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Book

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Assessing Nature-Related Financial Risks:

The Case of Lithuania

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ABSTRACT

All real economic sectors depend on nature. Accordingly, lending to economic sectors carries some degree of nature-related financial risk. To assess and mitigate the potential impact of ecosystem service loss on financial stability, it is crucial to identify and measure nature-related financial risks. Using FINREP and ENCORE data, we assess the direct material dependence on nature and evaluate physical nature-related financial risks in Lithuanian commercial bank lending. While a substantial share of bank loans (70,1%) in Lithuania goes to sectors that are very highly dependent on at least one ecosystem service, the financial risks arising from hypothetical scenarios of disruption in the provision of some of these ecosystem services is markedly lower than in other European countries due to Lithuania's geographic specificity. The case study of Lithuania illustrates that the impacts from the loss of ecosystem services are not uniform across geographic regions, that the assumption that the level of dependence on ecosystem services can serve as an approximation of physical nature-related financial risks is inappropriate for certain geographies, and that an accurate assessment of nature-related financial risks requires location-specific dependency-risk mapping matrices.

Keywords: Ecosystem Services, ENCORE, Nature-related Financial Risks, Financial Stability

JEL Codes: E58, G21, Q01, Q57

1. INTRODUCTION

All real economic sectors depend on nature. According to the World Economic Forum (2020), over half of global gross domestic product (GDP) is highly or moderately dependent on nature and ecosystem services. In a worst-case scenario of partial ecosystem collapse, the world would experience significantly lower global real GDP growth (Johnson et al., 2021). Due to the high dependence of the global economy on ecosystem services, nature-related risks can be transmitted to the financial system via the real economy, with the potential to trigger financial instability.

The impacts from the loss of ecosystem services are not uniform across geographic regions and different income levels. To assess and mitigate the potential impact of ecosystem service loss on financial stability, it is crucial to identify and measure nature-related financial risks locally.

The aim of this paper is to assess the direct material dependence (physical risk) on nature of Lithuanian commercial bank lending. We do this following the methodological steps proposed in OECD (2023). Banks lend to economic sectors that depend on ecosystem services. One prominent factor in ecosystem service degradation and loss is climate change, which, in turn, is amplified by nature loss (McElwee, 2021). Therefore, the evaluation of climate-related financial risk is incomplete without an assessment of nature-related financial risk, as risks posed by dependencies on ecosystem services interact with climate change risks in a vicious cycle (Kedward et al., 2022; Bradshaw et al., 2021).

An ecosystem service can be defined as the connection between an ecological function and an actual or potential benefit for humans (Haines-Young and Potshin-Young, 2018). There are four types of ecosystem services: supporting services, provisioning services, regulating services and cultural services. The identification and measurement of nature-related financial risk is challenging for four main reasons. The first is that there is limited substitutability of natural capital assets. The second is that the natural processes are intrinsically non-linear. The third is that the timing and severity of impacts is uncertain. The fourth is that we do not possess a clear metric to assess the state of ecosystem services.

Among the first central banks to have studied nature-related (i.e., biodiversity-related) financial risks is De Nederlandsche Bank (DNB), the central bank of the Netherlands. Van Toor and colleagues (2020) provide an assessment of how Dutch financial institutions are exposed to physical and transition risks related to ecosystem services and the collapse of biodiversity. To compute physical risk, they linked production processes, all of which depend on ecosystem services (given by ENCORE (Exploring Natural Capital Opportunities, Risks, and Exposure) tools[1], which provide the dependence of production processes on ecosystem services and natural assets) to economic sectors. The exposure of Dutch financial institutions to ecosystem services is then computed through equities, corporate bonds, and business loans. The authors found that 36% of the Dutch financial institution portfolio is dependent on one or more ecosystem service. The transition risk was assessed using the GLOBIO model developed by PBL (Netherlands Environmental Assessment Agency). The biodiversity footprint was expressed by the MSA metric (Mean Species Abundance, from pristine ecosystem (100%) to complete artificialization (0%)), as a function of six human pressures: land

[1] Developed by the Natural Capital Finance Alliance (NCFA). The NCFA secretariat is run jointly by the United Nations Environment Programme Finance Initiative (UNEP FI) and Global Canopy.

use, road disturbance, fragmentation, hunting, atmospheric nitrogen deposition and climate change. It was concluded that the biodiversity footprint of Dutch financial institutions was comparable to the loss of over 58,000 km² of pristine nature (more than 1.7 times the land surface of the Netherlands).

The Banque de France, the central bank of France, has also assessed biodiversity-related financial risks. Following the work of van Toor and colleagues (2020), Svartzman and colleagues (2021) investigated the physical and transition risks of French financial institutions. To do so, they assessed dependencies and impacts of these institutions on ecosystem services based on the equities and bonds they hold, by assessing the exposure and the impacts of issuers. Exposure to ecosystem services is calculated using the ENCORE framework and EXIOBASE3 (an open-access environmentally extended multi-regional input-output). The authors computed the direct and upstream exposure of issuers crossing the ENCORE tool, which gives dependency scores for each production process, and EXIOBASE3, which provides information on output values and chain values for each sector in each region. According to the authors, 42% of the value of securities held by French financial institutions comes from issuers that are highly dependent on one or more ecosystem service. To assess the risks of transition, the authors assumed that the more negative a firm's impact on nature, the more likely that firm is to be constrained by law or to be affected by changing consumer habits. Svartzman and colleagues (2021) adopted the BIA-GBS methodology (Biodiversity Impact Analytics – Global Biodiversity Score). This method uses the GOBIO model, which calculates pressure-impact relationships between biodiversity and economic activities using the MSA metric (Mean Species Abundance) from 100% (pristine ecosystem) to 0% (complete artificialization). According to the results, the accumulated biodiversity footprint of securities is comparable to the loss of at least 130,000km² of pristine nature, which corresponds to the complete artificialization of 24% of the area of metropolitan France.

More recently, the Central Bank of Georgia and the Banco de Mexico studied biodiversity-related financial risks. Martinez-Jaramillo and colleagues (2023), following the approach of van Toor and colleagues (2020) and Svartzman and colleagues (2021), used the ENCORE database to assess the exposure of the Mexican financial sector to physical and transition risks. Their results indicate that a significant portion of Mexican banks' credit portfolio is highly or very highly dependent on nature and its ecosystem services.

Nikuradze and Tvalodze (2023) computed Georgian financial institutions' dependencies on nature and the impacts of these institutions through business lending to legal entities. They also used the ENCORE framework to assess the exposure of each economic sector to ecosystem services, which they combined with the business lending information to compute the dependencies of Georgian financial institutions on ecosystem services. In addition, as ecosystem services cannot be separated from natural assets, they also assessed institutions' dependencies on natural assets through ecosystem services (provided by ENCORE tools). They found that 46% of the Georgian commercial banks' lending portfolio is exposed to companies with at least a moderate dependence on one or more ecosystem services.

This paper is the first to assess the exposure of the Lithuanian financial sector to nature-related risks. Adopting a methodology similar to Nikuradze and Tvalodze (2023), we find 70.1% of Lithuanian banks' commercial lending portfolio to be to firms with a very high dependence on at least one ecosystem service. Among the ecosystem services on which Lithuanian banks' commercial lending portfolio is found to be highly dependent are surface and ground water provisions and climate regulation. Lithuania is one of a handful of states with abundant fresh ground water resources, and it is not in a risk zone for freshwater shortages. Furthermore, as Lithuania is located in a geographic area with a high potential for adaptation to climate

change, it is ranked among the countries with lowest physical risk from climate change. These specificities of Lithuania highlight that the assumption of van Toor and colleagues (2020), Svartzman and colleagues (2021), and Nikuradze and Tvalodze (2023), equating level of dependence on ecosystem service to level of risk, is not always appropriate. We argue, instead, that to accurately assess nature-related risks, it is necessary to use a location-specific dependency-risk matrix. We conclude by providing some suggestions on how such location-specific dependency-risk matrices could be created.

