencies on different ecosystem services of firms whose securities are held by French financial companies, and transition risks by measuring the biodiversity impact or footprint of firms whose securities are also held by French financial companies through direct activities or upstream value chains. Using quantitative estimates of dependencies and effects on biodiversity by the French financial system, Svartzman et al. (2021) discover that 42% of the values of securities in the hands of French financial institutions originate from issuers considered as highly or very highly dependent on one or more ecosystem services.

To measure the impact of economic activities on biodiversity and conversely, biodiversity-related financial risks, the Network for Greening the Financial System (NGFS, 2022) discuss emerging methodologies that includes among others, measuring biodiversity footprints, exposure to physical risk from biodiversity loss (Van Toor et al., 2020), assessing dependencies and impacts on ecosystem services by securities held by the financial sectors (Svartzman et al., 2021), and exposure of banks to biodiversity loss through lending to non-financial corporations (Calice et al., 2021).

The impact of biodiversity loss in the insurance industry cannot likewise be discounted, in fact, Augeraud-Veron et al. (2017) use a stylized dynamic model that provides a motivation for biodiversity conservation, which performs a crucial role as an insurance against agricultural productivity fluctuations. The Swiss Re Institute (2020) develops the Biodiversity and Ecosystem Services (BES) Index that provides a color-coded map indicating the state of different ecosystem services in order to provide information to the financial and re/insurance markets for risk protection and capital provisions to clients.

As previously mentioned, the ENCORE database contains maps that help visualize the areas considered as hotspots relative to the natural capital depletion on a global scale. Natural capital is "the stock of renewable and non-renewable resources that combine to yield a flow of benefits to people."[13] In cases of depletion of natural capital, the area loses its capability to support ecosystem services that supports businesses, economic activities, and other human activities. The hotspot depletion that is available in ENCORE indicates areas where investors should be concerned with market, credit and operational risks associated with natural capital loss as well as areas for positive outcomes of investments through transitioning into nature-positive activities (UNEP-WCMC, 2021).

Using the ENCORE database, a report on nature-related financial risks in Malaysia by the World Bank and Bank Negara Malaysia (2022) introduces a spatial analysis of the country's Key Biodiversity Areas (KBA). The said report examines the Malaysian banks' exposure to sectors and regions which are considered as highly vulnerable to nature-related risks. Complementing Bank Negara Malaysia's efforts to build capacity in assessing the local

[13] UNEP-WCMC (2021). Mapping global hotspots of natural depletion: Using ENCORE to identify natural capital risks and opportunities and focus investor engagement. Cambridge, United Kingdom.

financial system dependencies and impact on nature, the report examines three main types of banking exposures as follows: (a) sectors that are highly dependent on ecosystem services and pose physical risk, (b) sectors that negatively affect ecosystem services and pose transition risk, and (c) KBAs that may become protected in the future. The report finds that (a) Malaysian banks are exposed to a wide array of nature-related physical and transition risks; (b) in terms of physical risk, heterogeneity in bank portfolio to one or more sectors which are highly or very highly dependent on ecosystem services (5% to 83% of total commercial loan portfolio); (c) limited exposure of banks to KBAs that may be increasingly protected going forward; (d) using an exploratory set of nature-related events, a wide range of adverse physical and transition risks scenarios can affect banks; and (e) agriculture, forestry, fisheries, and tourism are affected by a number of financial and transition risk scenarios.

A roadmap from the World Wildlife Fund (WWF, 2022) declares that monetary policy authorities, and financial regulators and supervisors must take immediate action on climate change and biodiversity risks since these challenges fall within the respective mandates of said authorities. The said roadmap features a "There Is No Alternative" (TINA) agenda which outlines the measures that monetary authorities and financial regulators should implement within 2022 or 2023 (at the latest).[14] Among the measures included in the TINA agenda are focusing on the contributions for the rapid reduction of GHG emissions and stop biodiversity loss, and adapting an appropriate time horizon in financial regulation and prudential supervision. Accompanying the roadmap is a Technical Background Report that features an in-depth analysis of the role of central banks and financial regulators in addressing climate change and biodiversity losses, the roadmap's theoretical background, and a list of prescribed measures to be implemented by said authorities. The roadmap provides three key takeaways for central banks and financial supervisors: (a) treat biodiversity loss and climate change as single twin crisis and recognize the destabilizing effects on financial and price stability; (b) Using a precautionary approach, work proactively and decisively to prevent future risks, since this is within the ambit of the mandates of central banks, and financial supervisors; and (c) the said authorities should act immediately and use all regulatory and supervisory tools available to significantly reduce greenhouse gas emissions and recover/restore biodiversity in their respective jurisdictions.

In February 2023, the Toronto Centre released a Toolkit that is designed for financial supervisors in emerging markets and developing economies, who are considering how best to respond to climate and biodiversity-related risks, or who have made progress in this area but want to check that they have covered the right topics and are headed in the right direction. The main objective of this Toolkit is to build supervisory capacity in factoring climate and biodiversity-related risks into the assessment of the risks facing financial institutions and of financial stability more generally; the assessment of areas where consumer or investor protection may be needed, including through standards of disclosure to enable investors and consumers to make well-informed decisions; and addressing the impact of climate change and biodiversity loss on financial inclusion.

