# Dependencies and impacts of the Mexican banking sector on ecosystem services

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# Abstract

In recent years, a wide consensus has been reached that financial markets do not price adequately environmental risks like climate change and biodiversity loss. To bridge this gap, globally an important body of work is taking on financial risks related to climate change.

Incipient work is being done in relation to financial risks related to biodiversity loss. It is also well-known that there is a close link between climate change and biodiversity loss and to consider them separately could lead to inadequate assessments of environmental risks to the economy as a whole and to the financial system in particular. Mexico is among the most biodiverse countries in the world, and biodiversity loss is an all-important phenomenon which brings severe consequences for the economy, the well-being of its population and the financial system as well. In this report we start to explore, from a broad perspective, the relationship between the natural capital in Mexico and the economy. Then, we estimate the dependency of the banking system on ecosystem services and study its exposure and possible economic losses related to biodiversity loss. In doing so, we are able to identify relevant sectors and ecosystem services for financial stability.

# Introduction

# 1

In recent years, a wide consensus has been reached (among academics, investors and financial authorities) about the inadequate pricing by financial markets of environmental risks like climate change and biodiversity loss. While there is an important body of work that is taking on climate change and financial risks little work has been done in relation to biodiversity loss. Fortunately, this gap is being addressed by different private and public stakeholders notably international organizations and multilateral development banks. It is natural to start by analyzing the close link that exists between climate change and biodiversity loss. To consider them as separate could lead to inadequate assessments of risks to the whole economy and to the financial sector in particular.

Mexico is a megadiverse country, that is, a large percent of global biodiversity (ecosystems, species and genetic diversity) occurs within its boundaries. Megadiverse countries have certain commonalities, e.g., large areas with ecological complexity that can harbor different ecosystems and the ecosystem services they can provide. For instance, Mexico ranks as the fourth country with the largest number of species of flora and fauna, which provide key provisioning, regulating, cultural and supporting services. Unfortunately, the country has not escaped from the global trend of human induced fast environmental degradation, which has lead into a global biodiversity crisis IPBES (2019). As we are embedded in nature, loss of natural capital and biodiversity loss in Mexico is currently one of the major environmental threats for sustainable development, with severe consequences for our well-being, the economy and the financial system.

Human development depends on the exploitation and transformation of natural and anthropized ecosystems. The biodiversity (including biomes, species, ecosystems and genetic variation) within those environments is directly associated with the nations' natural capital. As Dasgupta (2021) has clearly shown, natural capital not been considered in our economic analysis at our peril. Its contribution to human well-being and wealth can no longer be disregarded. The goods and services provided by ecosystems are essential to our very existence. We can no longer ignore that natural capital underpins other forms of capital, or are transversal to the processes of goods accruing.

In this report, focused in Mexico, we start to explore the relationship between natural capital and the financial system from a broad perspective. Then, we estimate the dependency of the banking system to ecosystem services and study its exposure and possible economic risks related to biodiversity loss. In doing so, we are able to identify relevant sectors and ecosystem services for financial stability. This is the first approach to this important subject and further lines of work are also explored.

**The views expressed in this work are those of the authors and do not represent the views of their respective institutions. The authors are grateful to Rafael Del Villar Alrich, Laura del Carmen O'Dogherty Tabora Solares and Edna López Estrada for their valuable comments.*

In order to pursue a sustainable development, a transition to an economy in which natural capital is preserved and even restored is needed. We aim to provide a data-driven analysis that supports informed decisions of the different stakeholders. Importantly, in Mexico CONABIO,[1] has been evaluating the biodiversity's health and the condition of ecosystems, and has been developing tools and frameworks for their adequate monitoring. For instance, two of these tools are the Ecological Integrity Hierarchy Framework (EIHF) and the Natural Capital Index Framework (NCIF), described in Mora (2019) which are used to compute ecosystem indicators for monitoring and supporting policy and decision making purposes.

In this work, we study the temporal variation of the Natural Capital Index (NCI) from 1985 to 2021. The NCI is a spatial adjustable indicator which takes into account the quantity and quality of remnant ecosystems[2] after being impacted by human activities. The NCI is composed of two main spatial measures. The natural area index quantifies the amount of remnant natural not being transformed from the resulting process of human activity. Second, the quality in remnant ecosystems is evaluated according to their capacity of sustaining ecological processes on the long term. This quality property is evaluated by the Ecological Integrity Index, as an overall indicator of the emergent property that allows to sustain evolutionary and ecological process in a stable, autoorganized natural systems Mora (2019). Therefore, the temporal variation of the NCI allows us to detect significant changes in natural capital, and shows the rate and geographic locations where it has been degraded or lost. The NCI was analyzed for the years in which spacial information of remnant natural areas in Mexico is available (1985, 1993, 2002, 2007, 2011, 2014 and 2021). This information is provided by the National Institute of Statistics and Geography (INEGI by its acronym in Spanish).

The NCI shows an important steady decline on Natural Capital (NC) in the Mexico as will be shown further along this paper. The index helped us monitor changes of natural areas and biodiversity loss in the country, and identify the locations of resulting ecological degradation. This ecological degradation, shown in the maps and on **Table 1**, has likely significant implications for our well-being and might put the Mexican economy at risk as well as the stability of its financial system.

*[1] The "Comisión para el conocimiento y uso de la biodiversidad" (CONABIO) was created in 1992 as an interministerial permanent commission.*

*[2] Remnant ecosystems refers to ecological groups and geographical areas which contain natural flora and fauna that haven't been severely affected or transformed by humans or invasive non-native species.*

Given that this is a report produced by the Mexican central bank, an important question that arises is: how do the concepts of biodiversity, natural capital and ecosystem services relate to a central bank? The answer is not simple and has many different important aspects. Nevertheless, a shortened answer is that all the economic activity, and the financial system as a consequence, depend directly or indirectly on the services that biodiversity and ecosystems provide.

The financial system faces potential physical risks in the case that these services are no longer available. In turn, the financial system has an impact on biodiversity and ecosystems through its investments and also faces the prospect of transition risks, as it is explained in NGFS-INSPIRE (2022).

We also studied the dependencies and impacts of the Mexican financial system to ecosystem services by resorting to the ENCORE[3] database. The exposures used for this study comprise direct loans and securities holdings from several types of financial institutions: banks, brokerage houses, pension funds, insurers and credit societies.

Only the banks' credit portfolio information contains information of its geographical location and economic sector at the municipality level where the loans were granted. This information allows us to identify exposures in municipalities with relatively high or low NCI and loans granted to municipalities in which there are protected areas (at the federal and municipal level).

In principle, the fact that there are loans granted in municipalities with either high NCI or are part of or contain natural protected areas does not imply that there will be a negative impact on the ecosystem services of such municipality. Nevertheless, such loans and the banks which grant them, face higher physical and transition risk. Nevertheless, some of the identified loans are located on municipalities with high NCI or which are part of a natural protected area, belong to economic activities which have high or very high impact to biodiversity and ecosystem services.

The rest of the paper is organized as follows: **Section 2** introduces the Natural Capital Index for Mexico, **Section 3** describes the different data sources used in this work and provides some descrip- tive statistics of the data. **Section 4**, shows the dependencies and impact of the Mexican financial institutions to ecosystem services. **Section 5** shows the relationship between credit exposures vs NCI and Natural Protected Areas. Finally, **Section 6** concludes the report.

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[3] *The database was developed by the Natural Capital Finance Alliance, see: https://encore.naturalcapital. finance/en*

# Natural Capital in Mexico

# 2

In the last two centuries, the world, including Mexico, has gone through a considerable anthropogenic transformation of the natural landscape, and this trend has worsened during the last decades. This transformation, mostly occurring since the middle of the 20th century, has affected negatively the natural environment. We are facing an incredibly fast environmental degradation and biodiversity loss at rates never seen before. Many crucial ecosystems have been highly impacted and are under severe stress, with the subsequent loss of critical natural capital, and leading into a situation where the loss of natural areas could reach critical tipping points after which the damage caused is irreversible and no further restoration might be possible.

Biodiversity loss and ecological degradation are negatively affected by climate change and they, in turn, can accelerate climate change. Environmental degradation that negatively impacts critical global biomes, which are necessary to preserve the world's ecological balance, can lead to further increase in global climate instability. Therefore, the result of an ongoing global degradation is the irreversible loss of natural capital and ecological processes, and this, consequently, increases the possibilities of a less foreseeable future for sustainable development.

Natural capital is defined as the world's stocks of natural assets that provide essential benefits from nature. We are embedded in nature and cannot exist without it. It is from natural capital that humans derive a wide range of ecosystem services, which make human life possible. Gradual depletion of natural capital is catastrophic as we depend on the productivity and resilience of ecosystems. Without natural capital, sustainable human development is not possible.

For a country with many different ecosystems like Mexico, due to its geographic characteristics, it is challenging to measure and monitor the state of the ecosystems, species and biodiversity, and, therefore, the complete set of assets that define the natural capital. Such analysis, is a prerequisite to develop adequate spatial tools and metrics that can guide decision making that fosters preservation and restoration of national ecosystems. Most of these new tools have used proxies for ecosystem integrity, which are derived from attributes that describe structure, composition function. Metrics like these, can be used for evaluating the overall state of diverse ecosystems, and provide ecological information to preserve and restore them.

As such, biodiversity indicators have evolved from metrics that measure the number and diversity of organisms to more complex metrics that describe in a more comprehensive manner the state of ecosystems. Among some of such indicators, Ecological Integrity (EI) is a central concept to assess the state of ecosystems. According to Parrish et al. (2003), EI can be defined as

*"... the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region."*

Thus, the NCI provides enough information for evaluating the condition of natural ecosystems based upon ecological integrity. The greater the ecological integrity is preserved after human impacts, the greater is the remnant natural capital. Therefore, NCI summarizes the condition of ecosystems, and the quality on which ecosystem services can be provided.

In this work, we use the NCI proposed in Bálint Czúcz et al. (2012) and implemented for Mexico in Mora (2019) as the indicator of the state of ecosystems in Mexico. The NCI can be computed at different geographical levels: landscape units of eco-regions; Environmental Units of Ecological Ordination (UAOT); and Administrative Units (Municipalities). In this work we use the NCI at the administrative unit level (i.e., municipalities) because that is the level at which we can link the financial system exposures to biodiversity loss. The NCI is composed by two main indicators: the Ecological Integrity Indicator (EII) as proposed in Mora (2017a), Mora (2017b) and Mora (2018); and the remaining ecosystem size as proposed in Bálint Czúcz et al. (2012).

The index is computed in the following way:

NCI = *Ecosystem quantity(remnant natural areas)×Ecosystem quality(ecological integrity)*

The ecosystem quality or ecological integrity can be interpreted as the ecosystem's state to sustain ecological processes. As a proxy, this is an indicator that results from the evaluation of the natural habitat condition for sustaining viable populations of top predators in Mexico, after being impacted by human activities (i.e., habitat loss and fragmentation), Mora (2017a). The evaluation of ecological integrity includes the interaction networks of 38 species of top predators (mammals and birds of prey) which includes pumas, wolf, jaguar, ocelot, several raptors such as eagles and falcons; and their interactions with their preys whitetail deer, mule deer, collared peccary, white lipped peccary, tapir. These large size species are characteristic of ecosystems with high integrity, since they require a wide space and their presence indicates good conditions to support predator-prey interactions and can be used as a metric of ecosystems quality.