The paper is organized as follows: Section 2 provides an overview of the methodology employed in assessing dependencies of Lithuanian banks' commercial loan portfolio on ecosystem services. Section 3 presents the main findings. Section 4 discusses the specificity of Lithuania with regard to linking dependencies to risks. Section 5 concludes with recommendations for policymakers on how to integrate nature considerations into financial decision-making process and suggests avenues for future research.

2. METHODOLOGY TO OBTAIN DEPENDENCIES ON ECOSYSTEM SERVICES AND NATURAL ASSETS

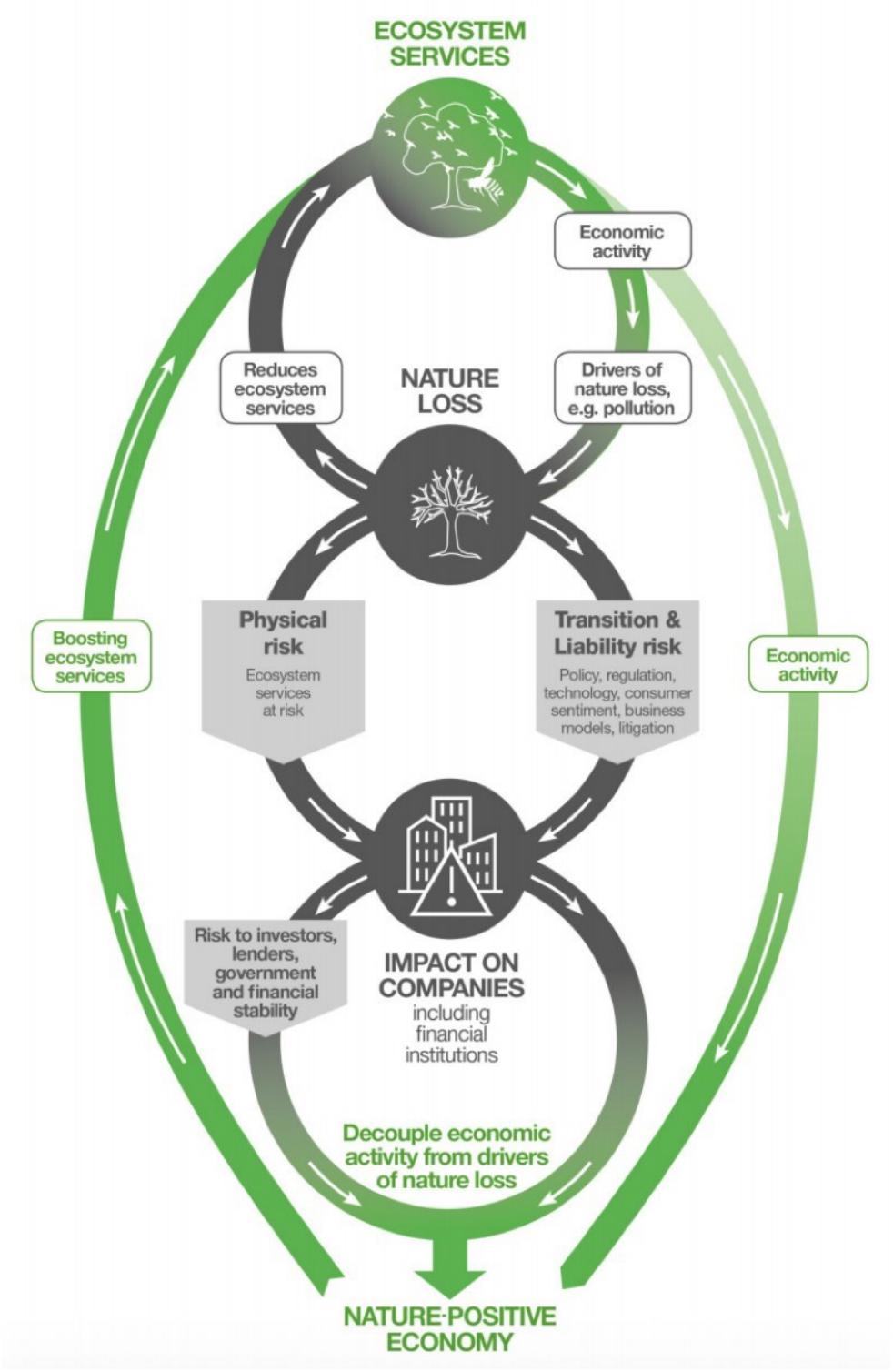
Nature-related financial risk comes from two main categories of hazards: physical risk and transition and litigation risk (Figure 1). Physical risk concerns the material dependency of financial assets on natural assets and biodiversity through ecosystem services. Because financial institutions hold securities of companies that depend on ecosystem services, the disappearance or degradation of an ecosystem service can have repercussions for the economic sectors that depend on it and, through credit or the market, lead to losses for financial institutions. Transition and litigation risk could emerge when a business is misaligned or incompatible with environmental objectives. The more a company has a negative impact on nature, the more it will be affected by future biodiversity protection legislation. Consequently, if a financial institution holds securities of this company, it could suffer heavy losses if the company has difficulty complying with a new law.

To assess the solidity of a financial institution and the stability of the financial system in the face of nature-related risks, the first step is to measure physical risk. The physical risk can be determined based on the direct exposure to physical shocks, by assessing the dependencies of the economic activities financed by financial institutions on a range of ecosystem services.

Physical risks can be acute (e.g., a drought), or chronic (e.g., a decrease in soil fertility due to a decline of microorganisms in the soil) (Bastida et al., 2008). As noted by Esposito (2021), physical risks are related to resource scarcity and quality and tend to occur at a local level. However, through sectoral interlinkages, physical risks have the potential to spread across multiple economic sectors, and as the financial sector is exposed to these sectors by providing lending, physical risks pose a threat to financial stability.

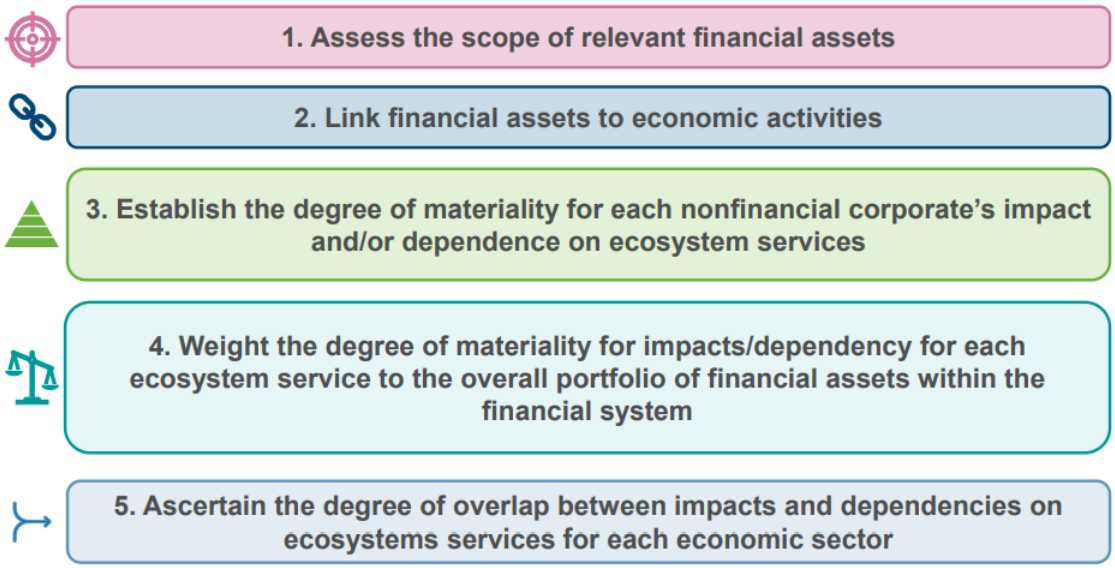
For the assessment of nature-related physical risks, we follow the methodological steps proposed by the OECD (2023) (Figure 2) and employ methodologies adapted from Svartzman and colleagues (2021), and Nikuradze and Tvalodze (2023). Both these papers use the ENCORE framework, with the main assumption being that the level of ecosystem service dependency of each financial institution can be approximated by examining all the companies (or sectors) the financial institution has on its balance sheet and calculating the combined dependencies of all these companies (or sectors) on ecosystem services.