[14] World Wildlife Fund (2022). Central Banking and Financial Supervision Roadmap: Transitioning to a Net Zero and Nature Positive Economy.

The Toolkit basically argues that work on climate-related risks to the financial sector is generally more advanced than on biodiversity- related risks, including in terms of disclosures, metrics, definitions and analytical approaches. However, biodiversity-related risks to financial institutions, financial stability, consumers and investors, and financial inclusion may turn out to be more important than climate-related risks for some countries and for some financial institutions. Climate and biodiversity-related risks may also interact as more or less equal partners in a harmful way.

Currently, there is a dearth of literature identifying the effects of climate change and biodiversity on the Philippine economy and financial system. Bayangos et al. (2021) use a dynamic panel generalized methods of moments (GMM) with data from a regional quarterly rainfall damage index and branch-level database from supervisory reports of the Bangko Sentral ng Pilipinas. The said paper shows evidence that the financial system in the Philippines is vulnerable to natural disasters and there are direct and indirect costs to banks that can impact banking operations and viability of financial institutions. Other papers include a report by La Viña et al. (2011) which argues that the Philippines should include the environment and natural sectors as a foundation of the country's inclusive growth, and focus on the continuous supply of ecosystem services as a form of natural capital. Ortiz and Torres (2020) discover that agricultural products (such as banana and pineapple) have significant impact on biodiversity in the Philippines, especially through habitat loss, and agricultural land use and land-use change (LULUC).[15] Berba and Matias (2022) study the systematic organization of biodiversity data on plant and animal species in the Philippines and find gaps in documenting biodiversity that can potentially constrain conservation and management efforts.

This paper first explores the extent to which Philippine banks' are exposed to risks resulting from the loss of natural capital, specifically biodiversity, using global data. As we mentioned in the earlier section, we have not studied all the risks caused by biodiversity loss specifically to the financial system. Second, we focus on the initial impact of biodiversity loss on bank-level outstanding credit by universal and commercial banks classified by economic sectors and by Philippine regions, and the resulting total effect on bank capital adequacy ratio by using a stylized bank solvency stress test. The results in this paper therefore represent a baseline for total exposure. The choice of the bank risks is based on the availability of balance sheets and biodiversity data. Moreover, we acknowledge that the interaction between disaster or extreme weather events and biodiversity loss could reveal that the banking system is susceptible to even more exposures toward nature-related risks in general. However, the potential systemic risks created by biodiversity loss have not been considered in the study. To the best of our knowledge, the use of bank-level balance sheet data and global data on biodiversity depletion rate in analyzing the potential impact of biodiversity loss on the Philippine banking system is a first in the Philippines.

[15] LULUC: when forests are cleared to make land available for cultivation.

D. Empirical Approach

Empirical evidence shows that production activities are largely absorbed by domestic institutions. Based on the latest Philippine Financial Social Accounting Matrix (PFSAM)[16], in 2017, about 90.4% of the total production was absorbed by domestic firms. Almost all outputs of electricity, gas and water; construction; public administration and defense; financial intermediation services; agriculture, hunting, forestry and fishing were consumed domestically.