For the ecosystem quantity indicator, an estimation of remaining areas with natural vegetation that can be considered as suitable habitat for predator-prey species is used. The amount of suitable habitat is calculated directly from the information documented by the Mexican National Statistics Institute (INEGI) through the vegetation and land use change maps, which exists since 1980. Unfortunately, such maps are not created yearly but around every seven years. For those years in which the INEGI maps exist, we were able to compute the NCI.

**Figure 1 and 2** show the NCI at the municipality level in Mexico in 1985 and 2021, respectively. The boundaries of the national states are shown in gray for the sake of clarity. The NCI values are shown in a red-yellow-green scale, corresponding to the values going from 0 to 1, and yellow for the middle value. In 1985, high values of the NCI are observed in large contiguous areas, predominantly in the Baja California Peninsula, the Northern part of the country and the Yucatan Peninsula, followed by scattered zones along the Pacific coast, and the state of Chiapas (in the southernmost part of the country). The Gulf of Mexico state of Veracruz is predominantly in the lower values of NCI, as well as the transversal corridor between the two oceans, going from the state of Jalisco to Puebla, an area with intense agricultural and industrial activities; Mexico City is embedded in this region.

**Figure 2** shows the NCI at the municipality level in 2021, the latest year with available data. In general, it is observed a significant decrease for most of the municipalities in their NCI. In figure 3 we will show the difference between those years in more detail. In 1985 73.5% of the land area had an NCI over 0.5; in 2021, it went down to 58.9%. In contrast, in 1985, 10.4% of the land area had an NCI below 0.2; in 2021, it increased to 19.6%. The degradation deepened and tended to connect those areas already degraded along certain corridors, such as the coastal plains in the Gulf of Mexico, the northern part of the Yucatan Peninsula, and the coastal plains in the Pacific, particularly those neighboring the Gulf of California.

**Figure 3** shows the losses on NCI in Mexico from 1985 to 2021 computed at the municipality level. The intervals for the loses are displayed in the legend; then, the first parentheses show the number of municipalities, and the second parentheses show the corresponding percentage of total area. Green shades represent NCI gains, and correspond to 511 municipalities that cover approximately 4.3% of the total land area, which are generally smaller in size, with exceptions in the northern part of the country. NCI losses are represented with shades of red. There are 1081 municipalities whose NCI loss is less than 0.1, and represent 50.8% of the total land area.

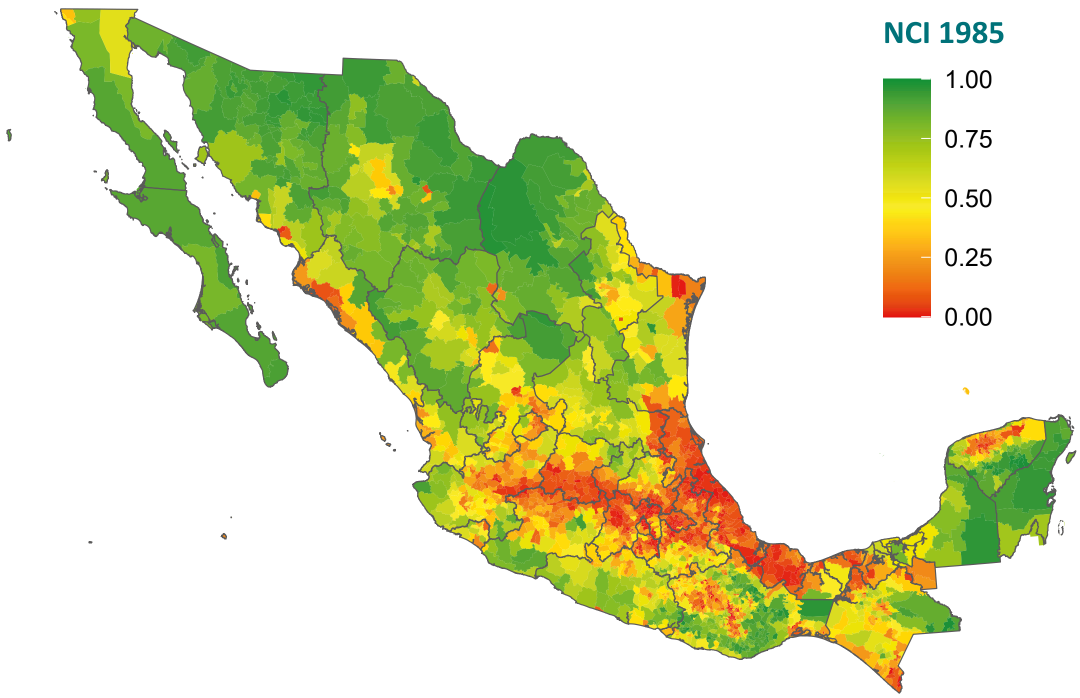


**Figure 1:** Natural Capital Index by Municipality in 1985.

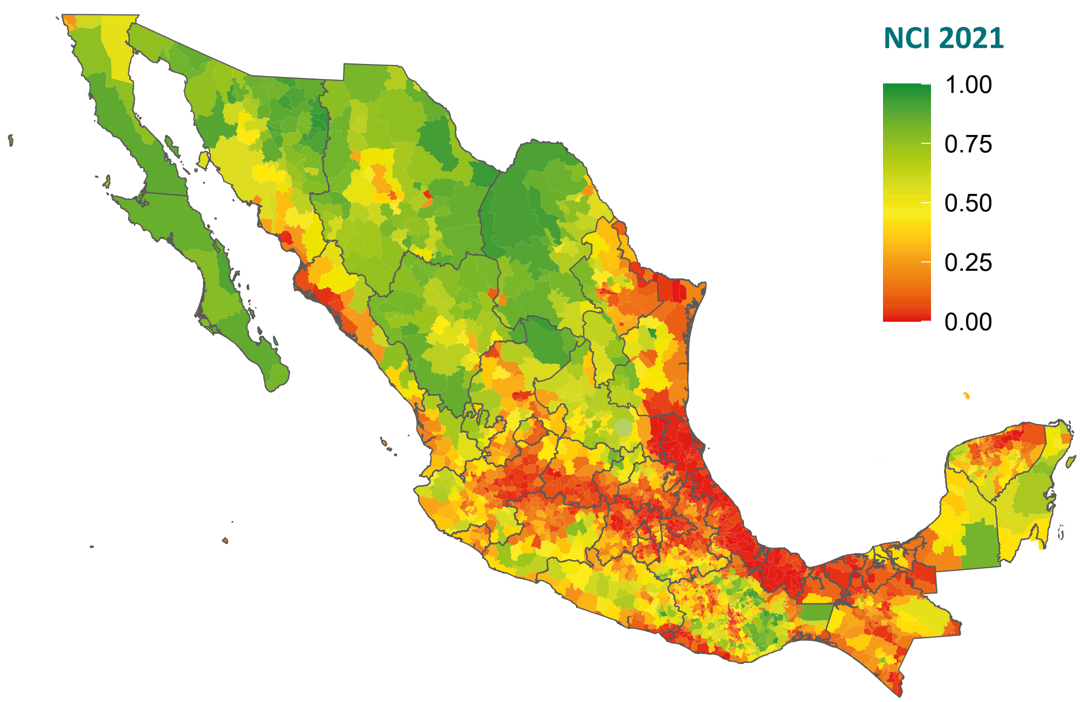


**Figure 2:** Natural Capital Index by Municipality in 2021.

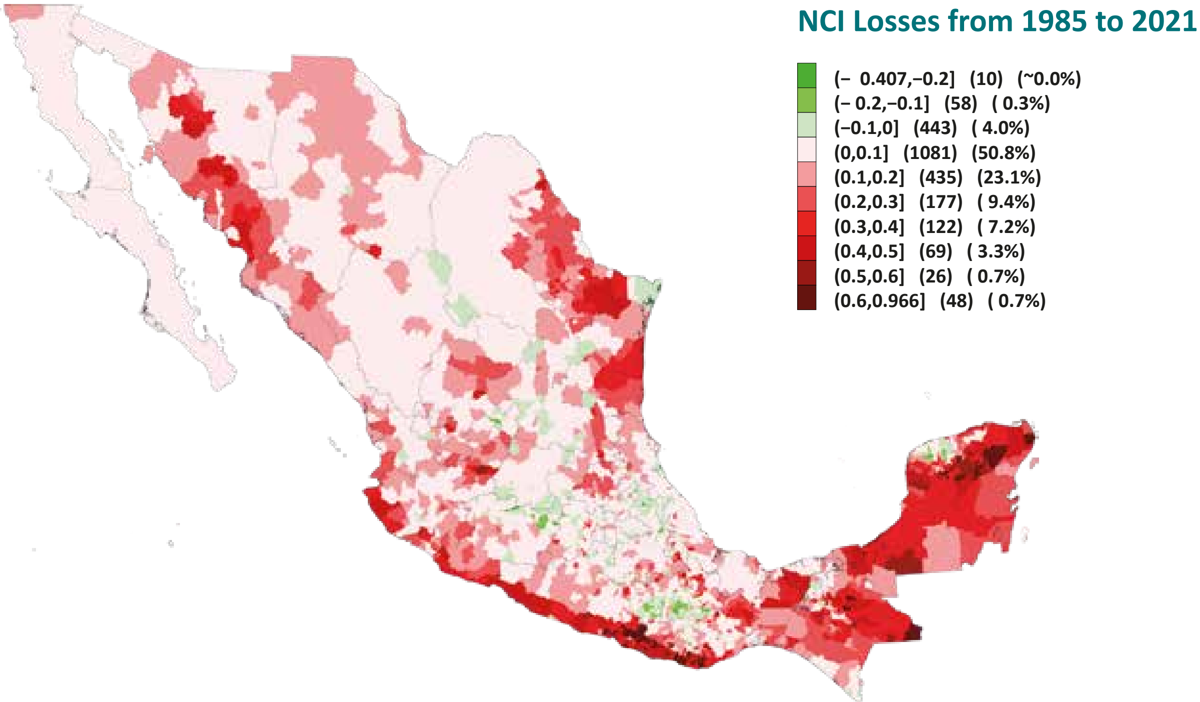


**Figure 3:** Natural Capital Index Losses from 1985 to 2021.

The remaining 44.9% of land area, distributed on 442 municipalities, have losses greater than 0.2, and are located predominantly in The Yucatan Peninsula, in the Pacific coastal plains in the South and West, in the state of Sonora, in the highlands and the Lacandon Jungle in Chiapas, and in the border and coastal plains in Coahuila, Nuevo León and Tamaulipas.

In **Table 1** we present the descriptive statistics of the NCI at the municipal and state levels. Columns I to VIII present the number of observations, the mean, the standard deviation. the minimum, the percentile 25, the median, the percentile 75, and the maximum of the NCI computed at municipal and state level, respectively. The distributions at each level show signs of the worsening of ecological conditions as the computed statistics tend to lower their values. The minimum at 0 indicates municipalities that have already depleted their natural capital. These municipalities and their surroundings tend to belong to the lower deciles in **Figures 1** and **2**, which are associated to densely-populated urban areas, thus, its low land area. Overall, the previous results confirm a sustained deterioration in the NCI.