Figure 1. Connections Between Economic Activity, Nature, and Financial Risk



Source: University of Cambridge Institute for Sustainability Leadership, Handbook for Nature-Related Financial Risks: Key Concepts and a Framework for Identification (March 2021)

Figure 2. Proposed Methodological Steps to Assess Impacts and Dependencies



Source: OECD, 2023, A supervisory framework for assessing nature-related financial risks: Identifying and navigating biodiversity risks, OECD Business and Finance Policy Papers.

ENCORE is an online tool designed to help institutions assess their exposure to nature-related risks. It offers the first step in understanding institutions' dependencies and impacts on nature. The ENCORE tool is maintained and continually improved by the ENCORE partnership. This database assesses the interdependence of 86 types of production processes with 21 ecosystem services, which are themselves related to 8 types of natural assets[2]. The ecosystem services are classified according to the Common International Classification of Ecosystem Services (CICES). ENCORE also has tools for assessing the impact of economic activities on nature. To compile this database, literature reviews were carried out for each category of ecosystem service and each combination of production processes, using the Web of Science, Google and bibliographic searches. Interviews with experts were also conducted to fill in gaps or validate information relating to certain dependencies.

To measure the level of direct dependency of each production process on ecosystem services, ENCORE assigns a dependency score ranging from Very Low to Very High. The rating depends on the degree of disruption to production if the ecosystem were to disappear and the expected ensuing financial losses that would result.

Notably, the ENCORE methodology assesses direct nature-related dependencies for various economic sectors. Thus, indirect dependencies that could stem from downstream supply are not captured. Moreover, the levels of dependency are not regionalized. It should also be noted that ENCORE only indicates potential dependencies and impacts. ENCORE's dependency rankings should therefore only be used for preliminary assessment purposes and cannot replace more detailed assessments that take into account the specific

[2] Further details on ENCORE mappings of economic activities and ecosystem services and natural assets are provided in the Appendix. More information about ENCORE and the ENCORE tool is also available at https://encore.naturalcapital.finance

circumstances and location of the business. In addition, ecosystem services cannot be separated from the natural assets on which they depend.

The Lithuanian banking sector's exposure to the economic sectors was determined for the commercial banks' lending to each economic sector according to the NACE classification. However, ENCORE uses the GICS classification. Therefore, to link bank lending data to the ENCORE framework, GICS business process were manually re-mapped to match the NACE nomenclature (the same approach was taken by Nikuradze and Tvalodze (2023)).

In assessing the dependency of the commercial banks on the ecosystem services, two assumptions were made. First, for each sector the banks lend to, all production processes are represented proportionally. Second, each production process depends proportionally on each ecosystem service defined by the ENCORE database.

Before computing the dependency of the financial institution on ecosystem services, we assess the ecosystem-dependency score of each activity sector the financial institution lends to. For this we use the simple mean of those production process scores

$$DS_s^e = \sum_{k=1}^{n} \frac{P_k^e}{n} \tag{1}$$

where DS_s^e is the direct dependency score of sector s on ecosystem service e; there are n production processes k in sector s; and P_k^e is the level of dependency of production process k to ecosystem service e.

One limitation of the methodology is the substitutability or complementarity of production process in each activity sector. The previous computation (Equation (1)) has an implicit assumption that production processes are more substitutable than complementary. Thus, the dependency scores are mitigated for the whole sector. For example, if a sector has two production processes, one of which has a low dependency score and the other a high dependency score, that sector is given a medium dependency score.

To compute a dependency score for each bank (or for the entire banking sector, in which case there is no subscript b denoting each bank) on each ecosystem service, we calculate a weighted mean as follows:

$$DS_b^e = \sum_s^n DS_s^e \times \frac{loan\ amount_b^s}{Total\ loan\ amount_b} \tag{2}$$

where DS_b^e is the dependency score of bank b on ecosystem service e; and $DS_s^e$is the dependency score of sector s on ecosystem service e. This method gives us a dependency score by ecosystem service for each bank (or for the entire banking sector).

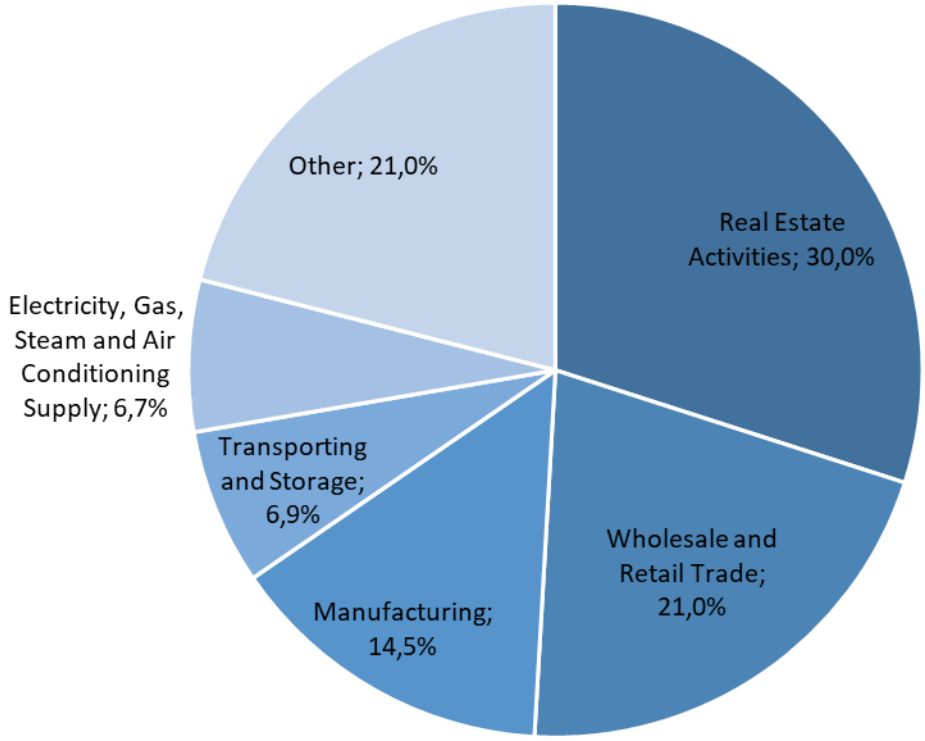
We also aggregate business lending according to the borrower's degree of dependence on ecosystem services as an alternative. For this paper, we focus only on "very high", "high", and "medium" dependencies defined by the ENCORE methodology ("medium" and "high" dependencies analysis is presented in the Appendix). In this way, we obtain the share of bank's loans that are exposed to ecosystem services at different levels of ecosystem dependence.