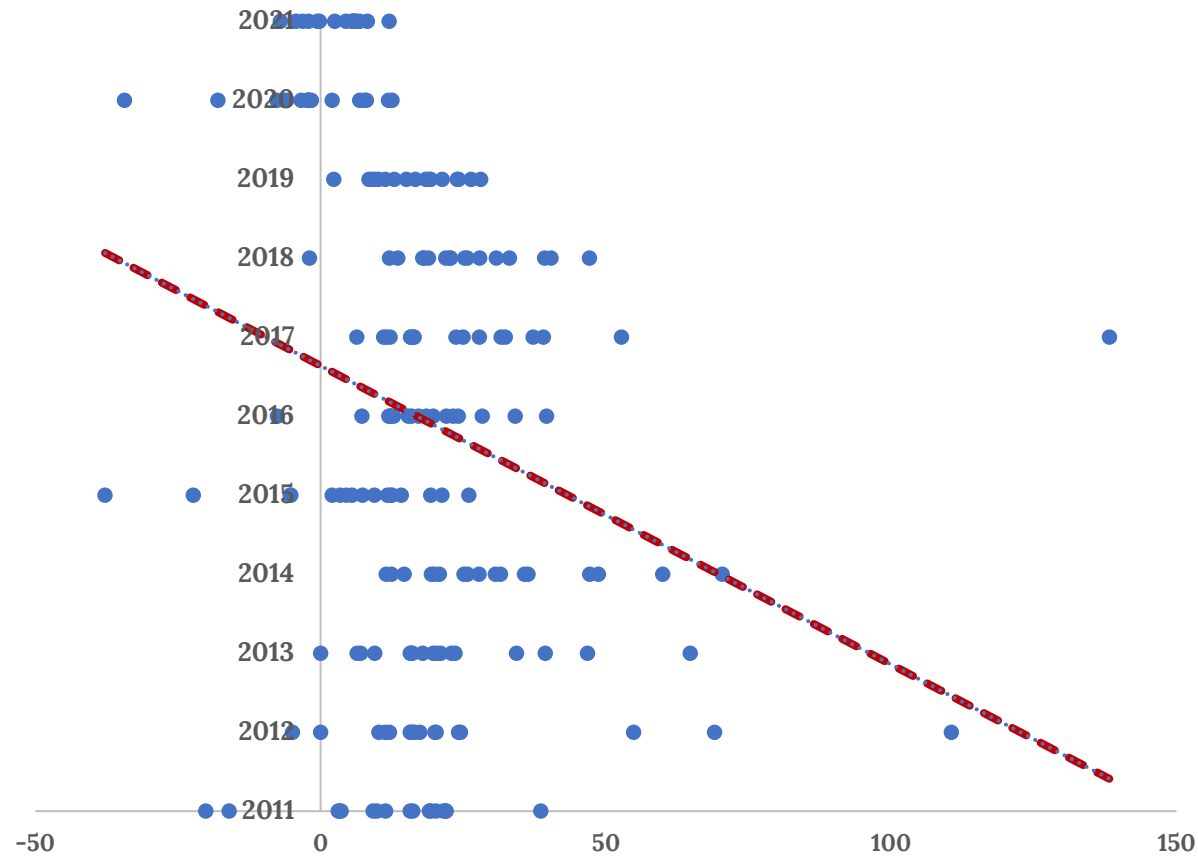
Importantly, banks mobilize deposits to provide the necessary funding to the domestic economy's requirements. Total deposits grew by 13.3% in September 2021 from the same period in 2020 despite the COVID-19 pandemic. The NCR had the largest share of deposit liabilities at PhP10.6 trillion (65.7% of the total), followed by CALABARZON (7.2%), Central Luzon (5.4%), and Central Visayas (5%). All regions registered growth rates, led by SOCCSKSARGEN (24.9%), Ilocos Region (13.6%) and Caraga (13.2%). Credit allocation, meanwhile, remained prudent as loans-to-deposits ratio (LDR) eased further to 62.6% as of September 2021 from 67.5% during the same period in 2020. Most regions (10 out of 17) registered higher LDR, led by Davao Region (4.4 percentage points or ppts), Bicol Region (4.0 ppts) and CALABARZON (3.6 ppts). On the other hand, the regions which recorded the biggest drop in LDR as of September 2021 were NCR and Caraga (- 8.0 ppts each), Central Visayas (-3.1 ppts) and SOCCSKSARGEN (-2.6 ppts). Despite the decline in LDR in the NCR, it is the only region that posted a higher LDR than the nationwide rate at 80.4%, which continued to reflect strong concentration of credit activity in the country's economic center. Other regions with high LDRs were Davao Region (43.2%) and SOCCSKSARGEN (39.5%).

In turn, outstanding loans of the banking system relative to annualized nominal GDP (net of amortization) expanded from 53.5% in 2017 to 56.2% in 2019 and to 58.7% in 2021. The rise in the share of the banking system's outstanding loans to annualized nominal GDP has been driven by the increase in the loans of universal and commercial banks (UKBs), net of reverse repurchase agreements, from 43.5% in 2017 to 47.4% in 2019 and further to 49.5% in 2021 following the increase in loans granted to the manufacturing, wholesale and retail trade, and real estate sub-sectors. In terms of year-on-year (YoY) growth, loans outstanding of UKBs decelerated from 19.4% in 2017 to 10.9% to 4.8% in 2021. Specific decline in growth has been noted in 2011, 2013, 2015, 2018, and in 2020 (Figure 3). However, a recovery has been reported in the first six months of 2022 after rising to 12.0%. Nevertheless, the relationship between the YoY real GDP and UKBs' loans outstanding, net of amortization, has been relatively stable based on the significant bilateral Granger causality between the two indicators from March 2014 to June 2022. Moreover, YoY growth of UKB loans outstanding has been significant in driving real GDP growth as banks provide the financial backbone needed to spur economic growth through business creation and expansion

[16] The PFSAM 2017 provides an overview of the real and financial transactions in the economy. The main objective of PFSAM is to connect the multi-industrial relationships in production to the multi-sectoral distribution of income, consumption, investment in produced and non-produced assets and financial instruments and the interlinkages between the domestic institutions and, in turn, these institutions with the Rest of the World (ROW).

(Dayag, 2019). This means that loans outstanding by regions could be used for analyzing any potential impacts of sources of financial risks.

Figure 3: Outstanding Loans of Universal and Commercial Banks, By Region (Year-on-Year Growth in %) 2011-2021



Source: Authors.