**Figure 4** shows the changes on the densities of the distribution of the NCI for the municipalities within the thirty two states in México. From this figure, it is possible to see that the densities are very different from state to state in terms of shape as well as regarding their change in time. For instance, on the left panel, the northern states of Baja California Sur, Chihuahua, Coahuila and Durango show big masses on the high part of the NCI and little change through the years. In contrast, Ciudad de México, Guanajuato, Hidalgo and Estado de México have densities with big masses around the lowest values of the NCI. Other very interesting states are Campeche, Colima, Chiapas and Guerrero which show important changes on the shape of the distribution to lower values of the NCI. The right panel shows that the state of Quintana Roo has had an important change in time to lower values of the index, whereas Nayarit, Nuevo León, Tamaulipas and Yucatán show a similar pattern.

*[a] The number of municipalities coincides throughout the years because, for the sake of intertemporal comparability, the spatial analysis was made based on the municipal division in 2020.*

| Year | N<br>I | Mean<br>II | S.d.<br>III | Min.<br>IV | p25<br>V | p50<br>VI | p75<br>VII | Max.<br>VIII |
|---|---|---|---|---|---|---|---|---|
| NCI:bymunicipalities[a] | | | | | | | | |
| 1985 | 2469 | 0.387 | 0.307 | 0.000 | 0.103 | 0.330 | 0.642 | 0.987 |
| 1993 | 2469 | 0.339 | 0.292 | 0.000 | 0.072 | 0.268 | 0.570 | 0.982 |
| 2002 | 2469 | 0.321 | 0.288 | 0.000 | 0.059 | 0.246 | 0.538 | 0.982 |
| 2007 | 2469 | 0.313 | 0.282 | 0.000 | 0.057 | 0.239 | 0.521 | 0.982 |
| 2011 | 2469 | 0.308 | 0.278 | 0.000 | 0.056 | 0.232 | 0.515 | 0.976 |
| 2014 | 2469 | 0.305 | 0.273 | 0.000 | 0.056 | 0.234 | 0.511 | 0.959 |
| 2021 | 2469 | 0.293 | 0.266 | 0.000 | 0.053 | 0.220 | 0.484 | 0.952 |
| NCI:bystates | | | | | | | | |
| 1985 | 32 | 0.522 | 0.247 | 0.076 | 0.305 | 0.527 | 0.685 | 0.911 |
| 1993 | 32 | 0.461 | 0.249 | 0.064 | 0.242 | 0.461 | 0.611 | 0.894 |
| 2002 | 32 | 0.442 | 0.249 | 0.057 | 0.233 | 0.435 | 0.594 | 0.883 |
| 2007 | 32 | 0.432 | 0.243 | 0.054 | 0.232 | 0.405 | 0.578 | 0.877 |
| 2011 | 32 | 0.426 | 0.243 | 0.052 | 0.231 | 0.394 | 0.565 | 0.876 |
| 2014 | 32 | 0.420 | 0.237 | 0.048 | 0.236 | 0.394 | 0.552 | 0.876 |
| 2021 | 32 | 0.396 | 0.230 | 0.046 | 0.234 | 0.366 | 0.500 | 0.871 |

**Table 1:** Descriptive statistics of NCI by municipalities and states.

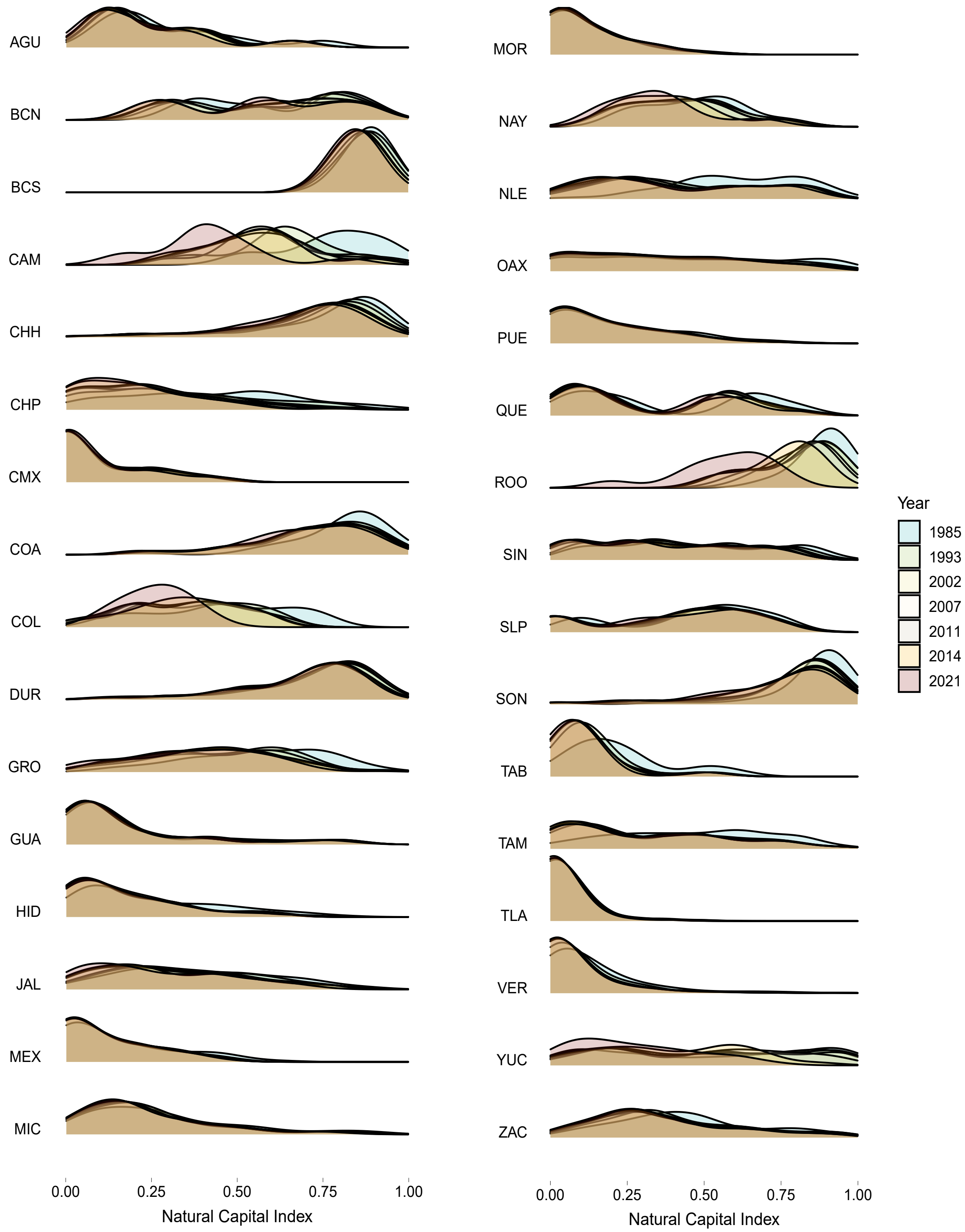


**Figure 4:** The NCI by State.

# Data

# 3

Regulatory, specialized and public data sets were used to produce this report. Firstly, the regulatory data includes a detailed credit registry containing all commercial credits issued by commercial banks, development banks, SOFOMEs[4], and governmental investment funds specialized in economic development. A data base containing all the securities holdings of commercial banks, development banks, brokerage houses, insurance companies and pension funds, this includes governmental, financial and corporate bonds.

The ENCORE database Natural Capital Finance Alliance (Global Canopy, UNEP FI, UNEPWCMC) (2021) was used to measure the relation between economic financed activity and the environment. ENCORE is a tool that helps to understand how the economic activities funded by financial intermediaries are linked to the services provided by biodiversity, their impacts and dependencies.

From the Mexican National Institute of Statistics and Geography (INEGI, by its Spanish acronym), we used the North American Industrial Classification System (NAICS) and the municipalities division map of Mexico. NAICS is widely used in Mexico to classify companies by their activity. The Mexican banking and securities regulator (CNBV), asks banks to classify the companies they fund using NAICS.

Following Calice et al. (2021), we conducted an exploration of the overlap between the geographic location of commercial loans and Natural Protected Areas. To do so, we resorted to the World Data Base Of Protected Areas[5], from where we obtained all the natural protected areas in Mexico, on all different levels, from federal to private designated areas.

Finally, we used the Natural Capital Index, mentioned above, which helps to monitor and assess the quantity and quality of biodiversity and ecosystem services in Mexico. Calculations from 1985 onward were made for the purposes of this study. The latest values of such index can be found in CONABIO's geoportal[6]. All the data from the credit registry and the holdings of securities correspond to December 2021.

The rest of this section describes the steps followed to harmonize and map the different data sets used. Next, we present the composition of the commercial credits registry and the securities holdings by economic activity, and other relevant variables.

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[4] *The Sociedades Financieras de Objeto Múltiple are regulated financial intermediaries in Mexico, specialized in credits and financial leasing.*

[5] *See Protected Planet*

[6] *See http://geoportal.conabio.gob.mx/*

# 3.1 Harmonization of the Data Sets

Given that multiple sources of data were used to conduct this study, some necessary steps were performed to be able to combine all the data sets.

From the credit registry the main variables used to combine with other sources of information were the industrial classification codes and the I.D. of geographical location of the credits. The names of the sectors and the states/municipalities were retrieved from INEGI's NAICS catalogue and maps, respectively.

It is important to mention that the NAICS catalogue has multiple levels of disaggregation, ranging from general sectors identified by a 2-digits numeric I.D., to several ”classes” identified by 6-digits codes. The credits registry classifies firms with a 5-digits code, however, for the purposes of this study such level of detail is unnecessary and complicated for visualization purposes, hence, credit amounts are aggregated to a 2-digit level. The same applies for the dataset containing the securities holdings; however. We constructed this later dataset as the classification of economic activities of the issuers of the securities had not been done before.

On the other hand, the geographical location in the credit registry ranges from country to ”locality” (a subdivision of municipalities). We aggregated the credits to the municipality level. This geographical information is not available for bonds listings. There is no information on the geographical locations of the bond issuers and how their funding is geographically allocated.

Regarding the mapping of the NAICS classification to the ENCORE database, an intermediate step was necessary. The ENCORE database can be mapped with ease to the GICS classification system[7], however, the mapping between the GICS classification and NAICS is not publicly available, hence it was also done for this study. With the NAICS-GICS mapping, the credit registry and bonds holding data can be related to the ENCORE database.

[7] *See https://www.msci.com/our-solutions/indexes/gics*

The NCI from CONABIO was provided in shape files, containing the index's value alongside the state and municipality codes, which are easily found in the credit registry data, which correspond to the geographical data provided by INEGI.

Finally, the natural protected areas were downloaded from the Protected Planet's website, also in a shape format. This dataset does not contain codes easily mapped with the geographic data in the NCI or the INEGI's maps; however, the analysis related to the natural protected areas were conducted in specialized software, which relied only in the spatial data, thus no mapping were necessary to combine with the other data sets.