3. ASSESSING THE LITHUANIAN BANKING SYSTEM'S DEPENDENCE ON NATURE

Lithuanian banks' commercial loan portfolio information (loan amount outstanding as of April 1, 2023, per NACE economic sector per bank) was collected using the supervisory financial reporting (FINREP) framework. At the end of the first quarter of 2023, there were €932 million in business loans outstanding, distributed over eleven banks. As illustrated in Figure 3, business lending is concentrated in five economic sectors in Lithuania, with Real Estate Activities accounting for almost one-third (30%) of outstanding commercial loans, followed by Wholesale and Retail Trade (21%), and Manufacturing (14,5%).

While the sectoral shares vary across banks, overall, two-thirds of any Lithuanian bank's corporate loan portfolio is allocated to the sectors of Real Estate Activities, Wholesale and Retail Trade, Manufacturing, Transporting and Storage, and Electricity, Gas, Steam and Air Conditioning Supply.

Figure 3. Sectoral Composition of Bank Commercial Lending in Lithuania

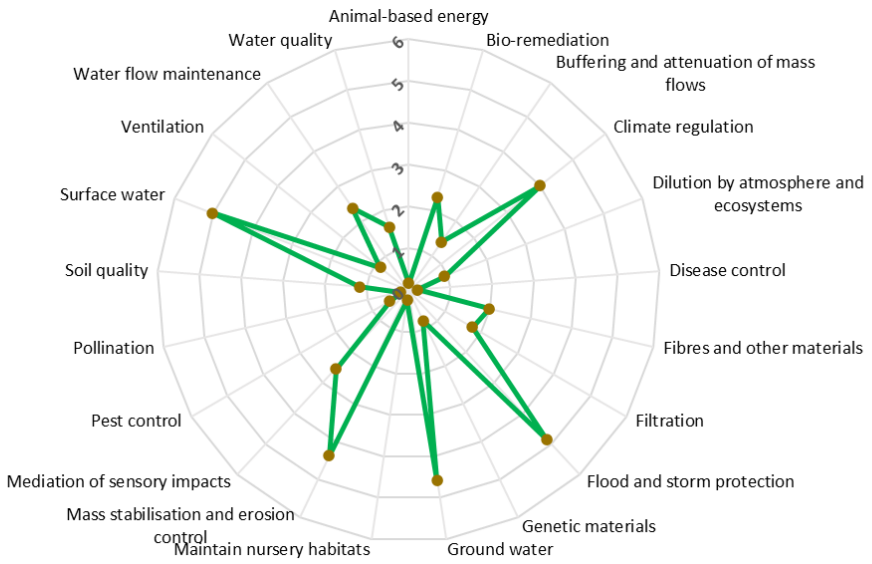


Source: Bank of Lithuania FINREP data.

Notes: Aggregate commercial loan portfolio composition as of April 1, 2023

Unsurprisingly, we find Lithuania's banking system to be most dependent on the same ecosystem services upon which the above-mentioned five economic sectors are listed as highly dependent in the ENCORE database (see Table A.2 in the Appendix). Namely, Lithuania's banking system highly depends on surface and ground water, flood and storm protection, mass stabilisation and erosion, and climate regulation (Figure 4).

Figure 4. Assessment of Ecosystem Service Dependence of Banks' Corporate Loan Portfolio

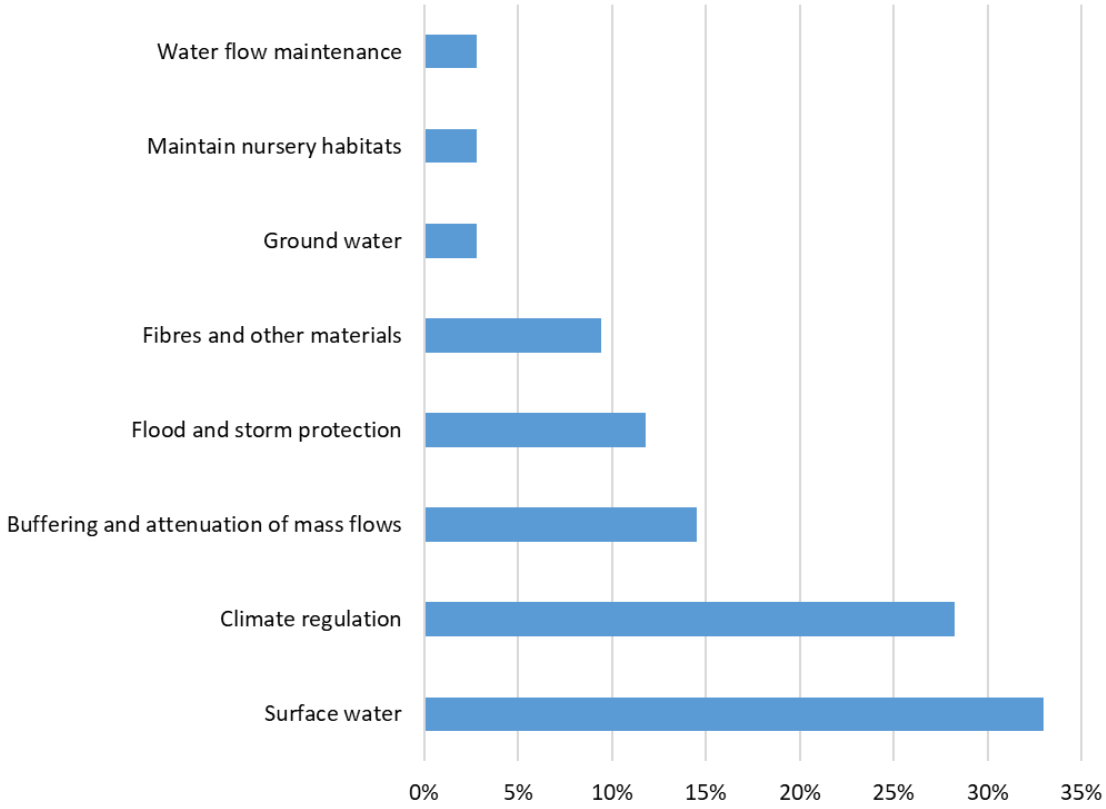


Sources: Bank of Lithuania and ENCORE data; own calculations.

Note: Dependence is measured in levels 1 to 10, where 10 would be an assigned dependence level of a firm whose business is solely extraction and sale of ground water to a ground water ecosystem service. Aggregated commercial loan information to the banking sector level is used.

These dependencies provide an overall picture of the exposures of the business loan portfolio to ecosystem services. To further assess the importance of these dependencies, we calculate shares of loan portfolio at different levels of dependency on each ecosystem service. We find that, for example, more than 30% of business loans have a very high dependency (dependency score at least 0.8) on surface water. Furthermore, almost 30% of business loans are very highly dependent on the climate regulation service. (See Figure 5 for very high dependency and Appendix Figures A.1 and A.2 for shares of loans at high and medium dependency scores to each ecosystem service.)