A bank solvency stress-testing exercise using bank-level loans by economic activity and by region. This study uses the BSP framework for stress testing exercises of banks. In March 2011, the BSP through the Monetary Board Resolution No. 17 dated 31 March 2011, approved the conduct of semestral stress tests on banks as part of the BSP's emphasis on pro-active financial surveillance and supervision. There are three components of the BSP bank stress

testing exercise – credit risk stress testing, uniform stress testing[17], and real estate[18]. In this paper, we utilize the credit stress test. The credit risk stress test simulates the stress in credit quality after imposing a 20%[19] and a 50% write-off (i.e., the default rates with zero recovery) on the net carrying amount of loans and investments categorized according to the 21 economic activities based on the 2009 Philippine Standard Industrial Classification (PSIC).[20]

A contribution of this paper is the use of U/KB-level loans outstanding classified by all regions in the Philippines. Individual banks are tested to withstand impairment assuming the 20% and 50% write-off rates against baseline values of CAR. Interbank loans, loans to BSP as well as loans and receivables arising from repurchase agreements are excluded from the credit stress tests since these are deemed to be loans primarily for liquidity purposes. It should be noted that overlaps exist in the assumptions used under the framework and that the classification by economic activity includes the sample bank's largest credit exposures to the top 20 identified conglomerates. In addition, consumer loans to finance residential real estate also fall under loans to the real estate economic activity.

In the absence of more concrete information of biodiversity depletion rate in the Philippines, we first use the biodiversity depletion rate for the Philippines in UNEP-WCMC Report (2021) and the share of each region's loans outstanding for the Philippines. We then extend the information in Table 4 and further identify the three scenarios that represent the assumed impact on banks' outstanding loans by Philippine regions. The assumed decline in outstanding loans by 10%, 15%, and 20% are based on specific declines in outstanding bank loans reported in the previous section: 2011 (-4.9%), 2013 (-4.9%), 2015 (-22.3%, -37.8%), 2018 (-1.9%), and in 2020 or the Covid-19 pandemic year (-1.9%, -18.0%, -34.3%) (Figure 3: Outstanding Loans of Universal and Commercial Banks, By Region, Year-on-Year Growth, 2010-2021). Table 4 shows the weighted assumed impact of various assumptions on depletion rates on bank-level loans outstanding.

[17] The uniform stress testing methodology for market risk covers the two main sources of market risk, namely, interest rates and foreign exchange (FX) rates, based on simplified assumptions which broadly capture the inherent risk emanating from adverse movements of these factors on the trading book, the banking book, and the banks' net open FX position.

[18] Circular 839 dated 27 June 2014 introduced a prudential real estate stress (REST) limit for universal/ commercial (UBs/KBs) and thrift banks (TBs) as a pre-emptive policy measure to ensure the banking system's continuous healthy exposure to the real estate sector. The REST limit shall be applied to universal, commercial and thrift banks on both solo and consolidated bases. An assumed write-off rate of 25 percent shall be applied on a bank's real estate exposures and other real estate property.

[19] Based on the highest recorded NPL ratio of 17.6% following the Asian Financial Crisis (March/June 2012).

[20] Memorandum No. M-2014-009 dated 7 March 2014 changed the basis of classification of loans, from 17 economic activities in the 1994 PSIC to 21 economic activities on the currently existing 2009 Philippine Standard Industrial Classification (PSIC).

Table 4: Regions with Hotspot, High, and Medium Probability of Biodiversity Depletion and Assumed Impact on Outstanding Loans of Universal/Commercial Banks [1/]

No	Region	Region Name	Share of Outstanding Loans to Total Loans (%)	Scenario 1: Medium Depletion Rate (10%)	Scenario 2: High Depletion Rate (15%)	Scenario 3: Hotspot (20%)	Total Impact (%)
1	NCR	National Capital Region	86.9			17.4	17.4
2	CAR	Cordillera Administrative Region	0.2		0.0		0.0
3	I	Ilocos	0.5		0.0	0.01	0.01
4	II	Cagayan Valley	0.5	0.0		0.01	0.01
5	III	Central Luzon	2.0		0.0	0.01	0.01
6	IV-A	CALABARZON	1.9	0.0	0.00		0.0
7	IV-B	MIMAROPA	0.3	0.0	0.0		0.0
8	V	Bicol Region	0.4	0.0			0.0
9	VI	Western Visayas	1.0	0.0	0.0		0.0
10	VII	Central Visayas	3.0	0.0	0.01	0.01	0.2
11	VIII	Eastern Visayas	0.4	0.0		0.01	0.01
12	IX	Zamboanga Peninsula	0.2	0.0	0.0		0.0
13	X	Northern Mindanao	0.6	0.0	0.00	0.0	0.0
14	XI	Davao Region	1.3	0.0	0.0		0.0
15	XII	SOCCKSARGEN	0.8	0.0	0.0		0.0
16	XIII	CARAGA	0.2		0.0		0.0
17	BARMM	Bangsamoro Autonomous Region in Muslim Mindanao	0.02		0.0		0.0

[1/] The impact is a weighted impact based on the share of each region's loans outstanding and assumed depletion rates.
Source: ENCORE; Authors.

Scenario 1 represents the medium probability of depletion rate and assumes a decline of 10% in outstanding loans for regions with medium probability of depletion rate. Scenario 2 represents the high probability of depletion rate and assumes a decline of 15% in outstanding loans from the baseline. Scenario 3 is the hotspot scenario and assumes a 20% in regions which are considered hotspots for biodiversity depletion. The total impact

assumes a higher decline in outstanding loans for banks in regions which capture higher share of total loans and considered hotspots, with medium and high probability for biodiversity depletion. Table 4 shows that bank loans to the National Capital Region pose the highest impact of biodiversity depletion at 17.4%.