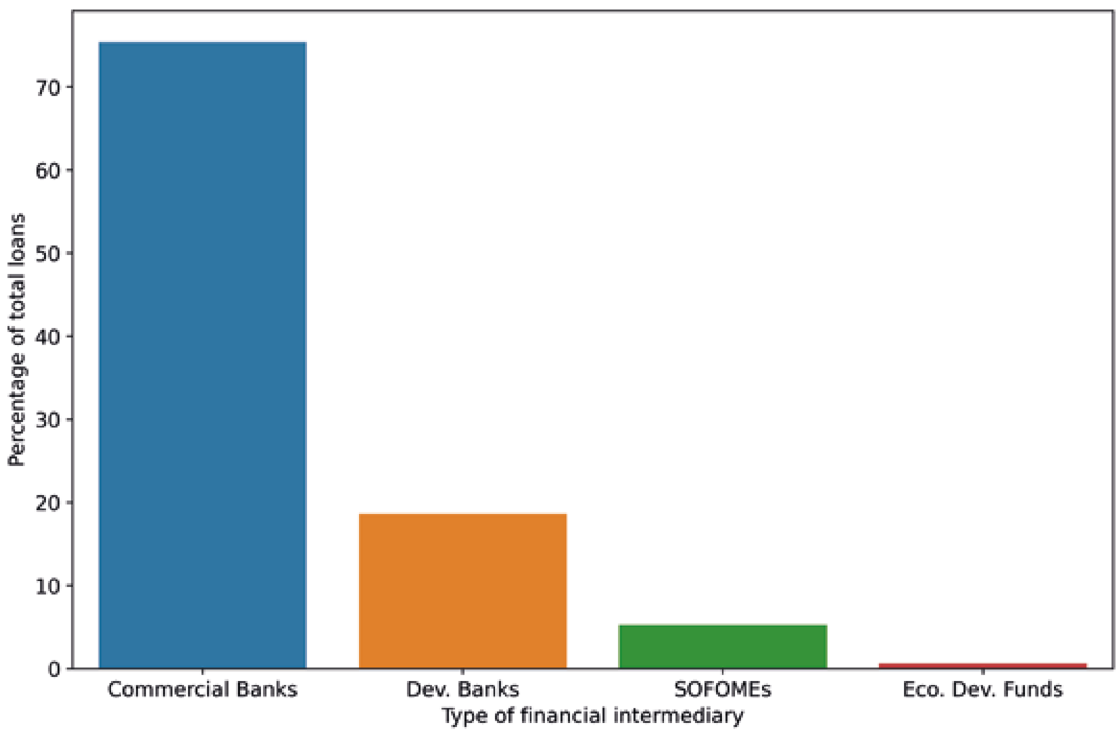



**Figure 5:** Share of Total Commercial Credits by Type of Intermediary.

# 3.2 Composition of the Credit Registry

As mentioned above, the credit registry contains detailed information about the loans granted by four types of financial intermediaries. As of December 2021, the total amount of commercial credits issued to firms in Mexico is around $4,140 bn MXN. In **Figure 5** we can see that the commercial banks grant the largest share of commercial credits in Mexico, with more than 70% of the total, followed by development banks with nearly 20% of the total, and with the SOFOMEs and government economic development funds with less than 10% of the total combined.

Looking at the composition of the credits portfolio by economic activity, we see in **Figure 6** that the largest amount of credit goes to the financial sector, with close to 15% of the total. The second and third sectors with most credit are Construction (14.03%) and Real Estate and Rental and Leasing (8.3%), respectively. However, there is an important heterogeneity in the composition of the four types of intermediaries. For example, construction is the largest sector for the commercial banks; finance, for the development banks; retail and wholesale trade amount correspond to more than 20% of the SOFOMEs' credits.

# 3.3 Composition of Bonds Holdings

The holdings of bonds and other securities is calculated from regulatory data sent by financial institutions to Banco de México. This data includes the selling, buying, repo transactions, and lending of all securities issued by governments, financial institutions and other private corporations in Mexico, and from abroad. It is worth mentioning that only securities issued by Mexican firms are considered in this report, since they were more easily classified under NAICS.

**Figure 7** shows the distribution of the total holdings of bonds in the Mexican financial system. Pension funds and commercial banks hold close to 60% of the total bonds issued by firms in México, followed by investment companies with close to 15%, development banks with around 12%, and brokerage houses and insurances companies with around 13% together.

The composition of the bonds holdings by economic sector is highly concentrated, as shown in **Figure 8**. The holdings of bonds issued by the public administration and the financial sector account for more than 90% of the total. Next, the construction sector represents 1% of the total bonds holdings, followed by the manufacturing sector, utilities (mainly electricity generation), real estate, transportation and mining (oil and gas extraction).


**Figure 6:** Composition of the Credit Registry by Economic Activity.

# 3.4 Geographical Distribution of Credit

Although it would be desirable to have the geographical distribution of all the financial system's exposures, this is only possible for the credit dataset. **Panel A** in **Figure 9** shows the distribution at the state level in percentage terms. This graph reveals that four states concentrate approximately the 72% of the credit: Mexico City, Nuevo León, Jalisco and Estado de Mexico. The bottom half of states receive only 6.4% of the loans.

**Panel B** in **Figure 9** shows the distribution of credit at the municipality level for the top 32 municipalities in percentage terms. The colors are assigned as those of their corresponding state as in **Panel B**. At the municipality level the concentration is even higher, as 10 municipalities concentrate approximately 60% of credit, corresponding to the metropolitan areas of Mexico City, Monterrey and Guadalajara, with the exception of the municipality Culiacan in the Sinaloa state, which received around 2% of the total credit.

The previous shows that financial institutions might be reporting the location of their credits in an inconvenient way for the purposes of climate and environmental related analysis. For example, they might be reporting the location of the corporate offices of the firms asking for credit, which is not helpful given that for climate and environmental analysis we require the location where the money is actually being used. **Figure 10** shows the comparison between the extraction of crude oil per state in December 2021[8], versus the total commercial credits granted to crude oil firms in December 2021.

Mexico City, Nuevo Leon and Campeche are clear examples of the latter, since they have the three largest amounts of commercial credits granted to crude oil and gas extraction firms. In particular, on the left-hand side of **Figure 10** we see that Mexico City holds an amount larger than all the following states combined. This is surely due to the commercial credits granted to the Mexican state company, PEMEX, with headquarters located in Mexico City, but with none of its crude extraction facilities located in the city.

*[8] For access to the crude extraction data see https://sie.energia.gob.mx/*

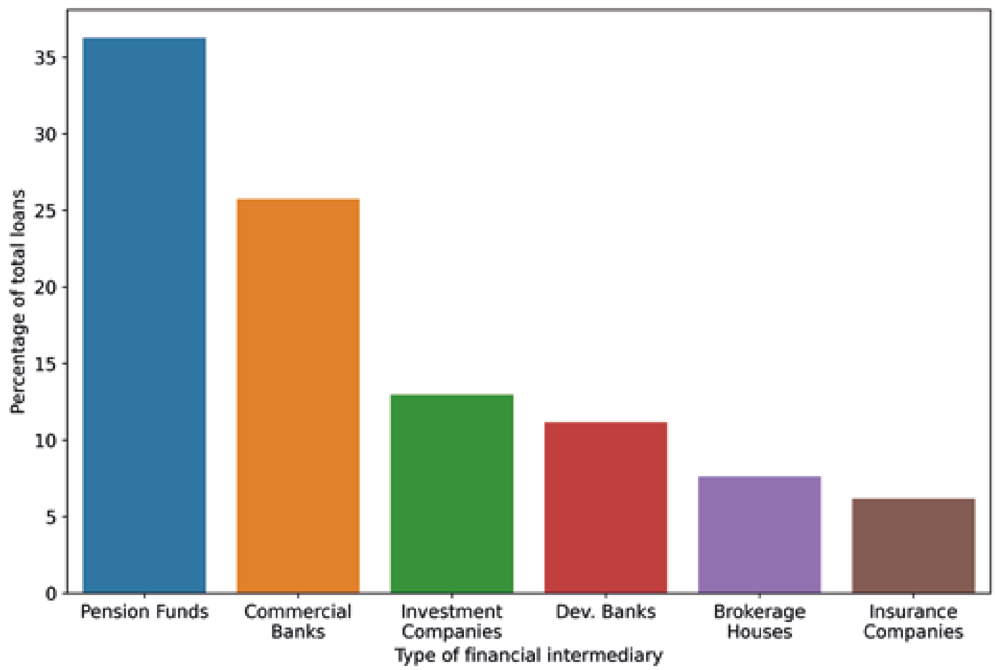



**Figure 7:** Share of Total Bonds Holdings by Type of Intermediary.


**Figure 8:** Composition of Bonds Holdings by Economic Activity.

Meanwhile, in the left hand side of **Figure 9** we see that the largest production of crude oils comes from “Territorial Waters” that are not related to any state, therefore there are no commercial credits granted in such location. Again, this poses a significant challenge to perform an accurate assessment of the financial impacts of climate change and biodiversity loss. Similarly to “Territorial Waters”, in the right-hand side of **Figure 9** we see that Chiapas is a state that has no commercial credits registered, but it provided the fourth largest amount of barrels of crude oil in December 2021.

We believe that the lack of a clear guidance on how to report ASG relevant information could be playing an important role in these inconsistencies, making the tasks carried out by institutions like the Task Force on Climate-Related Financial Disclosure (TCFD)[9] consortium or the ISSB[10] highly relevant if we want to achieve a sustainable financial system and to make better assessments of the risks and opportunities that climate change and environmental degradation pose on the financial system.

*[9] See: https://www.fsb-tcfd.org*
*[10] See: https://www.ifrs.org/groups/international-sustainability-standards-board/*