Figure 5. Share of Bank Loans with a very high Dependency Score to an Ecosystem Service



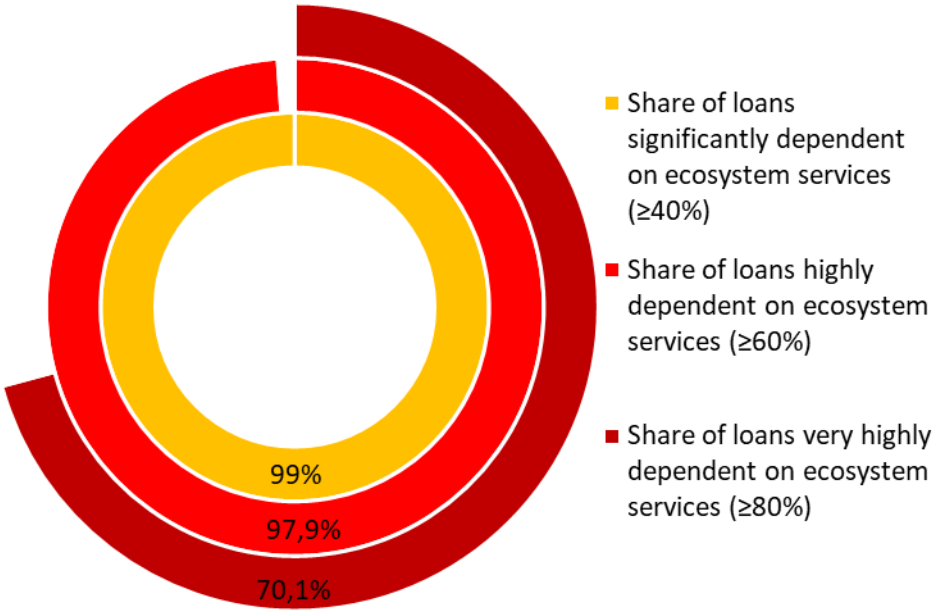
Sources: Bank of Lithuania and ENCORE data; own calculations.

Note: Share of loans with a very high dependency score (at least 0.8/ 80% dependency) for a given ecosystem service. Only those ecosystem services with share of loans higher than 1% at the given dependency score level are shown. A loan is labelled as highly dependent when the borrowing company has a sufficiently high direct dependency score. Aggregated commercial loan information to the banking sector level is used.

When assessed at bank level, there is a huge heterogeneity in terms of what share of a bank's loans are at a very high dependency level for a given ecosystem service. For example, more than 70% of one bank's loan portfolio has a very high dependence on surface water. At the same time, at another bank, less than 2% of its corporate lending is considered to be very highly dependent on surface water under our methodology. Interestingly, the list of ecosystem services on which borrowing companies are scarcely dependent at all - a negligible share of banks' loan portfolios is assessed to be very highly dependent - remains constant throughout the entire sample of Lithuanian banks, indicating that a list of relevant ecosystem services is location-specific (for risk assessment).

Figure 6 illustrates the banking system's dependency on nature on an aggregate level. As of April 2023, 70,1% of Lithuanian bank loans have been issued to firms with a very high dependency (dependency score at least 0.8/80% dependency). The share of loans dependent on nature rapidly increases to include almost the entirety of the banks' lending portfolio when the dependency threshold is lowered to high dependency (dependency score of at least 0.6/60% dependency). This implies that an accurate assessment of risks in the Lithuanian banks' loan portfolio is only possible if the risks arising from such significant portfolio dependence on nature are explicitly accounted for.

Figure 6. Exposure of Lithuania's Banks' Loan Portfolios to Ecosystem Services



Sources: Bank of Lithuania and ENCORE data; own calculations.
Note: Share of loans at selected dependency score for at least one ecosystem service. A loan is labelled as highly dependent when the borrowing company has a sufficiently high direct dependency score to at least one ecosystem service. Aggregated commercial loan information to the banking sector level is used.

Recently, ECB reported similar results in terms of bank corporate lending portfolio dependencies on nature for euro area countries[3]. Using AnaCredit data from December 2021 and the ENCORE framework, ECB reports that almost 75% of bank loans to companies in the euro area are granted to companies with a high dependency (dependency score of at least 0.7/70% dependency) on at least one ecosystem service, with only moderate differences between countries. For Lithuania, ECB reports that as of the end of 2021, the share of bank loans to companies with a high direct dependency on nature stood at just over 70%. Given our findings for a more recent period and a representative sample (AnaCredit covers only a very small fraction of Lithuania's corporate lending), it seems that the bank lending portfolio dependence on nature does not vary significantly over time. This does not in any way indicate that nature-related risks inherent in corporate lending portfolio remain constant. To evaluate the magnitude of these risks at a given point in time, however, we need to map dependencies on each ecosystem service to an associated risk arising from a disruption in the provision of this ecosystem service. This risk assessment is performed in the following chapter.

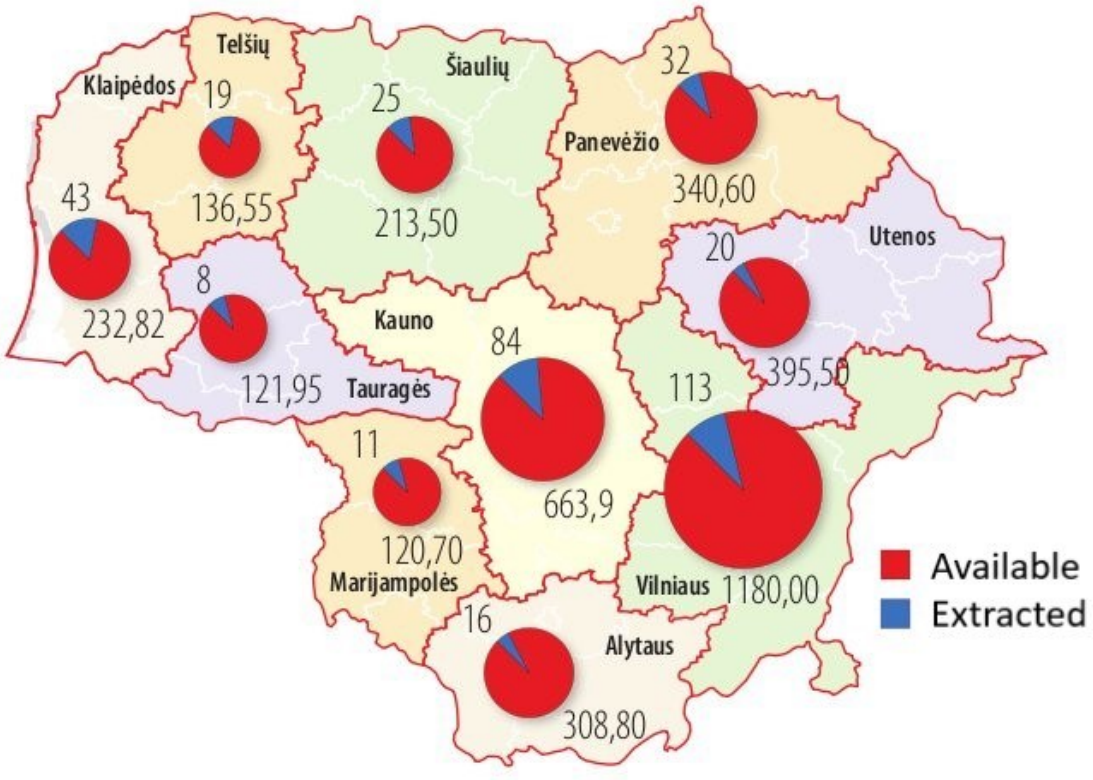
[3] The ECB Blog by Frank Elderson "The economy and banks need nature to survive", June 8, 2023
https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230608~5cffb7c349.en.html

4. ASSESSING NATURE-RELATED FINANCIAL RISKS IN LITHUANIA

When it comes to risks arising from dependencies on ecosystem services, it is important to remember that dependency cannot be equated with risk[4].The risk of losing certain ecosystem services is not uniform across the globe. Furthermore, the loss of different ecosystem services may not be homogeneous in their impacts. Therefore, to accurately assess the magnitude of financial risks associated with the dependencies on ecosystem services we document for the Lithuanian banks' corporate loan portfolios, it is necessary to take into account the geographical specificity of Lithuania.