We then assume that agriculture, hunting, and fishery and hotel and restaurants (including eco-tourism sub-sector) as the most affected sectors by biodiversity loss in all 17 regions. KPMG (2021) shows that industry sectors that are most at risk from biodiversity loss are food and agri-business, consumer and industrial manufacturing, infrastructure, energy and natural resources, financial services, asset management and insurance. Among these sectors, food and agri-business is seen as highly natural-resource dependent. We then use this as a shock for credit risk and its impact on U/KB-level solvency. This is a first approximation of the direct impact of biodiversity. The linkages with other sectors are yet to be identified.

Different scenarios in this stress test influence the credit risk, market risk, and profitability of individual institutions. This, in turn, has an impact on banks' balance sheets and profit and losses through changes in the loan loss provisions, RWAs, and market gain/losses. Based on actual aggregates, the U/KBs' credit RWAs averaged at 87.5 from 2010 to 2021. Actual credit RWA has risen from 83.0 in 2012 to 90.0 in 2018 before it dropped to 87.5 in 2021. Across scenarios, we assume additional provisioning of 20% in annualized net income. In turn, we use the information to adjust the capital and credit RWA.

We take our approach as an area for future research. Our methodology broadly follows the standard method by the International Monetary Fund (IMF) for the climate stress tests. While the IMF usually uses a macro-approach to translate climate scenarios into economic shocks, which are then linked to the financial sector with financial risk and banking stress-testing models, we follow a bottom-up approach. We focus on biodiversity depletion rate and its impact on bank solvency using regional loans outstanding or the bottom-up approach. In many studies, the solvency of a bank refers to its ability to pay its debts over all horizons (short, medium and long term). It implies that the amount of the bank's assets exceeds the amount of its liabilities, that is, its capital is positive or that it exceeds a minimum threshold. A good approach to see the strength of a bank's solvency is through a stress test. The solvency stress test assesses whether banks have adequate capital buffers to withstand a set of nature-related shocks envisioned under one year. The typical stress testing exercise includes a three- or four- year horizon. Our test only considers a year of impact analysis. The different years that are later presented are not interconnected over time and each year is treated as a static balance sheet approach independently.

Importantly, our approach does not account for regulatory relief/forbearance and borrower-support measures adopted during the COVID-19 pandemic. The different scenarios influence the credit risk, market risk, and profitability of individual banks. This, in turn, has an impact on banks' balance sheets and profit and losses through changes in the loan loss provisions, risk-weighted assets (RWAs), and market gain/losses. Post-stress

capital is calculated by adjusting the initial capital (C_0) of each bank and the U/KB industry with the stressed income (I_s) and the stressed RWA (RWA_s), as follows:

$$CRs = \frac{C0+Is}{RWAs} \quad . \qquad (1)$$

The stress test depends on estimating two major accounts: the risk-weighted assets and capital requirements for risk-weighted assets. Risk-weighted asset refers to an asset classification system that is used to determine the minimum capital that banks should keep as a reserve to reduce the risk of insolvency. Banks face the risk of loan borrowers defaulting or investments flatlining, and maintaining a minimum amount of capital helps to mitigate the risks. The different classes of assets held by banks carry different risk weights, and adjusting the assets by their level of risk allows banks to discount lower-risk assets.

Our approach assumes the following:

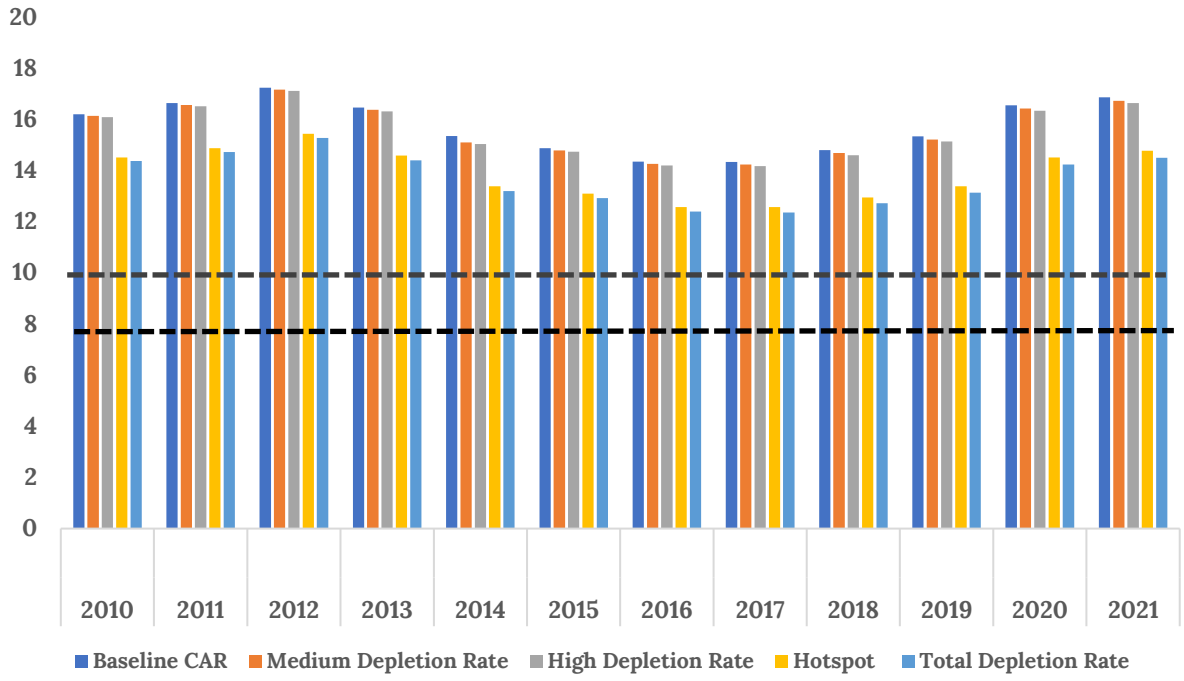
The initial bank capital and the resulting CAR for the industry is taken on solo basis and data on annualized bank profit and loss compiled from the semestral BSP Report of the Philippine Financial System, and balance sheet data from the Financial Reporting Package. Moreover, capital requirements refer to the minimum capital that banks are required to hold depending on the level of risk of the assets they hold. The minimum capital requirements set by regulatory agencies such as the Bank for International Settlements (BIS) are designed to ensure that banks hold enough capital, proportionate to the level of risk of the assets they hold. Bank capital acts as a cushion of cash if the bank incurs operational losses during its operations. In the absence of more detailed data on qualifying capital, Tier 1 ratio and CET 1 ratio, our methodology uses solo capital adequacy ratio.

When calculating the risk-weighted assets of a bank, the assets are first categorized into different classes based on the level of risk and the potential of incurring a loss. The banks' loan portfolio, along with other assets such as cash and investments, is measured to determine the bank's overall level of risk. This method is preferred by the Basel Committee because it includes off-balance sheet risks. It also makes it easy to compare banks from different countries around the world. Riskier assets, such as unsecured loans, carry a higher risk of default and are, therefore, assigned a higher risk weight than assets such as cash and Treasury bills. The higher the amount of risk an asset possesses, the higher the capital adequacy ratio and the capital requirements. On the other hand, Treasury bills are secured by the ability of the national government to generate revenues and are subject to much lower capital requirements than unsecured loans. We only focus on the movements of the share of credit risk to total risk-weighted assets. The bank-level share of credit risk to total risk-weighted assets is then derived from the CAR. Meanwhile, the average annual credit risk-weight from 2010 to 2021 for the U/KB industry is 87.5%.

E. Results

Using equation (1) in the previous section, the results are certainly sensitive to assumptions. In this initial study, we conducted a solvency stress test exercise across the U/KBs' balance sheets from end-December 2010 to end-December 2021 using a fixed assumption on biodiversity depletion rate. Gross exposures in bank balance sheets, such as loans and holdings of debt securities, are actual. We then compare the stressed CAR with the 10% BSP and 8% BIS thresholds to see the resilience of banks to withstand various scenarios of assumed depletion rate.

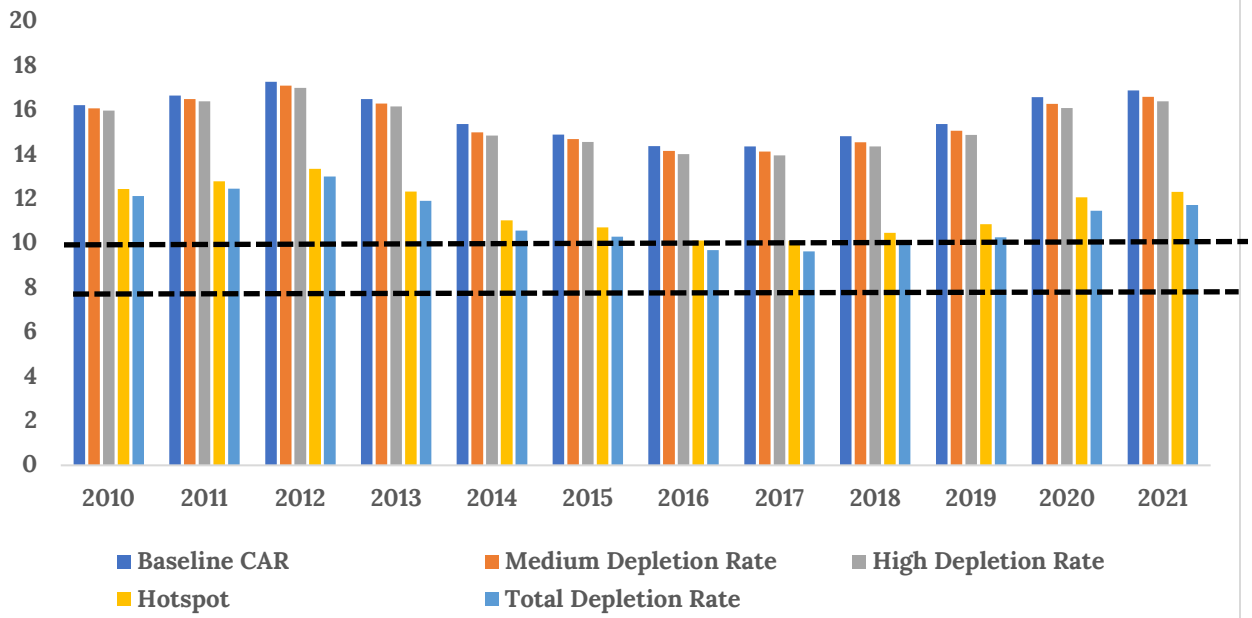
Figure 4: Equation 1: Bank Solvency Test Results (Without Income)
End December, 2010-2021, In %