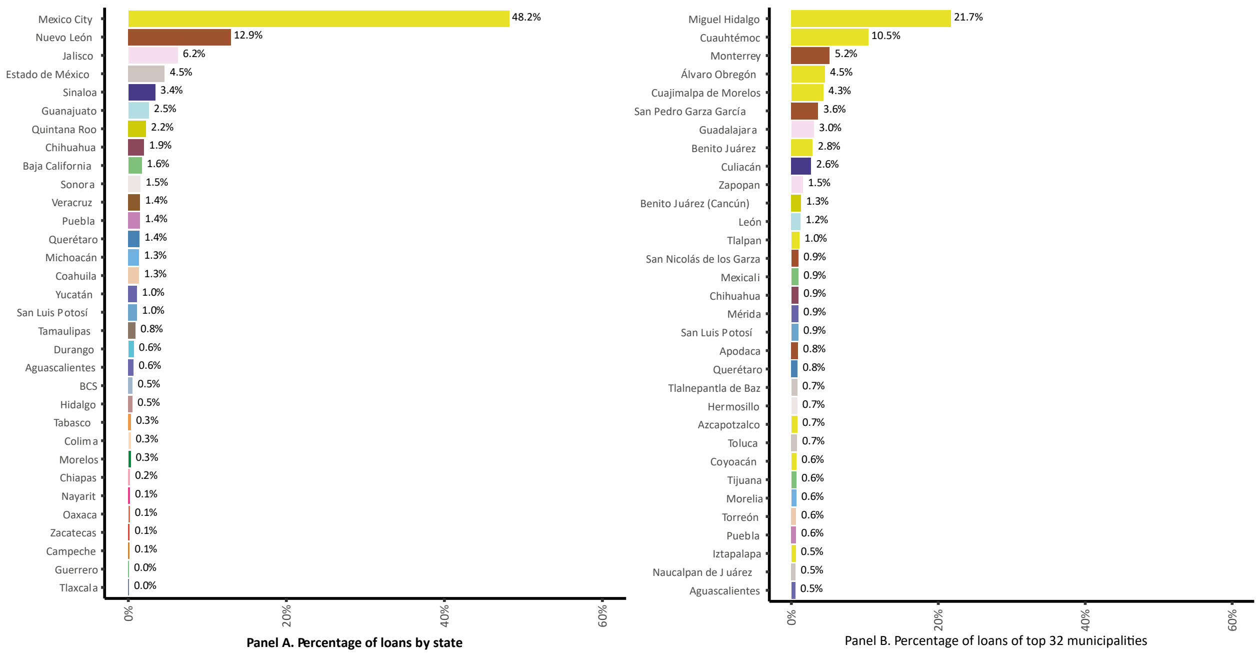



**Figure 9:** Credit Distribution by State (panel A) and top 32 Municipalities by Share of Credit (panel B).

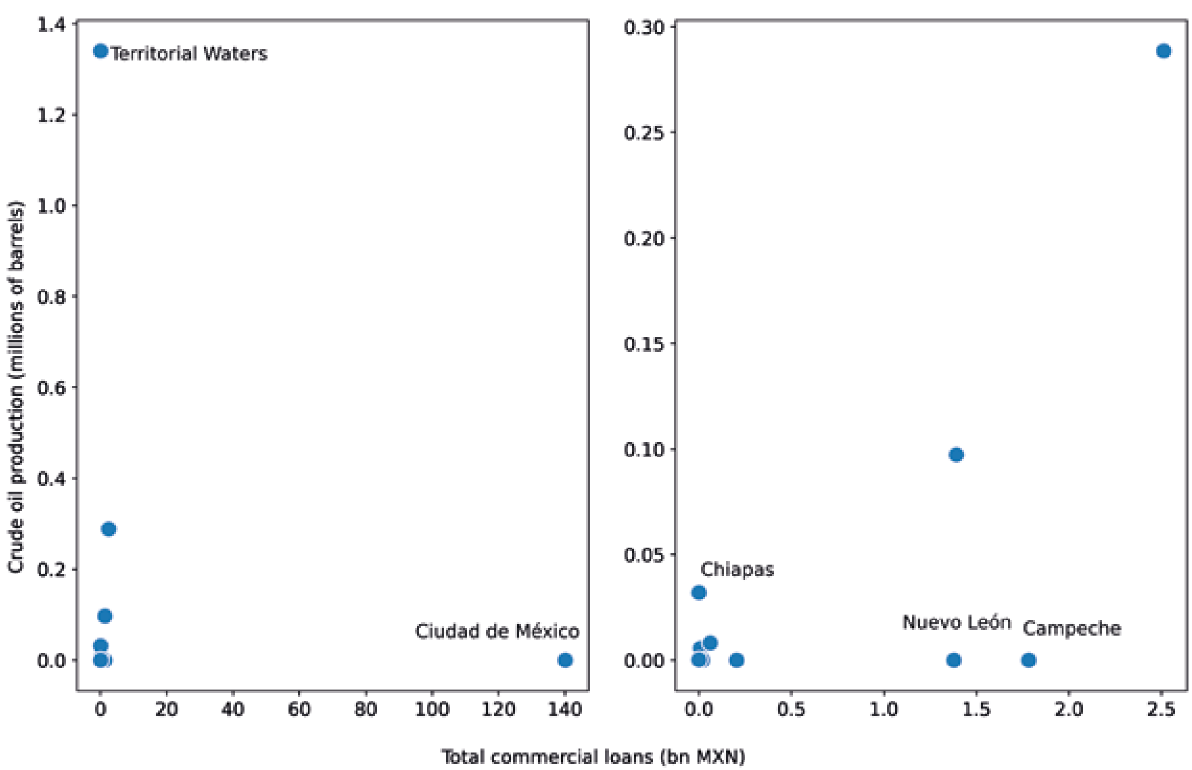
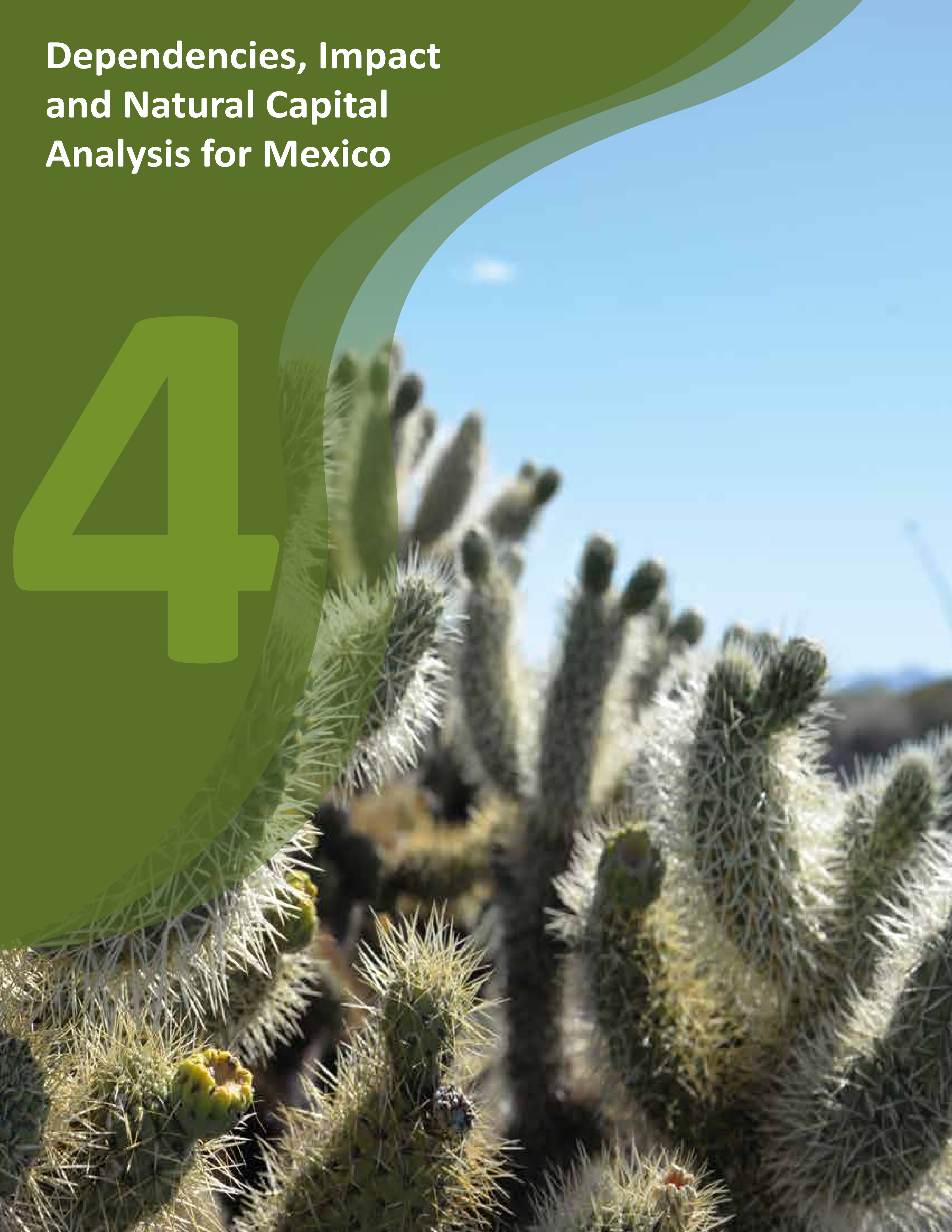



**Figure 10:** Comparison of Commercial Credits and Crude Oil Extraction by State.

# Dependencies, Impact and Natural Capital Analysis for Mexico

# 4



Following the same approach first used in van Toor et al. (2020), then in Svartzman et al. (2021) and Calice et al. (2021) we estimate the dependency and the impact of the banking system on ecosystem services. The ENCORE database allows to link ecosystem services to subindustries on the GICS classification, we find the relationship between such subindustries with the corresponding economic sectors in Mexico using the NAICS classification. To determine the credit exposure and the securities holdings to such sectors we used data from regulatory reports being held at Banco de México.

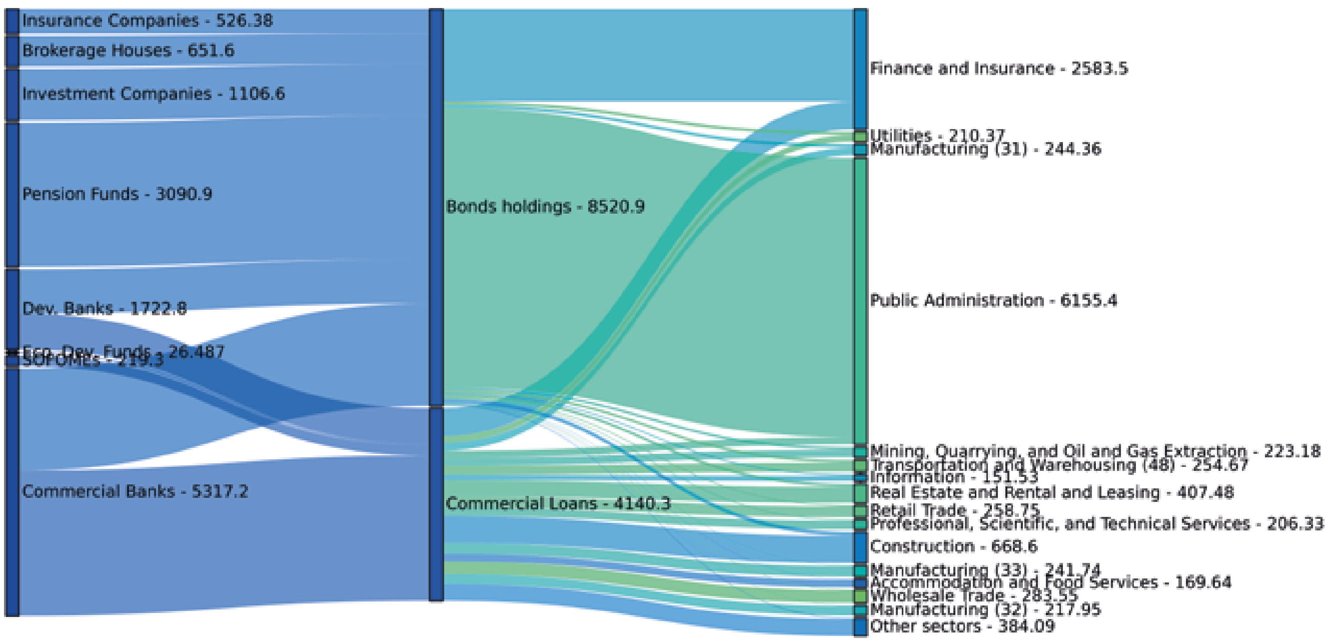



**Figure 11:** Exposures of the Mexican Financial System and the Associated Economic Sectors.

The ENCORE database also assesses the materiality of such dependency, by resorting to sector research and expert interviews. This results in a dependency rating that takes the following values: Very Low, Low, Medium, High and Very High. Here we only report High (H) and Very High (VH) ratings as it as been done in previous similar studies.

[11] *Climate Regulation refers to the ecosystem service that controls the functioning of the atmospheric chemical composition, greenhouse effect, air quality, precipitation and weather patterns Costanza et al. (1997).*

**Figure 11** shows the exposures of the Mexican financial system by type of exposure: securities holdings and loans. It can be seen that most of the securities being held by banks are government related securities and other banks' securities. On the lending side, there are many economic sectors and possibly more dependencies and bigger impact. The figure also shows that there are some loans to governmental or government related institutions, states or municipalities for example. The largest sectorial exposures, besides specialized finance, are to Construction, to Real Estate, Wholesale and Retail trading and Transportation, among others.