Lithuania is one of the few countries in the world with abundant fresh ground water resources (Figure 7). Water stress is very low in Lithuania compared to other OECD countries and water is not considered a natural resource at risk. After conducting an assessment of underground water resources, the Lithuanian Hydrometeorological Service states that 3.72 million cubic meters of water can be taken safely every day in Lithuania, while currently only around 12 percent of this quantity is extracted and used.[5] Therefore, Lithuania has more fresh water than it really needs. Unlike many other countries, which are forced to use surface water even for domestic consumption, in Lithuania underground water is used for technical purposes as well. It is precisely such extremely abundant fresh ground water resources that allow the dependence on the ecosystem services of ground water and surface water to be considered as low risk in Lithuania compared to the corresponding dependence in southern European countries, for example.

Figure 7. Fresh Ground Water Availability in Lithuania



Source: Lithuanian Hydrometeorological Service

[4] This assumption that dependency equals risk has been made in all studies on nature-related financial risks to date that the authors are aware of.

[5] http://www.meteo.lt/en/web/guest/hydro-information

The same is true with climate change and dependence on the climate regulation services provided by nature. According to the assessment of the European Systemic Risk Board and the ECB[6], the level of physical climate change risk attributed to Lithuania is one of the lowest in the EU countries. Lithuania is located in the mid-latitude zone, where there is a high natural potential for adaptation to climate change; thus, the risks posed by the dependence on ecosystem services associated with climate regulation and prevention of storms and floods are relatively lower than in other countries located in different climatic zones.

As discussed in Section 2, Lithuania's banking system highly depends on surface and ground water, flood and storm protection, mass stabilisation and erosion, and climate regulation. The risks to bank loan portfolios of depleting these ecosystem resources are relatively lower in Lithuania than in many other countries. This, however, by no means implies that no policy actions are warranted to protect ecosystem services provision in Lithuania.

Nature is rapidly changing, and if we do not take appropriate measures to preserve the diversity of nature and restore depleted or destroyed ecosystems, we may lose the vital services provided by nature, which form the basis of the economy of Lithuania and the whole world. Even though the nature-related financial risks are relatively lower in Lithuania than in many other countries, it is still necessary to continuously monitor and re-evaluate these risks.

[6] https://www.esrb.europa.eu/pub/pdf/reports/esrb.climateriskfinancialstability202107~79c10eba1a.en.pdf

5. CONCLUSION

This paper provides the first-ever assessment of nature-related financial risks for the Lithuanian financial sector. We investigate banks' lending exposure to physical nature-related risks by examining the economic sectors to which banks lend and assessing those sectors' dependence on ecosystem services, as well as analysing the risks of a disruption in provision of said services, taking into account the geographic specificity of Lithuania.

Based on ENCORE methodology, Lithuanian banks are found to be dependent on a range of ecosystem services and are therefore exposed to physical nature-related risks. A total of 70,1% of bank lending was found to be exposed to economic activities that are very highly dependent on at least one ecosystem service as of April 1, 2023. Physical nature-related financial risks to the Lithuanian banking sector stem from deterioration in provision of surface water, ground water, flood and storm protection, mass stabilization and erosion control, and climate regulation. Of these, more than 30% of all bank loans in Lithuania are issued to sectors with a very high dependence on surface water.

This study relies on ENCORE methodology for mapping economic sectors to ecosystem services. As this methodology is broad (i.e., it does not provide either a geographic region- or a firm-specific dependency assessment for an ecosystem service), more precise results require further analysis and more detailed data. Nonetheless, the results of this study have important implications for policymakers. First, they provide a better understanding of the sources of physical nature-related financial risks for the Lithuanian banking sector. These initial insights form the foundation for developing nature-related risk scenarios and stress-testing Lithuanian banks for ecosystem services disruptions. Second, the case study of Lithuania illustrates that the impacts from the loss of ecosystem services are not uniform across geographic regions, and that the assumption that the level of dependence on ecosystem services can serve as an approximation of physical nature-related financial risks is inappropriate for certain geographies.

Overall, this paper demonstrates that the evaluation of climate-related financial risks is incomplete without the assessment of nature-related financial risks, and that the comprehensive assessment of nature-related financial risks requires granular data and location-specific dependency-risk mapping matrices.

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APPENDIX

Table A.1: List of Ecosystem Services in the ENCORE Framework

Ecosystem Service	Description of the Ecosystem Service
Animal-based energy	Physical labour is provided by domesticated or commercial species, including oxen, horses, donkeys, goats and elephants. These can be grouped as draught animals, pack animals and mounts.
Bio-remediation	Bio-remediation is a natural process whereby living organisms such as micro-organisms, plants, algae, and some animals degrade, reduce, and/or detoxify contaminants.
Buffering and attenuation of mass flows	Buffering and attenuation of mass flows allows the transport and storage of sediment by rivers, lakes and seas.
Climate regulation	Global climate regulation is provided by nature through the long-term storage of carbon dioxide in soils, vegetable biomass, and the oceans. At a regional level, the climate is regulated by ocean currents and winds while at local and micro-levels, vegetation can modify temperatures, humidity, and wind speeds.
Dilution by atmosphere and ecosystems	Water, both fresh and saline, and the atmosphere can dilute the gases, fluids and solid waste produced by human activity.
Disease control	Ecosystems play important roles in regulation of diseases for human populations as well as for wild and domesticated flora and fauna.
Fibres and other materials	Fibres and other materials from plants, algae and animals are directly used or processed for a variety of purposes. This includes wood, timber, and fibres which are not further processed, as well as material for production, such as cellulose, cotton, and dyes, and plant, animal and algal material for fodder and fertiliser use.
Filtration	Filtering, sequestering, storing, and accumulating pollutants is carried out by a range of organisms including, algae, animals, microorganisms and vascular and non-vascular plants.
Flood and storm protection	Flood and storm protection is provided by the sheltering, buffering and attenuating effects of natural and planted vegetation.
Genetic materials	Genetic material is understood to be deoxyribonucleic acid (DNA) and all biota including plants, animals and algae.
Ground water	Ground water is water stored underground in aquifers made of permeable rocks, soil and sand. The water that contributes to ground water sources originates from rainfall, snow melts and water flow from natural freshwater resources.
Maintain nursery habitats	Nurseries are habitats that make a significantly high contribution to the reproduction of individuals from a particular species, where juveniles occur at higher densities, avoid predation more successfully, or grow faster than in other habitats.