Source: Authors.

The results show that without any adjustments in bank income, higher probability of depletion would not cause extreme bank solvency risk on its own as banks continue to post CARs above the BSP and BIS thresholds across scenarios (Figure 4). In addition to the impact of tail events, such as a Covid-19 pandemic or extreme weather events, biodiversity depletion would reduce bank capital ratio by less than 1 percentage point across scenarios.

Figure 5: Equation 1: Bank Solvency Test Results (With Income)
End December, 2010-2021, In %

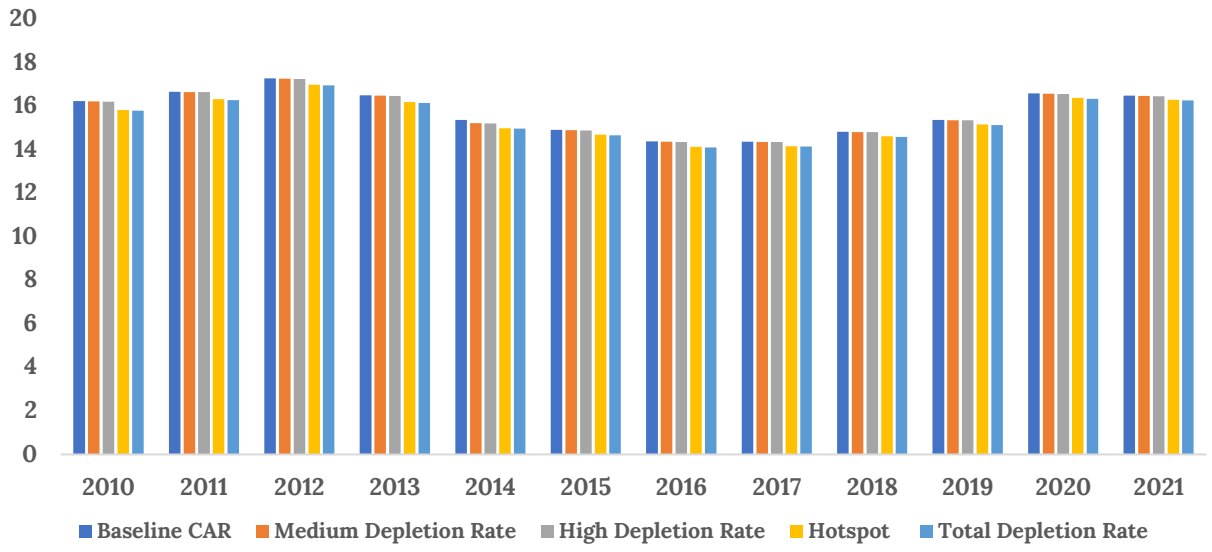


Source: Authors.

With the inclusion of the impact on bank income, the effects of biodiversity loss remain marginal for those regions which are assumed to have medium to high biodiversity. The impact deepens for banks whose loan exposures to regions that are classified as hotspots such as the NCR. Bank CAR slides by 4.6 percentage points from the baseline CAR in December 2021 (Figure 5).

Using the weighted loans outstanding by economic activity (or the share of loans by economic activity to total loans outstanding) in Figure 6, the total impact on CAR remains modest at an average of 0.3 percentage point from 2010 to 2021. It should be highlighted that R/CBs which are particularly active in those hotspot areas might be particularly at risk. Bayangos et al. (2021) found evidence of a deterioration in loan growth and loan quality following extreme rainfall events from 2014 to 2018 in branches of U/KBs and R/CBs in those hotspots. Specifically, compared to actual data, total outstanding bank loans decline, on average, by 12.5% from 2010-2021 if the effects of biodiversity loss are taken into account. It should also be emphasized that the current focus of this initial study is on the direct impacts, not including supply and value chain impacts or the indirect impacts. Considering that almost 70% of lending goes to NCR, it is reasonable to assume that such indirect effects could also emerge and be material. Moreover, by economic activity, the Agriculture, Forestry and Fishing (AFF) sector provides the largest amount of intermediate goods and services to the economy as mentioned in the previous section. The AFF sector is connected to almost all industries either directly or indirectly. Thus, other sectors of the economy have a high dependency on the AFF. This also means that the indirect impacts could even be larger than the direct impact.

Figure 6: Equation 1: Bank Solvency Test Results (With Income)
End December, 2010-2021, In %



Source: Authors.