**Figure 12** shows the banks' exposures to specific economic sectors economic sectors. On the left part of the plot we have the type of exposure to the different economic sectors, which are in the middle, represented by the cyan-colored bar. The economic sectors, following the GICS classification, are ranked according to the amount of the total exposure of the banking system. On the right side of the plot, one can find the different ecosystem services, the links among sectors and services represent the dependence of the economic sector on such ecosystem service. The industries with the largest number of services dependencies are Agricultural products (15 services) and Forestry production (12 services). The services on which more sectors rely on are: Surface water (28 subindustries), Ground water (24 subindustries), Climate regulation[11] (15 subindustries) and Floods and storm protection (11 subindustries).

**Figure 13** shows the total amount of exposure (left axis) and the number of subsectors (right axis) with H or VH dependence on ecosystem services. The largest amount of exposure does not have H or VH dependence on any ecosystem service[12] (the total number of subsectors in NAICS is 626 and the number of sub-industries in GICS is 158) the number of subsectors is also high, 350. On the other extreme there are 36 subsectors which depends on 12 ecosystem services and with an important amount of exposure. There are 64 and 110 sub-sectors with sizable exposures with H or VH dependency on 1 and 2 services, respectively. As it was mentioned before, these exposures can be considered a proxy for physical risk, whereas the impact metrics (**Figures 13** and **14**) are useful to estimate transition risk.

*[12] Although the number of sub-sectors which do not have H or VH dependency seems to be large, this could change considerably if medium (M) dependency is considered. For instance, in the case of the ecosystem services surface and ground water, there are many additional sub-sectors and sub-industries whose dependency is at least M.*

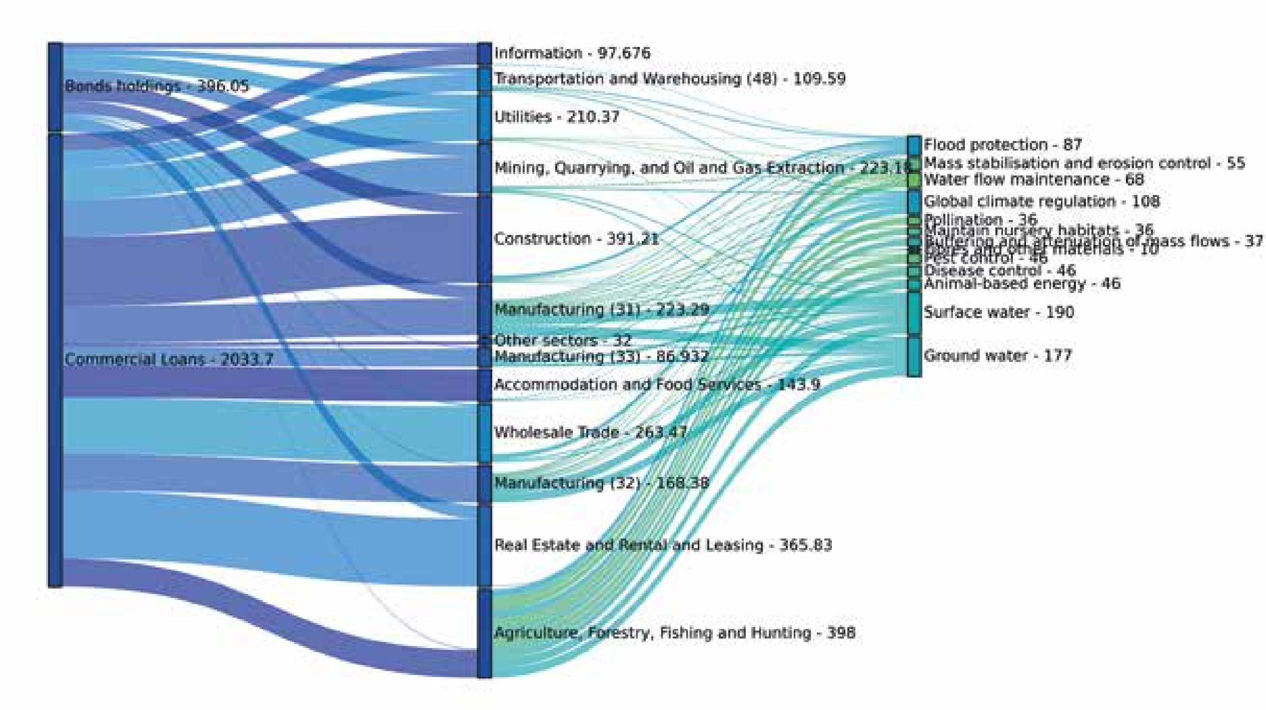



**Figure 12:** Exposures and Eco-systemic Dependencies of the Mexican Banking Sector.

**Figure 14** shows again, as in **Figure 12**, on the left the total exposures (investment) on different sub-industries (middle panel) and the impact on different ecosystem services (right panel). The links represent only H or VH impact. Unlike the dependency plot, there are many sub-industries which have an impact (H or VH) on different ecosystem services.

Finally, **Figure 15** shows the total amount and number of sub-industries with H or VH impact on different ecosystem services. Here, the implications are quite different to the dependency case as the number of subsectors with no impact (H or VH) is only 98. There are 11, 30, 226, 37 and 88 subsectors with sizable credit and investment from banks which impact 1, 2, 3, 4 and 5 services. On the other extreme, there are 31, 55 and 19 subsectors with non-negligible credit and investment from banks which have an impact on 7, 8 and 9 ecosystem services.

# 5 Credit Activity, Natural Capital and Natural Protected Areas

With the information available for all the credits described in **Section 3** we are able to explore the location of each single outstanding credit from the financial system. As a consequence, in addition of having the information of the economic sector of each loan, we can locate it at the municipality level. This is helpful to assess the distribution of loans by the degradation level of each municipality in Mexico.

**Figure 16** shows the NCI's quartiles and the associated amount lent. Municipalities in the first quartile (the lowest NCI) are the ones with the largest amount of credit granted, with around 50% of the total loans granted, and the municipalities with the largest NCI are the ones with the lowest amount of credit, with less than 10% of the total loans.

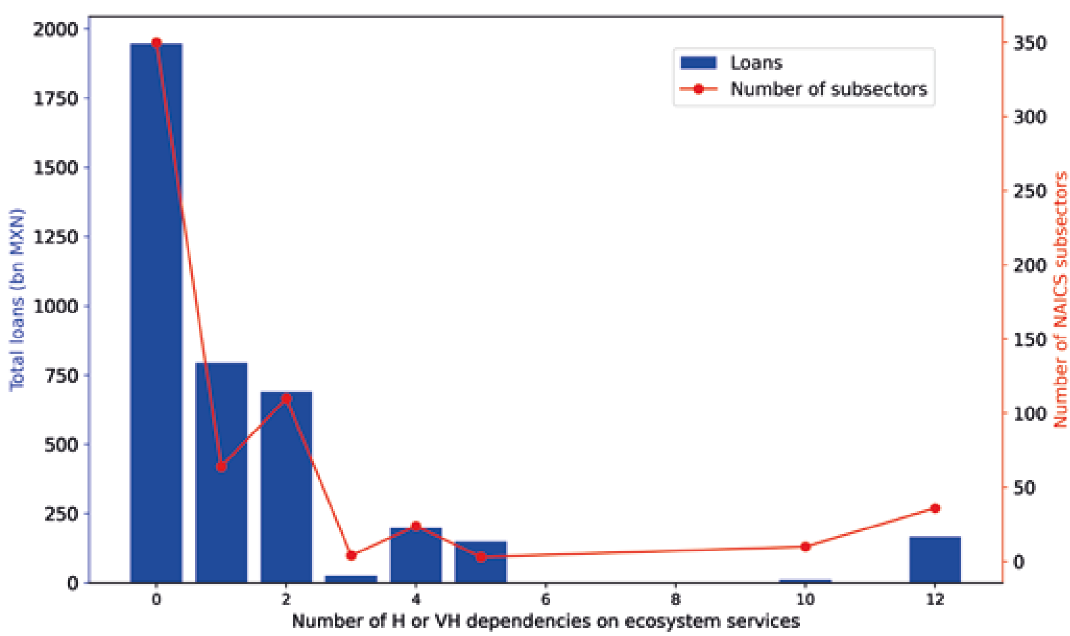



**Figure 13:** Exposures and Eco-systemic Dependencies of the Mexican Banking Sector.

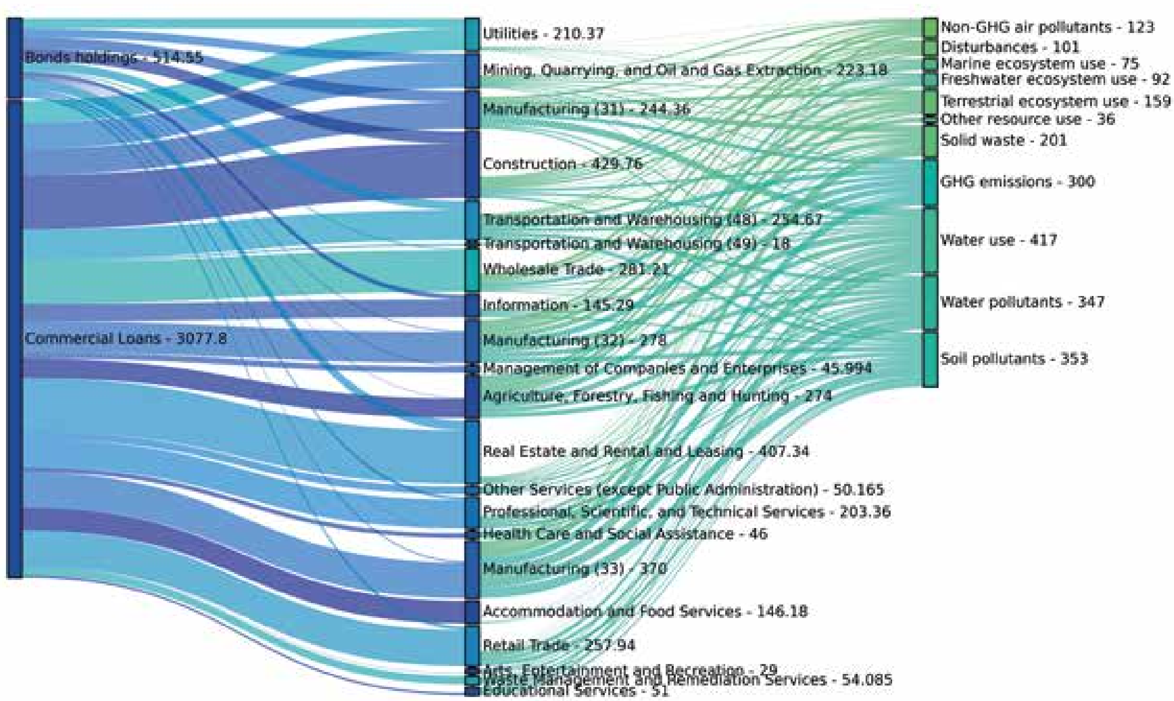



**Figure 14:** Economic Sectors' Impact on Ecosystems.

Furthermore, **Figure 17** shows that the municipalities with the lowest level of NCI (1st quartile) have a large and heterogeneous credit portfolio, with the largest share going to construction, mining, utilities, public administration and financial services. Furthermore, we see that the construction sector represent a significant amount of credit for all four quartiles of NCI. This is relevant given that the construction sector is a sector that involves land use change, which is one of the main drivers of biodiversity loss.