Mass stabilisation and erosion control	Mass stabilisation and erosion control are delivered through vegetation cover protecting and stabilising terrestrial, coastal and marine ecosystems, coastal wetlands and dunes. Vegetation on slopes also prevents avalanches and landslides, and mangroves, sea grass and macroalgae provide erosion protection of coasts and sediments.
Mediation of sensory impacts	Vegetation is the main (natural) barrier used to reduce noise and light pollution, limiting the impact they can have on human health and the environment.
Pest control	Pest control and invasive alien species management is provided through direct introduction and maintenance of populations of the predators of the pest or the invasive species, landscaping areas to encourage habitats for pest reduction, and the manufacture of a family of natural biocides based on natural toxins to pests.
Pollination	Pollination services are provided by three main mechanisms: animals, water and wind. The majority of plants depend to some extent on animals that act as vectors, or pollinators, to perform the transfer of pollen.
Soil quality	Soil quality is provided through weathering processes, which maintain bio-geochemical conditions of soils including fertility and soil structure, and decomposition and fixing processes, which enable nitrogen fixing, nitrification and mineralisation of dead organic material.
Surface water	Surface water is provided through freshwater resources from collected precipitation and water flow from natural sources.
Ventilation	Ventilation provided by natural or planted vegetation is vital for good indoor air quality and without it there are long term health implications for building occupants due to the build-up of volatile organic compounds (VOCs), airborne bacteria and moulds.
Water flow maintenance	The hydrological cycle, also called the water cycle or hydrologic cycle, is the system that enables circulation of water through the Earth's atmosphere, land, and oceans. The hydrological cycle is responsible for recharge of ground water sources (i.e., aquifers) and maintenance of surface water flows.
Water quality	Water quality is provided by maintaining the chemical condition of freshwaters, including rivers, streams, lakes, and ground water sources, and salt waters to ensure favourable living conditions for biota.

Table A.2: Economic Sector Dependency Scores on Ecosystem Services

Sector	Ecosystem Service	Dependency
Accommodation and Food Service Activities	Climate regulation	High
Accommodation and Food Service Activities	Fibres and other materials	High
Accommodation and Food Service Activities	Flood and storm protection	High
Accommodation and Food Service Activities	Ground water	High
Accommodation and Food Service Activities	Mass stabilisation and erosion control	Medium
Accommodation and Food Service Activities	Surface water	High
Accommodation and Food Service Activities	Ventilation	Low
Accommodation and Food Service Activities	Water quality	Medium
Administrative and Support Service Activities	Bio-remediation	Low
Administrative and Support Service Activities	Climate regulation	High
Administrative and Support Service Activities	Filtration	Medium
Administrative and Support Service Activities	Flood and storm protection	Very High
Administrative and Support Service Activities	Mass stabilisation and erosion control	Medium
Administrative and Support Service Activities	Mediation of sensory impacts	Low
Administrative and Support Service Activities	Pest control	Low
Administrative and Support Service Activities	Soil quality	Low
Administrative and Support Service Activities	Ventilation	Low
Administrative and Support Service Activities	Water flow maintenance	High

Agriculture, Forestry and Fishing	Animal-based energy	High
Agriculture, Forestry and Fishing	Bio-remediation	High
Agriculture, Forestry and Fishing	Buffering and attenuation of mass flows	High
Agriculture, Forestry and Fishing	Climate regulation	Very High
Agriculture, Forestry and Fishing	Dilution by atmosphere and ecosystems	Medium
Agriculture, Forestry and Fishing	Disease control	High
Agriculture, Forestry and Fishing	Fibres and other materials	Very High
Agriculture, Forestry and Fishing	Filtration	Medium
Agriculture, Forestry and Fishing	Flood and storm protection	Very High
Agriculture, Forestry and Fishing	Genetic materials	Medium
Agriculture, Forestry and Fishing	Ground water	Very High
Agriculture, Forestry and Fishing	Maintain nursery habitats	Very High
Agriculture, Forestry and Fishing	Mass stabilisation and erosion control	High
Agriculture, Forestry and Fishing	Mediation of sensory impacts	Medium
Agriculture, Forestry and Fishing	Pest control	High
Agriculture, Forestry and Fishing	Pollination	High
Agriculture, Forestry and Fishing	Soil quality	High
Agriculture, Forestry and Fishing	Surface water	Very High
Agriculture, Forestry and Fishing	Ventilation	Low
Agriculture, Forestry and Fishing	Water flow maintenance	Very High
Agriculture, Forestry and Fishing	Water quality	High

Arts, Entertainment and Recreation	Flood and storm protection	High
Arts, Entertainment and Recreation	Ground water	High
Arts, Entertainment and Recreation	Mass stabilisation and erosion control	Medium
Arts, Entertainment and Recreation	Surface water	Very High
Arts, Entertainment and Recreation	Water quality	Medium
Construction	Bio-remediation	Medium
Construction	Climate regulation	Very High
Construction	Filtration	Medium
Construction	Flood and storm protection	Very High
Construction	Ground water	High
Construction	Mass stabilisation and erosion control	Medium
Construction	Mediation of sensory impacts	High
Construction	Pest control	Low
Construction	Soil quality	Medium
Construction	Surface water	High
Construction	Ventilation	Low
Construction	Water flow maintenance	High
Education	Mass stabilisation and erosion control	Medium
Electricity, Gas, Steam and Air Conditioning Supply	Bio-remediation	Low
Electricity, Gas, Steam and Air Conditioning Supply	Climate regulation	Medium

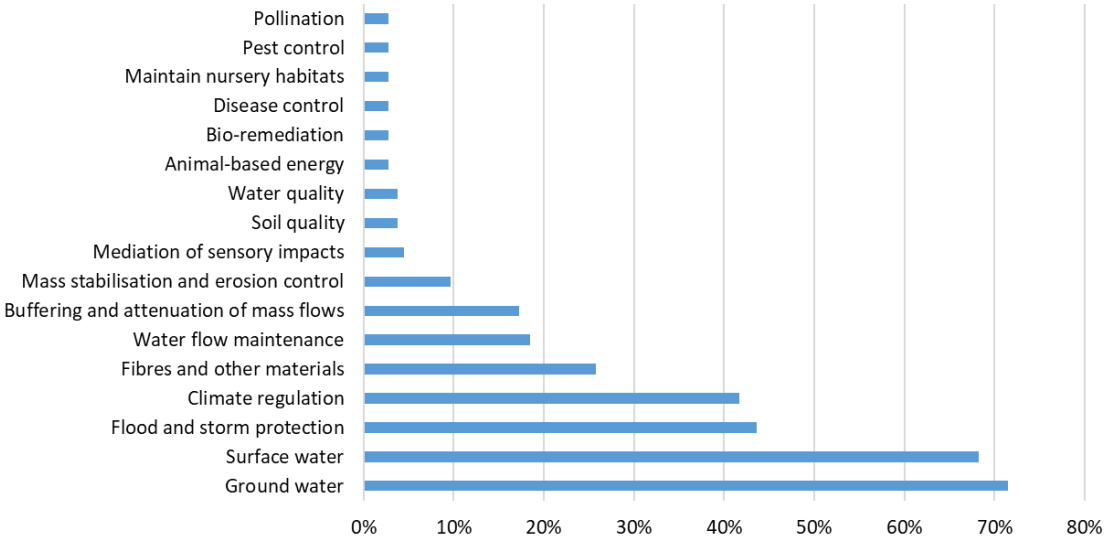
Electricity, Gas, Steam and Air Conditioning Supply	Dilution by atmosphere and ecosystems	Low
Electricity, Gas, Steam and Air Conditioning Supply	Fibres and other materials	Very High
Electricity, Gas, Steam and Air Conditioning Supply	Filtration	Low
Electricity, Gas, Steam and Air Conditioning Supply	Flood and storm protection	High
Electricity, Gas, Steam and Air Conditioning Supply	Ground water	High
Electricity, Gas, Steam and Air Conditioning Supply	Mass stabilisation and erosion control	Medium
Electricity, Gas, Steam and Air Conditioning Supply	Mediation of sensory impacts	Medium
Electricity, Gas, Steam and Air Conditioning Supply	Surface water	High
Electricity, Gas, Steam and Air Conditioning Supply	Ventilation	Low
Electricity, Gas, Steam and Air Conditioning Supply	Water flow maintenance	Medium
Electricity, Gas, Steam and Air Conditioning Supply	Water quality	Medium
Financial and Insurance Activities	Mass stabilisation and erosion control	Medium
Human Health and Social Work Activities	Climate regulation	Very High
Human Health and Social Work Activities	Dilution by atmosphere and ecosystems	Low
Human Health and Social Work Activities	Ground water	High
Human Health and Social Work Activities	Mass stabilisation and erosion control	Low
Human Health and Social Work Activities	Surface water	High
Information and Communication	Climate regulation	High
Information and Communication	Flood and storm protection	Very High
Information and Communication	Mass stabilisation and erosion control	Medium