F. Conclusion

This paper first identified the extent to which Philippine banks are potentially exposed to physical risks from biodiversity loss using bank-level data of universal and commercial banks and global data on biodiversity loss from 2010 to 2021. We then explored the possible impact of biodiversity loss on bank solvency. Currently there are limited methodologies for assessing economic impacts of nature and biodiversity loss. Likewise, scenarios are currently missing. This is what the NGFS Nature Task Force currently tries to address. We emphasized that we have not analyzed all the risks caused by biodiversity loss due to limitations in data. Hence, we focused on the initial impact of biodiversity loss on bank-level outstanding credit, the ensuing credit risk, and the total effect on bank capital adequacy ratio through a stylized bank solvency stress test. Other potential risk channels, such as market risk, are currently not considered. Nevertheless, the results of the stress tests show that the initial impact of biodiversity loss on the banking system remains modest.

The initial results of the paper bring us to a discussion on the key role of governments in creating a conducive ecosystem for business and the financial sectors, such as in setting conditions and incentives that encourage private investment in nature-positive projects,

including projects for the conservation of biodiversity. Moreover, the results also bring implications on the challenges of estimating the impact of not just biodiversity loss but nature-related risks on the banking system. Some studies observe that biodiversity loss, just like climate change, is an external driver of financial risk, which poses physical, reputational, and financial risks to the financial sector. In recent past years, few central banks have embarked on assessing the exposures of financial institutions. Given these exposures, financial institutions have a duty to carry out risk assessment of their portfolios and request disclosure from the clients they invest in.

One of the main characteristics of climate and nature risk in the literature is that the future might not resemble the past, hence working with historical observations might not fully grasp the potential impact of those risks. Economic agents understand a system's structure and nature of uncertainty sufficiently well so that they can put probability over potential outcomes and then formulate optimal policies to maximize expected utility (so-called predict-then-act framework). Modern macroeconomic models with general equilibrium structures and rational expectations are based on such premises to formulate optimal monetary or fiscal policies. However, the type of uncertainty climate scientists face is so "deep" that agents cannot even estimate or assign probabilities over potential outcomes (IMF, 2022).

Historically, an alternative to the predict-then-act framework to cope with tail risks and greater uncertainty has been scenarios, namely, stress tests. Scenario analysis sheds light on tail events that have very low probability but extremely high impact. These events may not affect optimal policy choice under the predict-then-act framework since their likelihood is very low. Nevertheless, the framework shares first approximations of the likely impact on variables of interest.

More recently, nature-related policy discussions started to emphasize the importance of good decision making under deep uncertainty. However, deep uncertainty with climate change means that we should be cautious when drawing policy conclusions from stress test results. Our stress tests are subject to deep uncertainty at multiple levels, climate scenario, climate model for the Philippines, Catastrophe (CAT) risk model, macro-financial model, and stress testing model. Therefore, trying to draw prudential policy implications at this stage is premature.

At this current stage, more exploratory work to examine the potential impact of biodiversity loss and the broader natural capital depletion, on financial stability would need more focus and analysis. As for physical risk, inter-agency collaboration, including non-government agencies (NGOs) and academic/research institutions on dependencies and exposures by economic agents such as the Philippine Statistics Authority (PSA), Department of Environment and Natural Resources (DENR), Bankers Association of the Philippines, Chamber of Thrift Banks (CTB), Rural Bankers Association of the Philippines (RBAP), World Wildlife Fund-Philippines (WWF-Philippines), is critical. The issue of deep model and scenario uncertainty would need to consider a variety of models and scenarios, including the interaction between climate change risks, including the impact of the intensity and

frequency of extreme weather events, and biodiversity and natural capital depletion and their combined impact on financial stability.

To increase the confidence in stress test results, it is also essential to improve data. As for the banking sector data, it will be good to increase the granularity of the exposure data by industries and locations. Improve the collection of loan-to-value (LTV) ratio to help assess risks from real estate loans and from other relevant sectors, regardless if LTV is used as a prudential tool or not. Also, further strengthening the disclosure requirements could enrich firms' and financial institutions' exposures to biodiversity loss and other nature-related risks. Such information would be helpful in identifying more micro-level channels of the linkages between biodiversity and natural capital and financial stability. Following Van Toor et al. (2020) paper, calling for financial institutions to assess their own biodiversity-related risks, and arguing it a question of sound financial risk management.

On the regulatory side and following Van Toor et al. (2020) paper, supervisory authorities ensure that financial institutions report on their biodiversity risks and resilience. In December 2022, the BSP launched an 11-Point Strategy for Sustainable Central Banking (SCB) to promote sustainability principles and practices in its own policies and operations and in the financial system. Under the SCB, the BSP, through the Taskforce on Nature-related Financial Disclosures (TNFD), is expected to undertake exploratory work on risk management and disclosure frameworks for banks to report and act on nature-related risks. Meanwhile, the local sustainable finance taxonomy is currently being developed by the BSP, Securities and Exchange Commission (SEC), and the Insurance Commission (IC) under the auspices of the Financial Sector Forum. The taxonomy could also be eventually enhanced to include nature-related aspects.

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