**Figure 18** shows the Natural Protected Areas in Mexico and the distribution of credits at the municipality level. This figure shows that there is some credit activity in municipalities with protected areas. The implication is not that credit should not be granted in a protected area but that banks' lending activities in these areas should be carefully monitored to avoid negative environmental impacts.

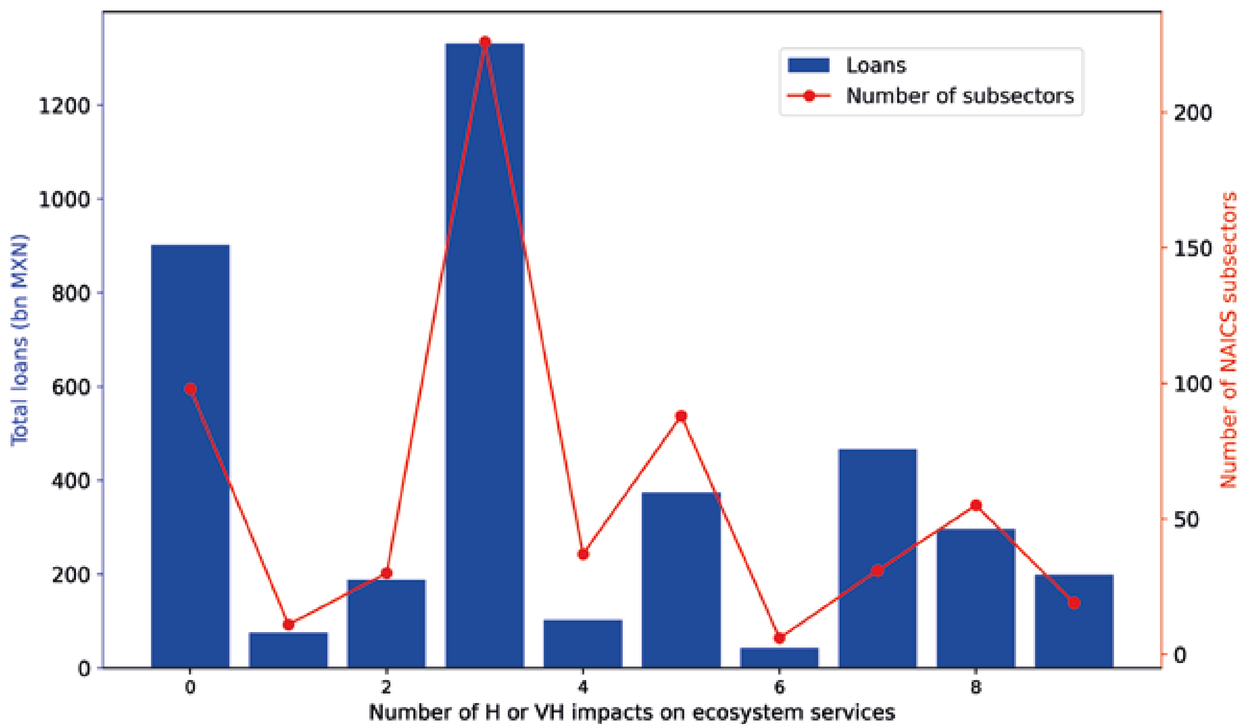



**Figure 15:** Investment Amount and Number of Subsectors Impacting Ecosystems.

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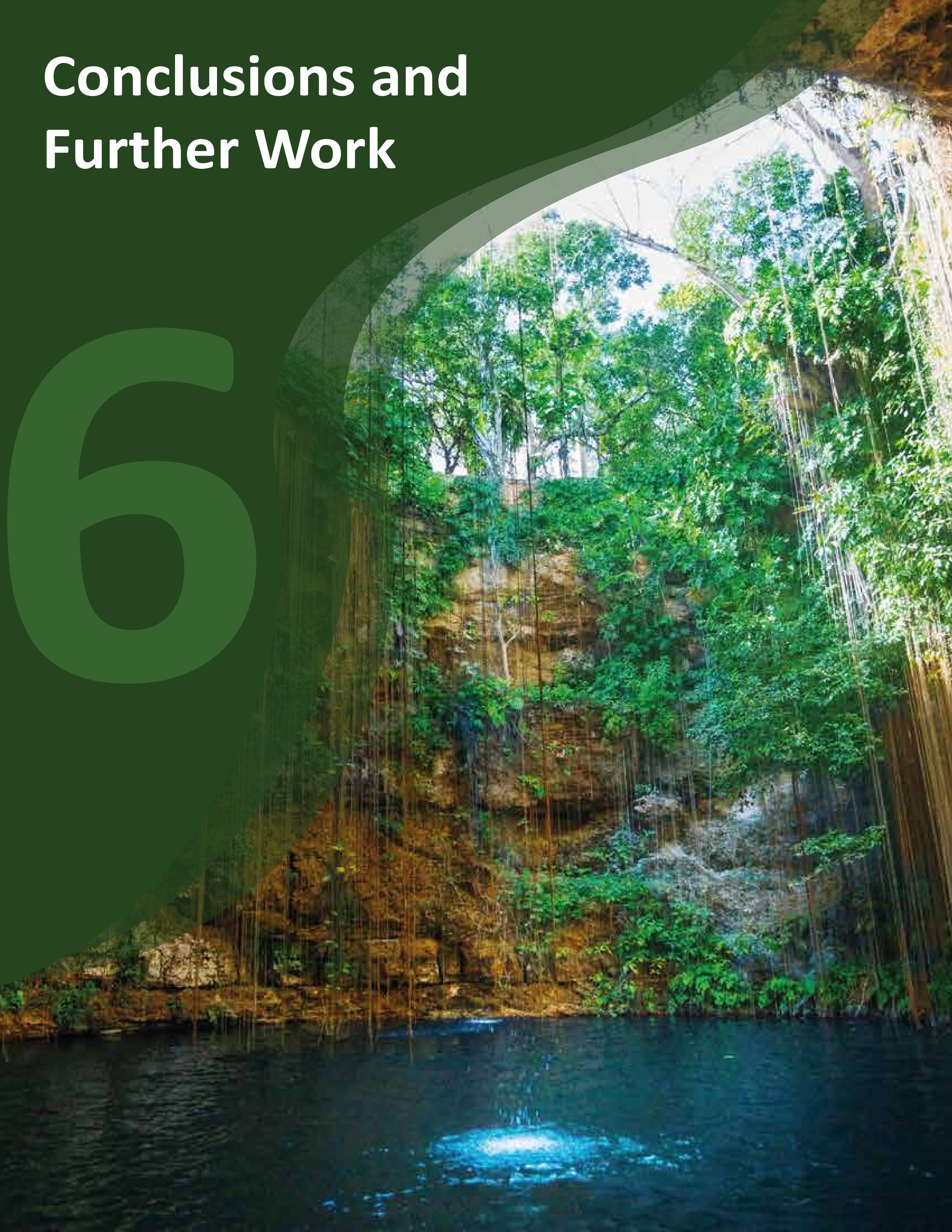
# Conclusions and Further Work



This report represents a first step to uncover the links between biodiversity loss and the financial system. As it has been shown here, there are already tools available in México to estimate biodiversity related physical and transition risks from the perspectives of financial authorities and intermediaries'. Several lessons can be withdrawn from this work but some of the most important conclusions are the following:

- An important share of the credit portfolio of banks is highly or very highly dependent on nature and its ecosystem services. As a result, it is subject to physical risks arising from biodiversity loss and ecosystems degradation.

- An important share of the credit portfolio has high or very high impact on ecosystem services and it is therefore subject to transition risks.

- There is a big potential of Natural Capital to be restored in M exico. Nevertheless, the distribution of the NCI at the municipal level shows that the first quartile (the municipalities with the lowest NCI) is the one with the largest amount of credit and investment from high and very high impact sectors.

- The quartile of the NCI with the highest values receives the smallest investment from sectors with high or very high impact on ecosystem services. These are relatively good news; however, financial institutions should be careful that their investments are not supporting harmful activities and monitor closely how their investments are being used.

- There are some loans on economic sectors with High and Very High impact on ecosystem services allocated to municipalities in which there are Natural Preserved Areas (NPA). It is important to note that some municipalities are larger on territorial extension to the NPA, this implies that not necessarily loans and investments are used on a NPA; however, this is not always the case. Financial institutions must stay vigilant that such credits and investments will not be used in NPA given that the associated economic sectors have high or very high impact on biodiversity according to the ENCORE database.