Manufacturing	Bio-remediation	Low
Manufacturing	Buffering and attenuation of mass flows	Very High
Manufacturing	Climate regulation	Low
Manufacturing	Dilution by atmosphere and ecosystems	Low
Manufacturing	Fibres and other materials	High
Manufacturing	Filtration	Low
Manufacturing	Flood and storm protection	High
Manufacturing	Genetic materials	Medium
Manufacturing	Ground water	High
Manufacturing	Mass stabilisation and erosion control	Low
Manufacturing	Mediation of sensory impacts	Medium
Manufacturing	Soil quality	Medium
Manufacturing	Surface water	High
Manufacturing	Ventilation	Low
Manufacturing	Water flow maintenance	Medium
Manufacturing	Water quality	Medium
Mining and Quarrying	Bio-remediation	Low
Mining and Quarrying	Climate regulation	High
Mining and Quarrying	Filtration	Low
Mining and Quarrying	Flood and storm protection	Low
Mining and Quarrying	Ground water	High

Mining and Quarrying	Mass stabilisation and erosion control	Medium
Mining and Quarrying	Surface water	High
Mining and Quarrying	Water flow maintenance	High
Professional, Scientific and Technical Activities	Ground water	High
Professional, Scientific and Technical Activities	Mass stabilisation and erosion control	Medium
Real Estate Activities	Bio-remediation	Medium
Real Estate Activities	Filtration	Low
Real Estate Activities	Flood and storm protection	Low
Real Estate Activities	Ground water	high
Real Estate Activities	Mass stabilisation and erosion control	Medium
Real Estate Activities	Mediation of sensory impacts	Medium
Real Estate Activities	Surface water	Very High
Transporting and Storage	Climate regulation	High
Transporting and Storage	Flood and storm protection	High
Transporting and Storage	Ground water	High
Transporting and Storage	Mass stabilisation and erosion control	High
Transporting and Storage	Pest control	Low
Transporting and Storage	Surface water	High
Transporting and Storage	Ventilation	Low
Transporting and Storage	Water flow maintenance	High
Transporting and Storage	Water quality	Medium

Water Supply, Sewerage, Waste Management and Remediation Activities	Bio-remediation	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Buffering and attenuation of mass flows	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Climate regulation	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Dilution by atmosphere and ecosystems	Low
Water Supply, Sewerage, Waste Management and Remediation Activities	Filtration	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Flood and storm protection	High
Water Supply, Sewerage, Waste Management and Remediation Activities	Ground water	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Mass stabilisation and erosion control	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Mediation of sensory impacts	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Pest control	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Soil quality	High
Water Supply, Sewerage, Waste Management and Remediation Activities	Surface water	Medium
Water Supply, Sewerage, Waste Management and Remediation Activities	Ventilation	Low
Water Supply, Sewerage, Waste Management and Remediation Activities	Water flow maintenance	High
Water Supply, Sewerage, Waste Management and Remediation Activities	Water quality	High
Wholesale and Retail Trade	Climate regulation	Very High
Wholesale and Retail Trade	Flood and storm protection	High
Wholesale and Retail Trade	Mass stabilisation and erosion control	Medium

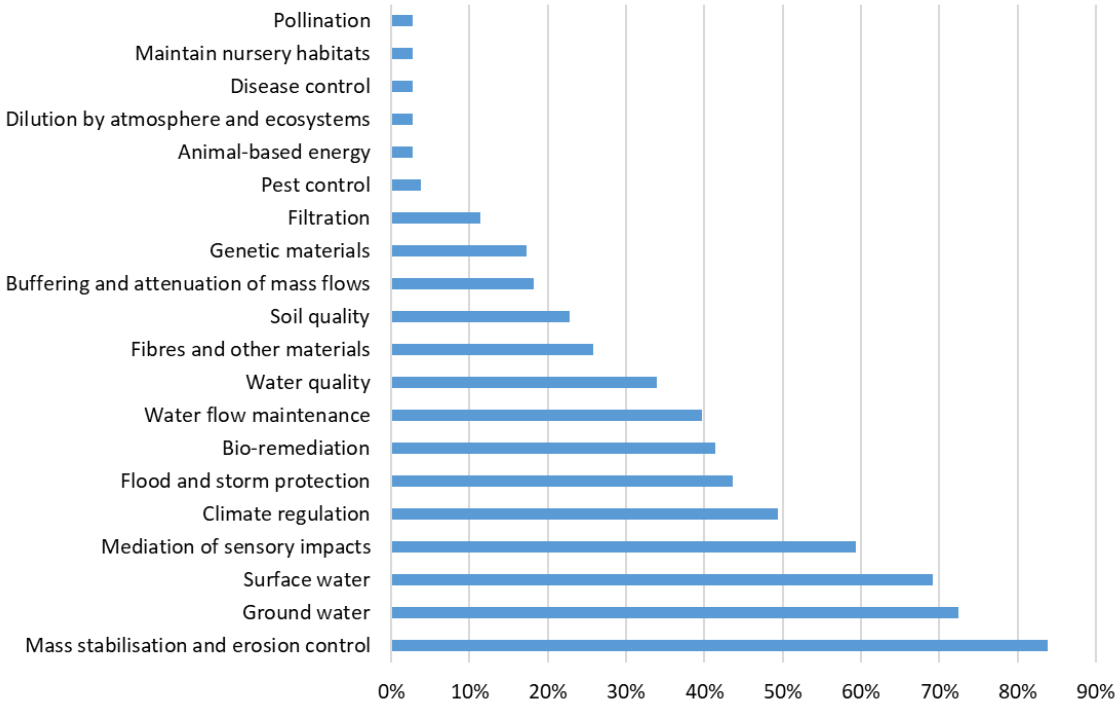
Figure A.1. Share of Bank Loans with a High Dependency Score to an Ecosystem Service



Sources: Bank of Lithuania and ENCORE data; own calculations.

Note: Share of loans with a high dependency score (at least 0.6/ 60% dependency) for a given ecosystem service. Only those ecosystem services with share of loans higher than 1% at the given dependency score level are shown. A loan is labelled as highly dependent when the borrowing company has a sufficiently high direct dependency score. Aggregated commercial loan information to the banking sector level is used.

Figure A.2. Share of Bank Loans with a Medium Dependency Score to an Ecosystem Service



Sources: Bank of Lithuania and ENCORE data; own calculations.

Note: Share of loans with a medium dependency score (at least 0.4/ 40% dependency) for a given ecosystem service. Only those ecosystem services with share of loans higher than 1% at the given dependency score level are shown. A loan is labelled as highly dependent when the borrowing company has a sufficiently high direct dependency score. Aggregated commercial loan information to the banking sector level is used.