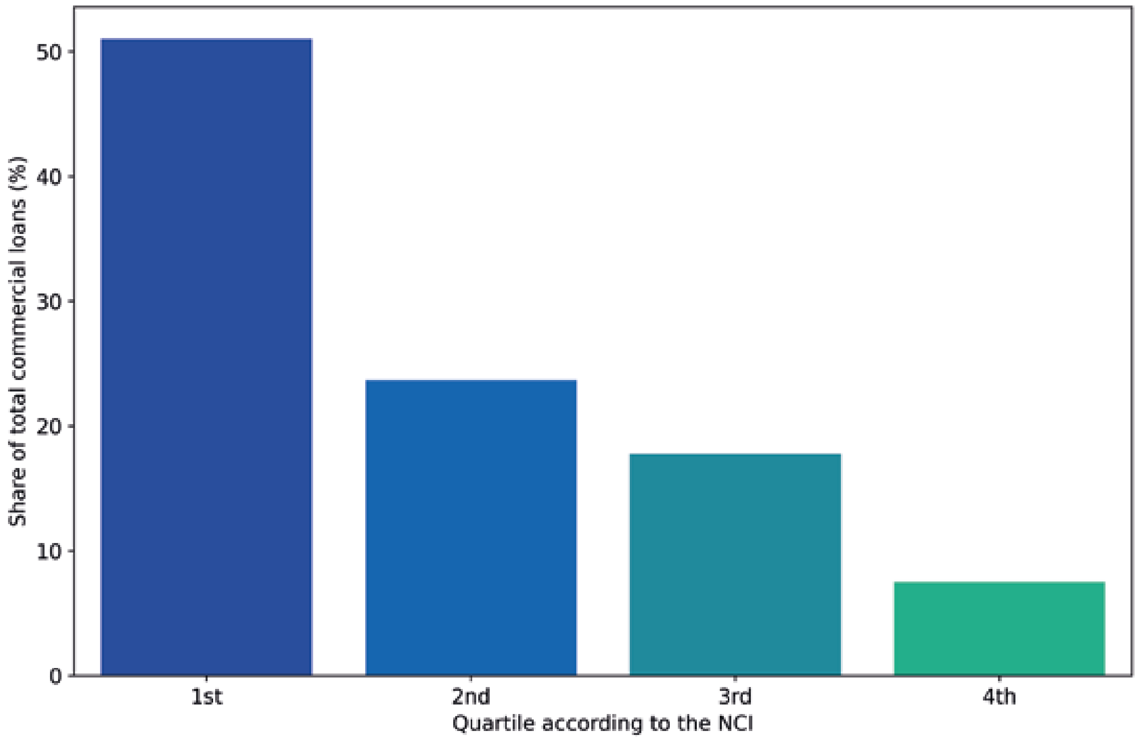



**Figure 16:** Share of Total Commercial Loans by NCI's Quartiles.

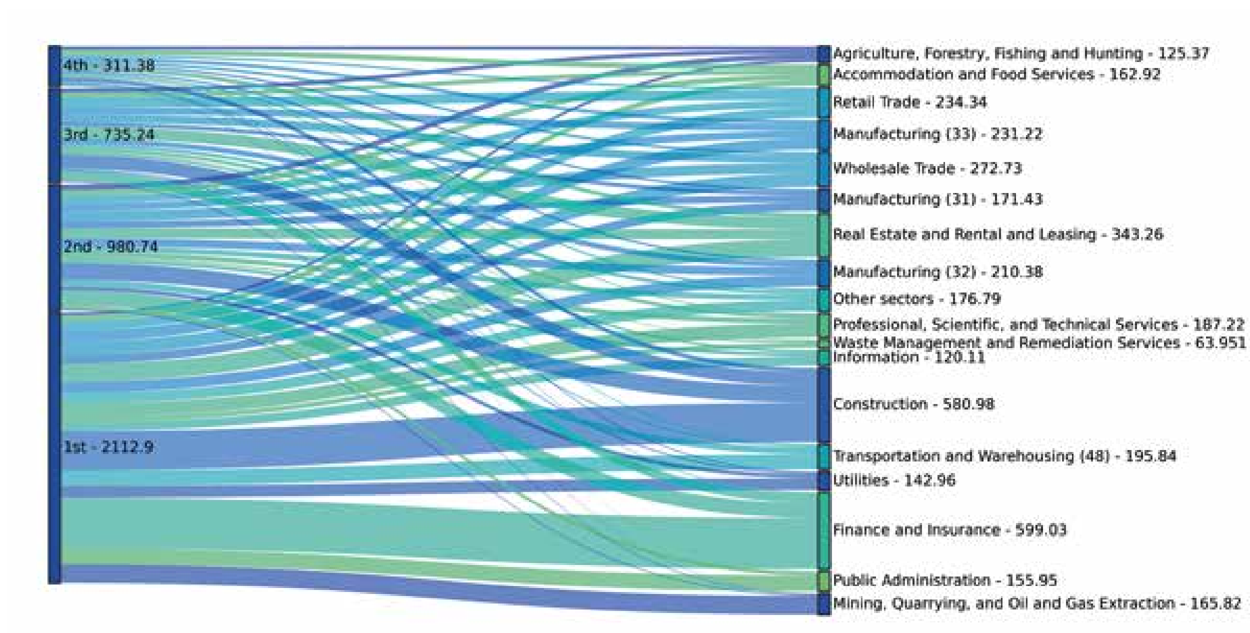



**Figure 17:** Commercial Loans by NCI's Quartiles and Economic Activity.

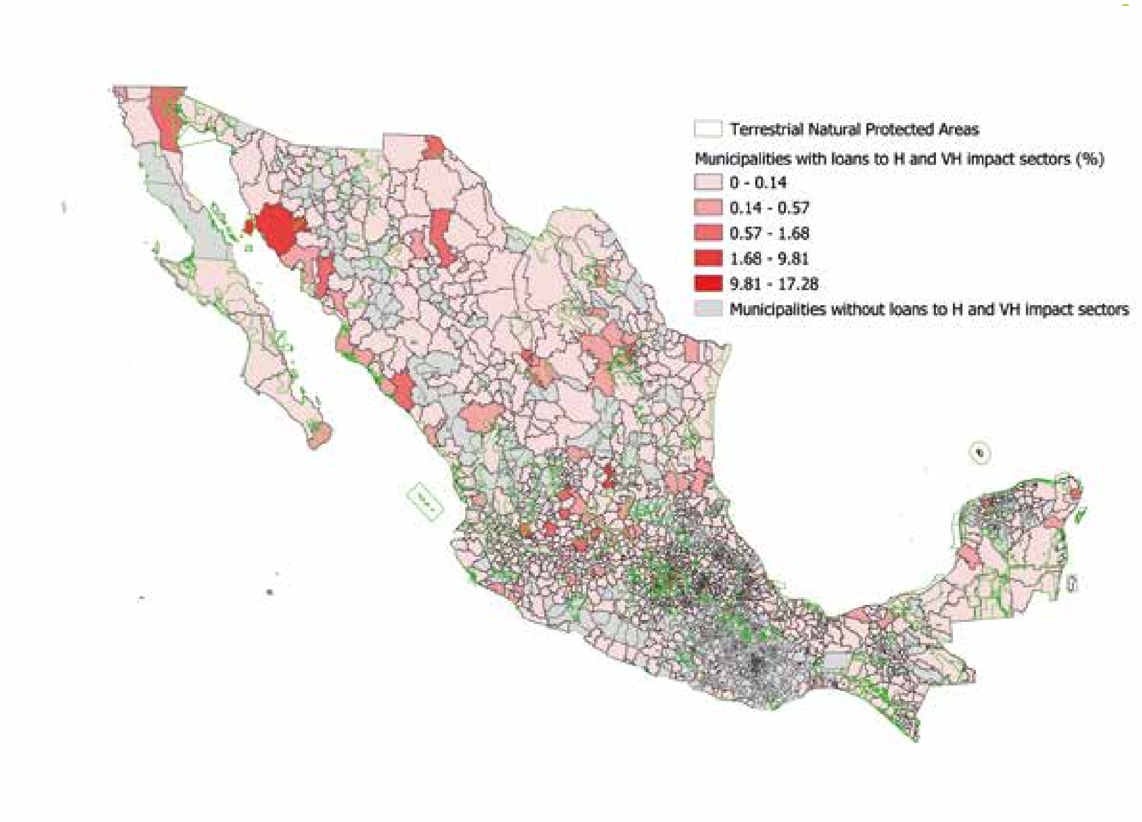



**Figure 18:** Credit and Natural Protected Areas.

Additional work will be needed to incorporate the exposures of other financial intermediaries like pension funds, insurance companies and investment funds, which are important players in the financial sector. Once a complete picture of the exposure to biodiversity loss is obtained, more comprehensive exercises can be performed like investigating the amplification effects that the financial system could have from shocks coming from the dislocation of important ecosystems in Mexico. The possible impact that credit activity and investment (and their associated economic sectors) could have on biodiversity must be further investigated.

Investigating the possible impacts from biodiversity loss along the supply chain can also be done with the information presented in this report. Further work is also needed on possible forward-looking scenarios on trends of environmental degradation, similar to current work being done on climate change.

Finally, since climate change interacts with nature and ecosystem services, in the future it would be important to aim at including in climate change analysis, nature and ecosystem services considerations.

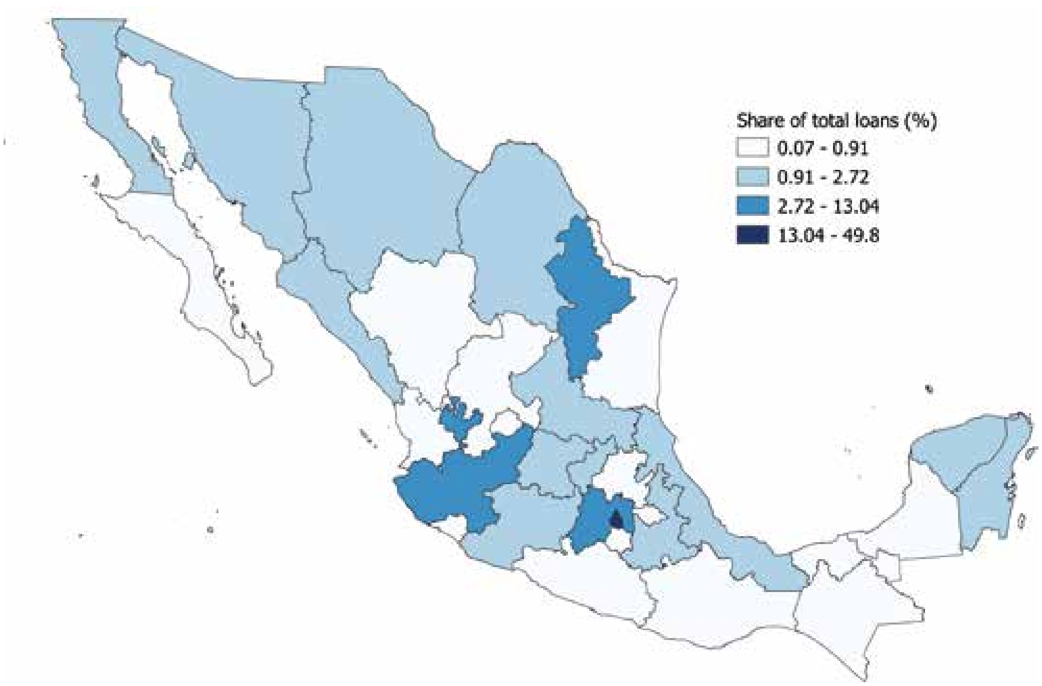



**Figure 19:** Spatial Distribution of Credit by State.

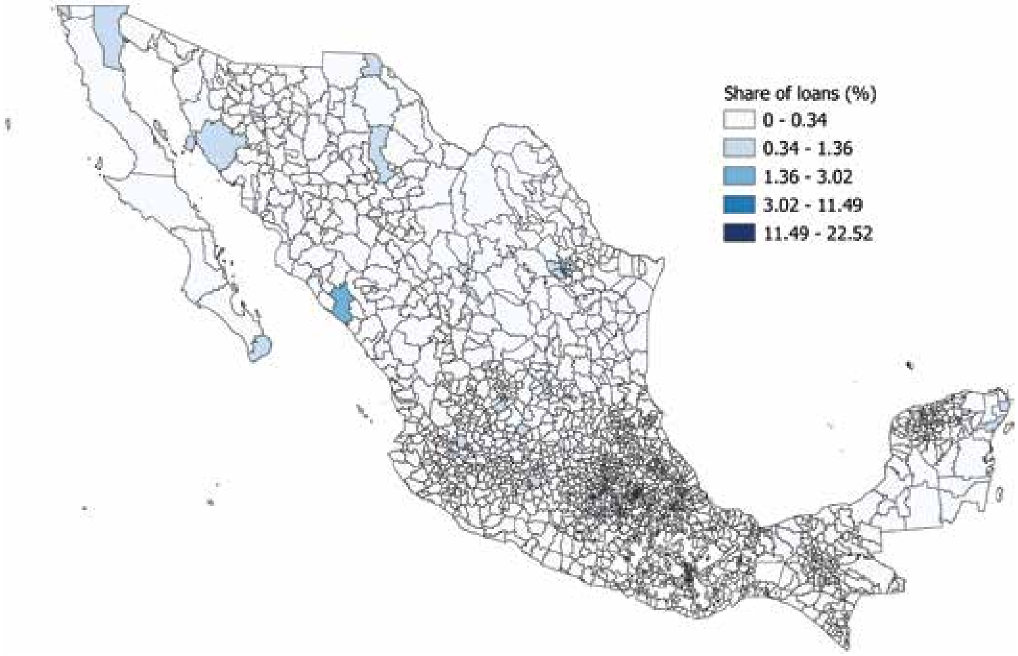



**Figure 20:** Credit Distribution by Municipality.

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